

MuseumsForward

Beyond rigid standards: exploring flexibility in collections environments through a sustainability lens

Madeline Blair Miner

Abstract

This study investigates the challenges and hesitation among West Coast museum professionals to implement expanded climate set points in collection spaces and through loan agreements, despite the decreased energy consumption benefits and financial gain. Through interviews conducted with eleven institutions, a better understanding of how museums set their climate standards and the hesitations or challenges they face when attempting to implement more sustainable practices was investigated. Overall, the findings concluded that limited upper-level support and financial resources pose difficulties for many institutions in considering implementing more eco-friendly practices in their everyday work.

Keywords

Collections Management, Sustainability, Artifact Loans, Environmental Ranges, Preventive Conservation

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Introduction

The climate crisis is one that can no longer be ignored or denied. As temperatures become more extreme, natural disasters more common, and nonrenewable resources more scarce, we must take action to build a more eco-friendly and sustainable future. The cultural heritage field is not exempt from climate change considerations, as there are many industry practices that contribute. Institutions develop state-of-the-art buildings to house their growing collections, perfectly climate-control their display and storage spaces, and transport and loan objects internationally. These practices are unsustainable since they require increased operating costs and fail to incorporate the local environment and individual needs of the objects in the collection.

Current museum collection practice relies on an industry standard of 50% +/- 5% relative humidity and 68-70° F +/-2° F control on storage and exhibit spaces (Atkinson, 2014; Bickerseth, 2014). These tight ranges came into practice after professionals began to observe damage to materials in their collection spaces (Van Duin, 2014). Temperature and relative humidity, two of the ten agents of deterioration, play a role in objects' mechanical and chemical deterioration (Groupe Bizot Group, 2023a). Without control of these factors, many materials will deteriorate over time, rapidly and irreversibly. Due to these agents and their inherent risk to collections, the industry began standardizing its approach with environmental ranges they deemed safe in the mid to late 1900s. These ranges are now often required for insurance purposes and loan agreements (Ahern, 2024a) and the parameters serve as industry indicators for museums. The establishment of parameters suggest that museums who cannot meet these standards should not be requesting loans. Instead, they should be focused on maintaining their own collections (Bickerseth, 2014). The requirement of safe ranges for loans results in large capital investments in mechanical systems and increased operating costs (Boersma et al., 2018)

Although there is no denial that carefully manipulating areas housing many precious, irreplaceable, and one-of-a-kind objects can benefit the long-term preservation of collections, the practice of carefully controlling the interior environment against the outside world and using a one-size-fits-all approach is unsustainable, expensive, and hard to maintain in the long run (Ahern, 2024a; Atkinson, 2014; Boersma et al., 2014; Boersma et al., 2018). Using strict parameters means that mechanical systems must constantly adjust and react to environmental fluctuations (Ahern, 2024b; Van Duin, 2014). As energy becomes increasingly expensive, the constant switching on and off of these systems ultimately results in increased operating costs (Boersma et al.,

2014; De Silva & Henderson, 2011). The reliance on these mechanical systems and their massive energy consumption often requires non-renewable resources, such as fossil fuels, that continue to increase carbon footprints.

To better understand how temperature, relative humidity, and the fluctuation of these factors impact museum collections, extensive research is being conducted in the conservation field regarding these subjects. This research has sparked an ongoing debate among professionals working closely with cultural heritage objects that the acceptable environments for these collections could be much more relaxed than originally suggested (Atkinson, 2014; Groupe Bizot Group, 2023a). New proposals push museums to expand their environmental ranges to better encompass the individual needs of the collection, local environment, building envelope, and mechanical system capacity (Atkinson, 2014; Groupe Bizot Group, 2023b; Bickerseth, 2014). More recent recommendations suggest that museums find a range somewhere within 40-60% relative humidity and 60-77° F with no more than a 10% fluctuation in 24 hours (Atkinson, 2014; Groupe Bizot Group, 2023b) These practices are believed to significantly reduce museum energy consumption, benefiting the institution financially and leading to more sustainable practice, while still properly stewarding collections and sustaining it's preservation (Atkinson, 2014). One study suggested that slightly expanding environmental set points can result in a 55% reduction in energy costs (Framer et al., 2015). At the same time, other studies have suggested that slightly expanded ranges have resulted in no observable damage.

Background

Controlling collection environments originated near the end of WWII, not out of curiosity, but observation (Ahern, 2024b). During the war, many prominent museums moved their collections to underground shelters to protect them from the threat of air raids. Collection professionals discovered that works of art in underground bunkers did not experience the levels of deterioration that works held in the museums experienced. This led to the discovery that controlled, and more stable climates minimize the risk of damage to the objects.

After the war, mechanical systems became much more advanced with the introduction of air conditioning in rooms becoming common during the 1950s (Atkinson, 2014). These new technologies continued to advance the industry's knowledge of preventative conservation. In 1978, Garry Thomas published a book titled *The Museum Environment*,

which introduced the industry standard the field is familiar with today (Atkinson, 2014; Bickerseth, 2014). Using a limited study, Thomas introduced the 20/50 notion, which suggested that works of art survived well at 20° C and 50% relative humidity (Atkinson, 2014). The theory behind this idea was that for museums to exhibit materials with a range of needs, they must maintain an environment suitable for the most sensitive objects (Bickerseth, 2014). Although Thomas established the industry standard that we know today, it is important to note that Thomas did not attempt to create a standardized rule but instead provided a starting number (Bickerseth, 2014). Thomas suggested that local climate, human comfort, and the collection's individual needs should be considered (Bickerseth, 2014). Ultimately, Thomas predicted that a prescribed industry standard would eliminate the need to understand the object's history and further simplify the loaning process (Boersma et al., 2014; Taylor & Boersma, 2014). Despite Thomas's recommendations against setting an exact rule, museums began to adopt a more standardized approach due to fears that loaned objects would not be able to safely shift from one museum climate to another (Atkinson, 2014). The fear stemmed from the understanding that if the lending museum's environment drastically differed from the borrowing institution, the item would experience catastrophic shock when introduced to the new environment.

Today, loans and exhibitions are among the most unsustainable and expensive aspects of a museum's yearly budget (Filley et al., n.d). Additionally, there is an increased pressure felt by institutions to raise the number of exhibitions and loans to boost visitor attendance (Filley et al., n.d). Expenses range from loan crating and transportation costs, designing and fabricating the exhibition space, and maintaining strict relative humidity and temperature environmental parameters. As Bickerseth (2014) stated, one of the main points of irritation among museum professionals is that, oftentimes, loan climatology requirements are:

1. Not maintained by the lending institution
2. Have little flexibility, and
3. Rarely consider the individual object and its specific needs

Due to the expensive and wasteful nature of exhibits, loans, and collections practices generally, there has been a push within the past few decades to rethink how museums implement sustainable practices. Since the 1990s, conservators have become increasingly concerned

about the carbon footprint associated with HVAC systems (Ahern, 2024a). Some museum professionals abide by the “stable is safe” approach with the idea that tighter controls is a less risky means to collections management (Ahern, 2024b; Bickerseth, 2014) and find that the research is not comprehensive enough for justification to risk further deterioration (Atkinson, 2014; Groupe Bizot Group, 2023a; Staniforth, 2014). On the other hand, many professionals and scholars have conducted substantial research, suggesting that most museum objects can easily withstand much more without compromising safety (Bizot’s Refreshed Green Protocol, 2023; Group Bizot Group, 2023) One study found that 10% fluctuation within 24 hours resulted in a minimal risk of damage for most items (Bizot,2023a; Maekawa et al., 2015), some sturdier objects may even be safe within a 20% fluctuation (Ahern, 2024a; Maekawa et al., 2015).

Beginning in 2009, one of the major groups driving the mission to relax climatology standards is the Bizot Group, a large-scale exhibition group based in the UK. In 2014, the Bizot group (2023) released their Bizot Green Protocol, which suggests a range of 60-77° F and a 40-60% relative humidity range with less than a 10% shift in 24 hours (Atkinson, 2014; Groupe Bizot Group, 2023b). Although the Bizot group has offered a number range, similar to Thomas, they are not trying to replace one blanket range with another. Instead, they want museums to use it as a starting point while encompassing the museum's local climate and type of collection to make an informed decision about the best individual approach (Bizot’s Refreshed Protocol, 2023).

In the last two decades, associations such as the Getty, Image Permanence Institute, International Council of Museums, International Institute of Conservation, American Association of Museum Directors, and the American Institute of Conservation, National and other large governing institutions have released statements advocating for change in collections environments and adopting a customized approach to environmental conditions in storage and gallery spaces based on the individual needs of the collections and the local environment. (Ahern, 2024b; De Silva and Henderson, 2011; Fugett, 2024; Kozlowski, 2018). These recommendations are in response to emerging conservation research, the ongoing climate crisis, and the increasing operating costs faced by many institutions.

Research Gaps

Although there is a wealth of research and positive findings supporting expanding ranges, there is a hesitancy within institutions to adopt

these new recommendations. With the approval of many large guiding associations, it seems like more museums would begin implementing energy- and cost-efficient practices since it benefits the institution financially with minimal risk to collections, allowing the additional funding to be allocated to other important projects. Despite the vast number of scientific studies conducted to better understand how museum collections will react to these changes, there is little research to understand the hesitation among collection professionals to implement these practices, especially regarding artifact loans and exhibitions. Additionally, there does not appear to be any information regarding how the institution's size, classification, and/or staff structure might play into the willingness or reluctance to broaden the current industry ranges.

Purpose Statement

This study aims to understand the challenges and concerns among West Coast museum professionals regarding the relaxation of rigid environmental standards for storage areas, exhibit spaces, and artifact loan agreements despite the decreased energy consumption and financial benefits, minimal risk, and approval by larger guiding associations.

Research Questions

- I. Are museums discussing sustainability and energy consumption topics when looking at ways to improve their practices? If so, how?
- II. How do West Coast museums decide their collection and display climate controls? Do they use a standardized approach or an individual approach?
- III. Do artifact loans impact how museums set their environmental standards?
- IV. Do museums consider the local climate when determining temperature and humidity levels?
- V. Does the size, type, location, or staff structure change the approach to the collection environment and loaning practices?

Methodology

This study uses a phenomenological approach to interview museum professionals throughout the West Coast. Data was collected by conducting semi-structured interviews with museum professionals to better understand how museums approach their collections environments and lending agreements, as well as their thoughts concerning expanded environmental ranges.

Research Design

This study uses a phenomenological research design to gain a deeper understanding of museum professionals' authentic experiences and perspectives.

Participants

This research aimed to target 10-12 museum professionals to share their insight and experience regarding collections and loan sustainability. Participants were identified based on their familiarity with collection practices. These professions included registrars, collections managers, and conservators.

Data Collection:

The primary data collection method was in-person or virtual, hour-long, one-on-one interviews, except for one individual who provided written responses. The interviews were semi-structured, utilizing a set of pre-prepared questions. *See Appendix 1* for these questions, except for one, more experience-driven interview, *see Appendix 2*.

In total, 13 individuals were recruited to participate. These participants were recruited based on their profession, institution type, and location. Many of the participants were identified through personal connections or networking experiences. Additionally, some individuals were identified by contacting specific institutions of interest.

Twelve individuals, two from one institution, were interviewed. They work for various art, natural history, and anthropology museums across the West Coast. Additionally, one individual was recruited who is the primary conservator for a private preventative conservation consulting firm that works with various institutions around the West Coast, emphasizing sustainable preventative conservation.

Sites:

This study focused on investigating institutions along the West Coast, including the states of Alaska, Washington, Oregon, California, and Hawaii. It should also be noted that due to California's size compared to the other states, it was split into Northern and Southern California to get a broader sense of these issues in different general climate zones.

The West Coast was chosen to narrow down the data for this study into a general regional area. Institutions were selected based on size and classification to diversify the information gathered. The main institution classifications chosen were art and natural history museums to help generalize the specific dataset for comparison.

Data Analysis

Following each interview, responses were coded and entered into a spreadsheet. The main objective of these interviews was to understand trends regarding the subjects of interest. Although detailed accounts were necessary for data collection, many responses were narrowed down to identify specific trends in museums across the West Coast, particularly institutional locations, types, and sizes.

The data was then organized to see the trends between different classifications, sizes, and staffing structures (meaning whether or not the museum had a conservator on staff). To avoid singling museums out, museums identified as large or medium/large were combined into one group, larger institutions; those identified as medium and medium/small were then combined into a second group, smaller institutions. For the division of museum classification, institutions were divided into art or natural history/anthropology categories. Due to one museum identifying as general (encompassing a wide range of collection materials), it was combined with the art museum group for the purposes of this analysis.

The raw data and comparison data was entered into relevant tables and graphs to compare how the idea of sustainability is applied in the museum group.

Ethical Considerations

Since the study asks questions regarding specific institutions, collection environments, and loan agreements, most responses are protected to avoid specifically targeting any museum and to prevent any repercussions for being transparent about their institutions' practices.

The majority of the responses were analyzed by looking for specific trends, which were then put into graphs and charts to avoid direct connection to any specific institution. These methods ensured that participants had full autonomy over their responses and felt comfortable providing accurate and detailed responses to potentially controversial questions.

Furthermore, before each interview, participants were asked to fill out a brief questionnaire regarding what information they were comfortable having shared in the final paper. Due to these responses, a few institutions and individuals will remain anonymous. Additionally, participants were informed that they could skip any question they did not feel comfortable answering. As a result of this, some questions were left unanswered.

Limitations:

The most significant limitation faced in conducting this study was receiving timely responses from potential participants. Due to the regionality and industry classifications within the study, some states lacked a significant pool of potential institutions to participate. The goal of this research was to interview one art and one natural history/anthropology museum from each state. Furthermore, since artifact loaning is a large component of the research, the museums chosen had to have a current loaning policy and be familiar with the process. Smaller states such as Hawaii ultimately had a lower number of museums that could contribute to this research compared to larger states such as California.

One final limitation was the content of the questions and the participants' roles. Many participants were more familiar with one aspect of the study, such as collections care, but less involved with loan agreements. By interviewing only one position at each museum, some questions could not be answered to the participant's complete knowledge or lacked significant depth.

Results

Museum Demographics:

Out of the 12 institutions that participated in this study, the content included: Five art museums, five natural history/anthropology museums, and one general museum. The art museums interviewed included two large institutions, two medium/large, and one medium institution. The natural history/anthropology interviews included two large institutions, two medium-sized institutions, and one

small/medium-sized institution. The general museum identified as medium in size. There was an overall total of four large institutions, two medium/large, four medium, and one small/medium. *See Chart 1*

The professionals interviewed included five collection managers, four conservators, and two registrars, *See Chart 2*. Additionally, one interview was conducted with a private preventative conservation conservator. For purposes of later analysis, it should also be noted that six of the museums interviewed have an onsite conservator. *See Table 1*

Table 1

Museum Demographics

Museum	Classification	General Size	City, State	Position Interviewed	Conservator on Site?
Alutiiq Museum	Anthropology	Small/ Medium	Kodiak, AK	Collections Manager	No
Anchorage Museum	General	Medium	Anchorage, AK	Conservator	Yes
Burke Museum of Natural History and Cultural	Natural History/ Anthropology	Medium	Seattle, WA	Registrar	No
Seattle Art Museum	Art	Medium/ Large	Seattle, WA	Conservator	Yes
University of Oregon Museum of Natural and Cultural History	Natural History/ Anthropology	Medium	Eugene, OR	Collections Manager	No
Anonymous	Art	Medium/ Large	Oregon	Collections Manager	Yes
California Academy of Sciences	Natural History/ Anthropology	Large	San Francisco, CA	Collections Manager	No
San Francisco Museum of Fine Arts	Art	Large	San Francisco, CA	Conservator	Yes
Honolulu Art Museum	Art	Medium	Hawaii	Registrar	No
Natural History Museum of Los Angeles	Natural History/ Anthropology	Large	Los Angeles, CA	Collections Manager	Yes
Anonymous	Art	Large		Conservator	Yes

Chart 1

Museum Classification and Size

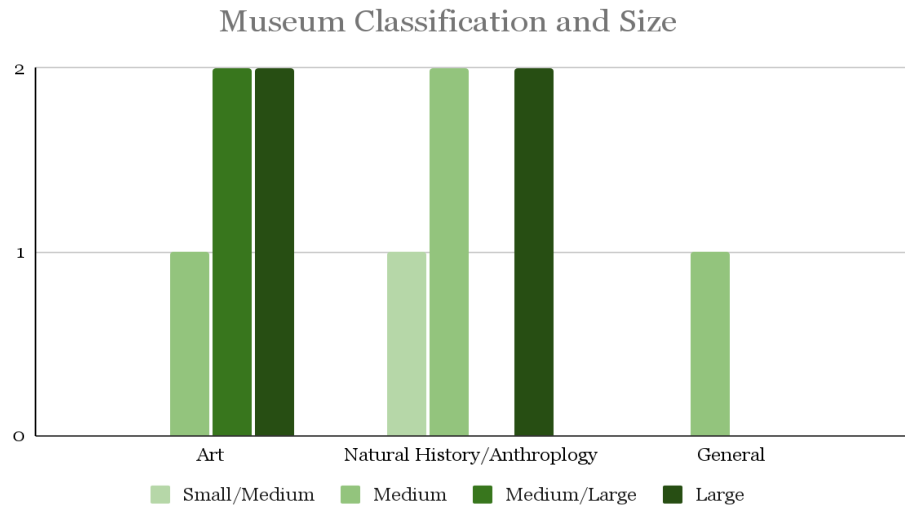
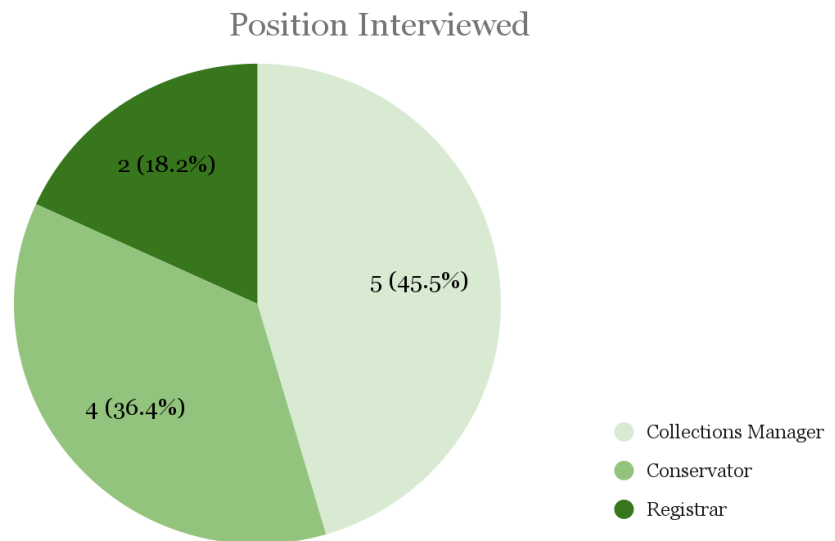


Chart 2

Position Interviewed



Institutions and Sustainability:

When asked about sustainability, almost every interviewee stated that sustainability was actively being practiced and discussed in their institution or had been in some capacity recently. In total, five museums were actively discussing sustainability, three had previously been in discussion, with the conversation on pause for other reasons or

priorities, and two museums stated that the conversation was not necessarily museum-wide but discussed by larger governing bodies such as the city, university, or individual staff members. Additionally, one museum stated that it was not necessarily a conversation within the museum, but staff were still conscious about their practices.

When asked who among the museum staff was having sustainability conversations, there was a wide range of responses. In total, higher-level and executive-level professionals were mentioned in three conversations, department directors in three conversations, “Green teams” in four conversations, Individual staff members in two conversations, and larger governing institutions in two responses.

There seemed to be some underlying trends for museums that were not actively discussing sustainable practice or had paused the conversation. The COVID-19 pandemic was brought up in three interviews, and subsequent staff turnover was discussed in two of those conversations. Below are responses involving these factors:

- Our museum has had conversations in the past, but those conversations were interrupted by the COVID-19 pandemic and staff turnover. We have had some conversations about overnight HVAC shutdowns and using a courier network, although the changes are not where I would like to see them. We previously had a dedicated green team, but it was led by individual staff members with little agency to make big changes.
- In the past, our museum actively engaged in sustainability conversations and had a dedicated green team. However, due to the Pandemic and staff turnover the conversation is more individual now. Our discussions are primarily focused on supply, use, and recyclability.
- Yes, this is a conversation we are having, although it is difficult to get things done with COVID-19 and other ongoing projects. Therefore, the conversation has been paused. The conversation has so far focused on the big picture instead of smaller steps.

Additionally, funding and a larger bureaucratic system were also mentioned in conversations. Direct responses included:

- Sustainability is not a front-runner in topics of conversation but is something the museum is conscious of. In collections, the conversation looks more at costs, as it is one of the most

expensive departments. We are usually looking at the cheapest, most efficient option.

- Our institution is controlled by a much larger institution that is actively discussing sustainability. The topic is not necessarily addressed within the museum or collections specifically. However, our building has previously been awarded a green award.

Below are other direct responses regarding the sustainability conversation within their museums:

- Sustainability, while implemented in many areas of the museum, still has a way to go. We have many ongoing initiatives that are working on improving the institution's overall goal.
- Sustainability is a part of our museum's mission and has been discussed for quite some time. Our museum has two dedicated staff members who focus on sustainability and track our energy use. Additionally, we recently replaced our HVAC system and utilize a free cooling system and LED lights. Facilities are our biggest consumer, but exhibits are also a significant component and expected to change quite frequently, which is unsustainable.
- At our institution, we actively discuss sustainability, usually on a higher level in terms of the building, which is Platinum LEED certified. In regard to loans, we are more concerned about artifact sustainability and ensuring the object's long-term preservation.
- Sustainability is not necessarily a larger conversation within our museum, but it is a part of our culture. Due to the museum's location, we must constantly be cautious of how we use materials and ensure we use them to the fullest extent. We must work with what we have available.
- Internally, our museum has been actively engaged in cross-departmental discussions on ways to reduce its carbon footprint.
- The museum is actively discussing sustainability, but more on an executive level. The conversation has primarily been focused on museum-wide initiatives like reducing Cafe and Printer waste, and excess library materials, as well as moving to online forms to minimize paperwork.

Expanded Ranges and Collections Environments:

When discussing the institution and its environmental standards, five institutions stated that they currently follow the industry standard of 70° +/- 5° F and 50% +/- 5% relative humidity. Two institutions said that ideally, they maintain these standards, but it is not always manageable. Two institutions said both yes and no to following industry standards, one stating that their temperature is often maintained. Still, humidity allows for a greater fluctuation, and the other museum stated that special exhibition galleries and storage spaces maintain the industry standards. Whereas permanent exhibit spaces follow the Bizot Group recommendations of 60-80° F and 40-60% RH with no more than 10% fluctuation in 24 hours. Lastly, two museums said they did not follow industry standards and had expanded temperature and relative humidity ranges. *See Chart 3.*

Although following industry standards leaned more toward the conservative side, five museums stated they had previously discussed broadening ranges when talking about the possibility of expanding current environmental set points. One museum said this was not a conversation within their institution, but they were aware of the concept, and two museums stated it had not been a discussion. Three museums had already expanded their ranges.

Below are a few direct responses regarding the discussions of expanding ranges within their museums:

- Expansion has not been discussed, it's important for our requirements to not start sliding as it can become a slippery slope. Our conservators and staff are aware of the building's challenges, though we still aim for the standards we set in the loan agreement.
- We have discussed changing the environment seasonally. Not meeting the standards does not necessarily have any repercussions for the institution besides the inevitable deterioration of the collection. Additionally, changing the standards likely will not result in a significant change in energy consumption.
- We have discussed modifying the ranges, but the building actually buffers the storage spaces quite well. At an additional location, we see more fluctuations, so there may need to be a larger conversation for that specific space.

When asked where museums got their current environmental standards, these were the most prevalent responses:

- American Alliance of Museums (x7)
- American Institute of Conservation (x3)
- The Bizot Group Green Protocol (x2)
- Personal research/professional advice (x3)
- Other well-established museums (x2)
- Previous education (x2)

Furthermore, four museums stated that accreditation was a factor, and two museums stated legal contracts for held-in-trust collections were also a consideration.

Investigating how borrowing from another institution impacted the museum's choice to maintain the current industry standard, four museums stated it was a consideration, three museums said it was a consideration, but not a driving factor, two institutions said no, and two institutions were unsure if this was a consideration or not. *See Chart 4.*

Below are direct responses regarding how borrowing from outside institutions influenced climatology standards within their museums:

- We have previously had issues loaning from another institution because we did not meet their specified standards. We ended up retrofitting a gallery space to accommodate the loan, which we continue to use today.
- We get a lot of traveling exhibits that require specific conditions for display that we must follow.
- We have designated galleries that fall within the industry standard to accommodate loaned objects. Larger institutions we borrow from often have stricter standards than smaller ones.
- Loaning is a byproduct of our institution. We have to maintain the industry standard for legal contracts for our held-in-trust collections.
- Maintaining the industry standard is not necessarily a factor for us since most lending institutions know the challenges of our location.

- The environment has not been an issue in the past, but we do borrow objects quite often and would like to continue, so it is a factor.
- We have had to make accommodations in the past for certain loans, but this is not necessarily a major concern for us.

Chart 3

Collection and Gallery Desired Environmental Ranges

Does Museum Maintain the Industry standard of 50% +/- 5% Relative Humidity and 70° +/- 5° F Temperature

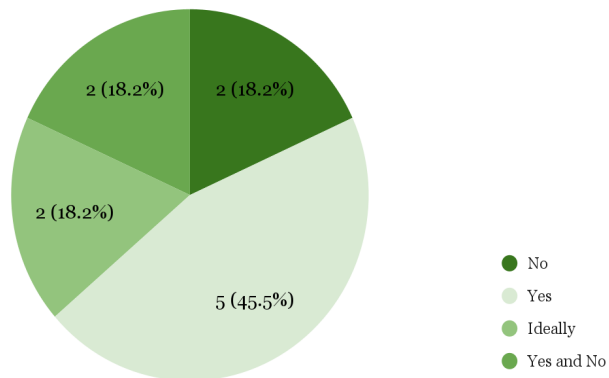
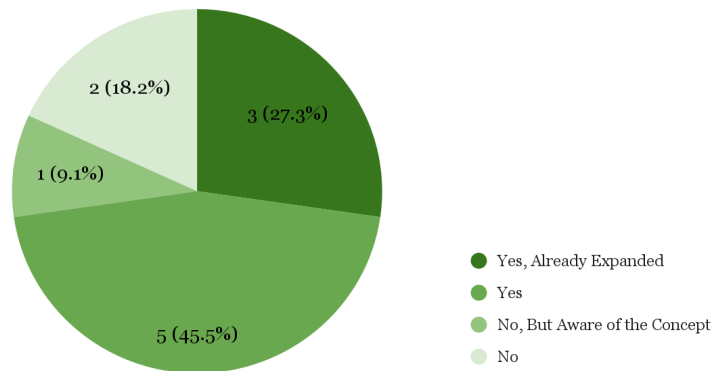


Chart 4

Discussion about expanding ranges

Has There Ever been a Discussion About Expanding the Current Environmental Ranges?



Loaning Practices:

When interviewees discussed lending and loan agreement practices, the methods seemed standard across the board. Seven museums explicitly mentioned the request for a facilities report, while others

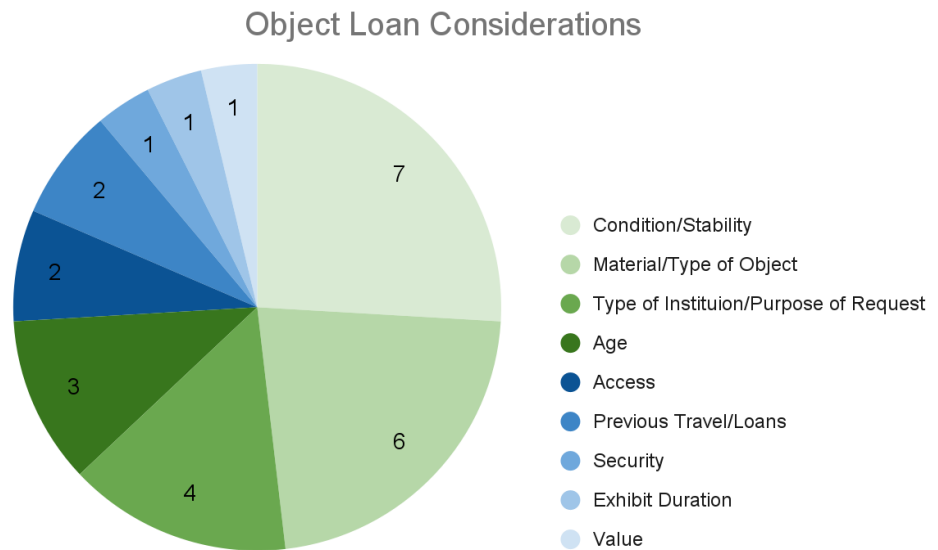
requested other documentation covering aspects of environment, security, loan duration, insurance, and more.

Three museums indicated exact guidelines regarding environmental requirements, while the other museums were more concerned about consistency. Other outgoing loan requirements included microclimates or visitor distance parameters, a courier, and AAM accreditation.

In all cases, loan agreements were approved on a case-by-case basis, determined by several factors. *See Chart 5.*

Chart 5

Loan Considerations



Concerning lending objects to other institutions, six museums stated that they have previously denied a loan request for an institution that could not meet the environmental conditions outlined in the museum's loan agreement. On the other hand, four museums stated they could not recall a scenario where a loan request was denied due to environmental concerns. In one case, a museum said that they had rejected a loan request due to their own conditions not being appropriate and the object being at risk of adapting to the "ideal" climate. Three institutions also claimed that due to their connection with the government and larger institutions, they have sent loans to non-museum spaces such as local schools and government buildings, often lacking any type of climate regulation.

Although some institutions have denied loan requests for not meeting required environmental conditions, when asked if they would consider sending a loan to an institution purposely not complying with the industry standard for sustainability purposes, no institution explicitly stated no. Eight institutions said they would consider it, while three said they would potentially approve the loan depending on the circumstances.

When asked how the museum approaches sending loans to different climates, all museums stated this was not often a factor evaluated since it was assumed the object would always be inside the climate-controlled building. Concerning the preferred methods of transportation, the distance the loan traveled, and the institution's location played a significant role in this decision. The most common mode of transportation was climate-controlled, air-ride trucks often operated by a professional art shipper, which was mentioned in seven conversations. For museums located on islands, airplanes were frequently the primary method of transportation for longer-distance travel. A regular vehicle operated by museum staff was mentioned in four conversations for more local loans. Three museums said they have used common carriers such as FedEx or UPS to mobilize their objects, with their objects' value and fragility in mind. Lastly, three institutions mentioned using a courier, often a museum staff member.

Building Envelopes and Local Climates:

When discussing variables for not meeting desired climate ranges, the building envelope, the exterior of the building, and its elements, such as windows and doors, that separate the interior from the exterior, and local climate, were factors for all ten museums that responded to the question. The variables that impacted this included:

- Local climate/seasonal fluctuations (x6)
- Large windows in exhibit and gallery spaces (x3)
- Large open entryways and exhibit spaces (x2)
- Older buildings (x3)
- Older mechanical systems that are unable to keep up with the demand (x3)

Below are responses regarding how local climate and building envelope impact the museum's ability to maintain its desired ranges:

- Some departments in the museum have newer systems. Ours is older, but it is really expensive to replace and install. Additionally, we would have to prepare for the replacement, which requires staff time to move the collection and a place to store it.
- The HVAC system pulls air from the outside, and most collection spaces and offices are on one system. When the weather is bad, it can cause more fluctuation in these spaces.
- Our building and mechanics are quite old, and we constantly have maintenance on-site to repair different aspects. We have actually implemented an extended climate range in case our system was to fail; it would allow us longer to respond and get the system back up and running.
- Our off-site storage spaces are operated by another facilities team, giving us little control over the area. Other off-site storage spaces also present challenges, but we must work with what we have.

Time In range:

When asked about the percentage of the time the institution maintained its desired range, the majority of the responses were above 80% for on-site storage and gallery spaces, but less so in off-site facilities. This question was asked generally in the initial interview but was followed up via email to obtain a better response regarding on-site storage and gallery spaces, as well as off-site storage spaces. Not all interviewees were able to respond to the follow-up email; therefore, some of the findings are incomplete. Additionally, not all institutions had off-site spaces, which led to a smaller data pool for that question.

In regard to on-site storage spaces, five institutions maintained their desired range above 90% of the time, five institutions between 80-90% of the time, and one institution approximately 70% of the time. *See chart 6.*

For gallery spaces, three institutions maintained their desired range above 90% of the time, and five institutions between 80% and 90% of the time.

Additionally, for off-site storage spaces, one institution maintained its desired range above 95% of the time, two institutions between 70-80%, and one institution between 40-50%. It should be noted that one institution's off-site facility is a second location, and another institution

keeps everything at the off-site storage location in crates and containers that create microclimates, minimizing the risk of fluctuations.

Chart 6

Time within desired range: storage spaces

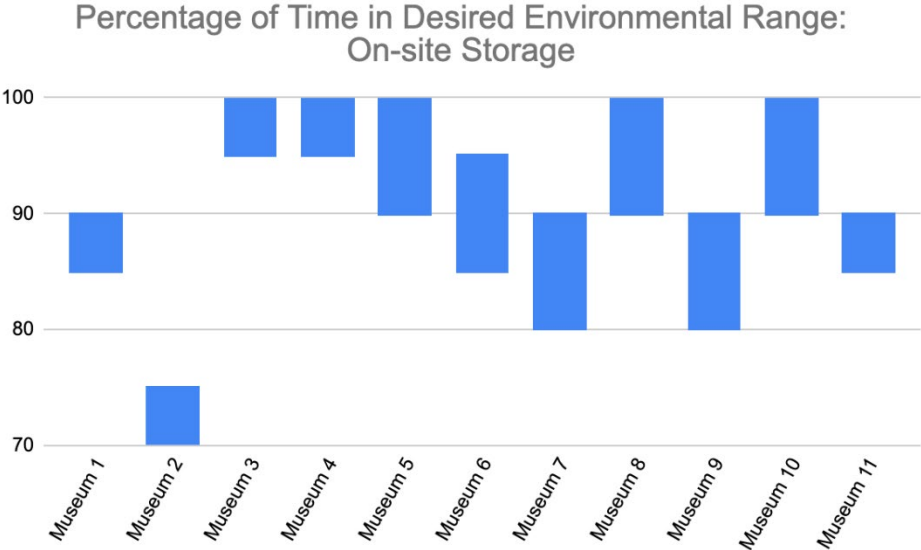


Chart 7

Time within desired range: gallery spaces

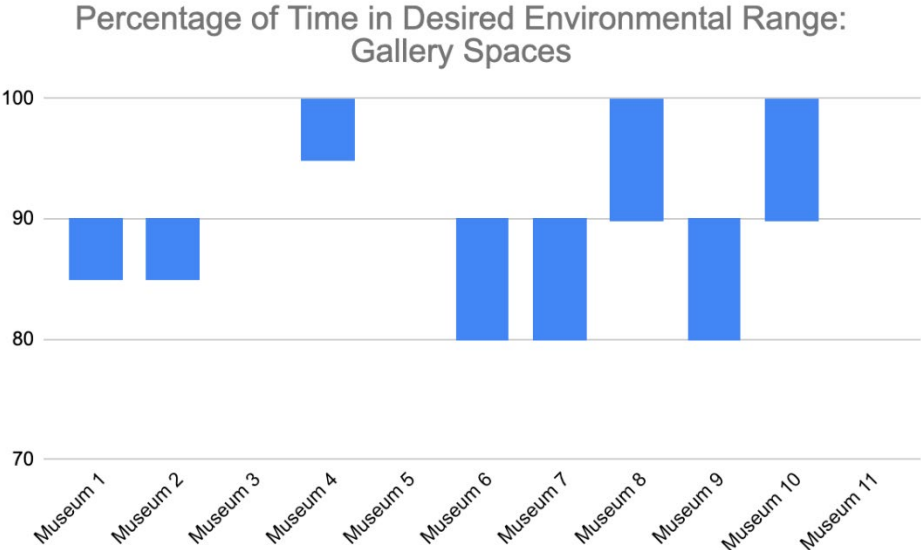
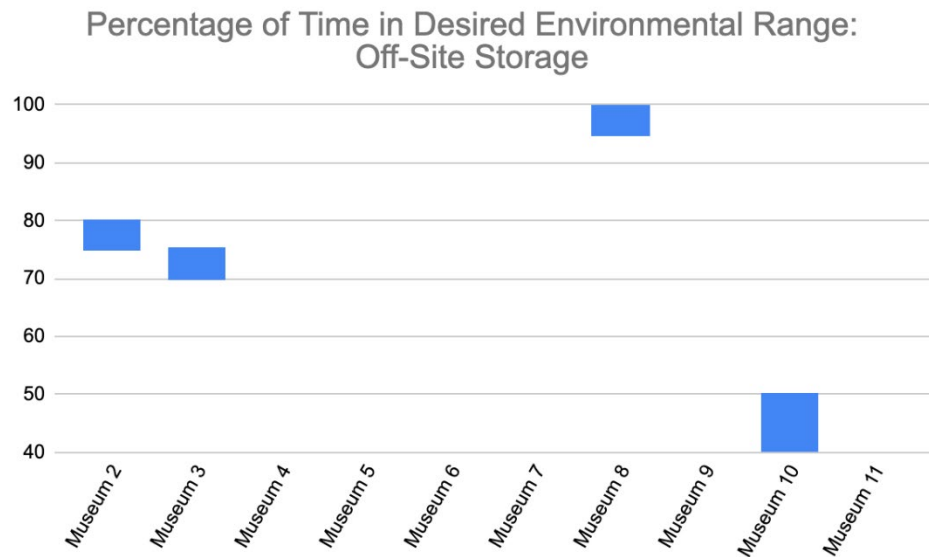


Chart 8

Time within desired range: gallery spaces



Biggest Risk/Challenge to Expanding Climatology Ranges:

When asked about some of the risks or challenges to expanding environmental ranges, the responses varied from person to person. However, there were a few emerging themes, such as the apparent fear of rapid deterioration. Responses included:

- Higher risk of overall deterioration (x3)
- Risk to mixed collections with conflicting needs (x2)
- Larger risk of unsafe/rapid fluctuations (x3)
- Long acclimatized item adjusting to change
- New observations in collections spaces, such as mold in areas with less airflow
- Undesirable working conditions
- Being the first museum to try something and facing the consequences of possible failure
- Struggling to meet the new standards and now falling out of range is in an extreme zone.
- Accepting/admitting we have a problem and not finding a real solution to fix the issue.

- Not enough staff or resources to closely observe the collection's reaction to change
- Getting collections managers and other professionals, who are skeptical about change, on board
- Levels of bureaucracy

As seen above, there is a wide range of concerns for the hesitation behind expanding ranges, but there were also mentions of ways these concerns could be minimized without the need for controlled environments. The primary and most abundant response was using microclimates: cases or storage solutions where the temperature and humidity can be manipulated to meet the object's needs, with seven responses. Other responses include:

- Segregating collections
- Rotating items on display more often
- Not sending sensitive items on loan
- Allow time for items to acclimate between spaces
- Reduce the amount of traffic in and out of the building
- Look at the landscaping, exterior walls, and shade outside the building
- Consider overnight HVAC system shutdowns
- Reduce large open spaces

Re-evaluating Environmental Standards and the Big Picture:

When asked if institutions re-evaluating environmental standards was a good or achievable goal, there was almost universal agreement that this idea could be beneficial and doable. Responses to the question are included below (respondent information in this section was redacted upon request):

Three responses indicated that re-evaluating environmental standards was achievable but must consider the emerging research and its reliability. These responses included:

- Possibly, changes require a lot of work, funding, and will. We can't be changing things every couple of years, so we must determine standards we plan to keep in the long term

(Collections Manager, Natural History Museum of Los Angeles County)

- Yes, I think it's a good and worthy endeavor, although I don't have the answers to how to achieve it. We seem to be moving in a direction where it is becoming more possible, but we get hung up on a lot of exceptions and need to move past that. Expanding ranges are way past due. Current industry standards are based on a limited research study from a moment in time and are not reflective of best practices. If we have more recent studies that show how collections are being impacted, we could expand the ranges on recent data. (Registrar, Burke Museum of Natural History and Culture)
- Yes, new research means new recommendations. There is a lot more data to work with today, and as new data emerges, we can use that to make changes. And if new changes don't work out, at least we can say we tried and we know they don't work. (Anonymous)

Two responses indicated that re-evaluating environmental standards was achievable but must consider the uncertainty of the results. These responses included:

- Yes. This is something museums should be talking about. Whether it will work or not that, I am unsure about. As things continue to change, I think it's necessary that we be flexible. The danger is that museum professionals don't understand everything that needs to be evaluated on a case-by-case basis. 70% of the collection could be completely fine in an expanded environment, but the other 30% may be more sensitive, such as items with soluble salts. We must be more vocal about the risks and be willing to listen when it is okay vs when it is not. (Anonymous)
- I think it's a good or achievable cause because reducing energy consumption is always good for the environment. It is achievable because current standards are pretty limited and slightly expanding them will likely not cause much damage. Although this could be helpful, it is reasonable to question whether collection environments are the biggest factor in environmental change compared to the larger institutions and other large companies, but we do have to start somewhere. Maybe looking at combining shipments for long-distance hauls

to limit the movement and number of climate-controlled trucks.
(Anonymous)

Two responses indicated that re-evaluating environmental standards was achievable and would create an easier and more efficient process. These responses included:

- Yes, we should be conscious of our carbon footprint and energy use. Over the past decades, we have made many improvements to get to where we are now. The more sustainability becomes the standard, the easier and more efficient the process will be. (Collections Manager, The California Academy of Sciences)
- Expanded ranges would be a good idea and allow for easier transport to warmer climates. Larger ranges give the item a larger breadth and are more adaptable to fluctuation, instead of always being so rigid. (Registrar, Honolulu Museum of Art)

Other responses included:

- Absolutely, it is not a choice. Conversions are already happening at conferences regarding topics like recycling gloves. It is likely achievable as museum professionals appear to be pretty liberally minded and want to help in ways they can. (Collections Manager, Alutiiq Museum)
- I think re-evaluating museum environment standards/requirements for reducing energy consumption and carbon footprint is good change, even a moral necessity, but it will never quite catch up with the changes in the outside climate, for instance, as the global environment gets hotter each year, we will spend more energy on cooling the building envelope. There will come a point where we may not be able to relax the environmental standards any further for the preservation of the collection, so spending on energy will rise. (Anonymous)
- I think it would depend on the institution, the location, and the size of the museum. The Smithsonian and a local house museum have very different energy consumption. For larger museums, their carbon footprint is something to consider. Many museums do not have the money or means to control the environment as they would like, or don't have control over it. Larger museums with multiple spaces are much better at

determining what they can do within their spaces. (Collections Manager, UofO Museum of Natural and Cultural History)

- Expanded ranges would be a good idea and allow for easier transport to warmer climates. Larger ranges give the item a larger breadth and are more adaptable to fluctuation, instead of always being so rigid. (Registrar, Honolulu Museum of Art)
- Yes, it is a very good and achievable change. It is interesting that the driver of these issues is to prove the prioritization of the institution. The Smithsonian, for example, is funded by taxpayer dollars, and therefore, it must appease the taxpayers by prioritizing sustainable practices. In contrast, other institutions are privately funded through donations and therefore likely don't have to prove much. I can't say if that is the exact reason sustainability is not a priority at some museums, but I do question what the driver is for the institution to become more sustainable. It is difficult to understand how reduced energy consumption and financial benefit the driving factors are not. Additionally, re-evaluating standards and executing the change is very expensive and requires a lot of staff investment. It may be difficult for museums to bite off the initial cost.

Analysis

Institutions and Sustainability

Overall, most museums are open to discussing sustainability. However, they may have other priorities that are putting the conversation on hold. Factors such as the COVID-19 pandemic, ongoing construction, funding, and staff turnover were commonly mentioned throughout the interviews, suggesting that these circumstances have ongoing and lingering effects. Many of these factors, such as COVID-19, are circumstantial, temporary, and will resolve themselves over time. Unfortunately, there have been additional systemic challenges surrounding the current presidential administration. There are looming fears of significant funding cuts, job security, and resource allocation, as well as a major de-emphasis on climate science and action. As a result of these wide-scale industry threats, conversations regarding sustainability practices may remain on hold as other priorities overshadow these dialogues.

Contrary to my initial anticipations, museums actively discussing sustainability had a broader range of participants within those conversations. Conversations were present at the highest and lowest levels of museum staff. Additionally, a few museums stated they had

dedicated “green teams.” Although some of these teams have been dissolved recently, they could reappear in the future.

Despite conversations happening among all levels of museum staff, there was no mention of board involvement in these discussions. This is surprising, considering the board’s inherent financial interests. This may indicate that sustainability conversations are not happening on a foundational level. Unfortunately, this may imply that sustainability changes are not commonly made on a systemic level. Individual and staff wide involvement is essential, but financially backed initiatives may have longer term impacts.

Interestingly, the most common areas where sustainability is discussed are everyday activities and building design. Multiple institutions mentioned practices such as material waste reduction and recycling materials, or awards such as LEED certifications and green awards. These are all incredible achievements and a step forward in creating an eco-friendlier future. Unfortunately, collection environments, exhibition spaces, and loan agreements were often left out of these conversations. Since these are some of the most expensive and resource-consuming practices within museums, these factors are essential to the conversation as they likely would contribute the most to more sustainable practice.

Some interviewees also mentioned frustration with bureaucratic systems that made it challenging to enact larger changes. Hence, these spaces are likely not involved in sustainability conversations because they take more executive approval and work with complex systems and levels of hierarchy. This reiterates the importance of board-backed sustainability initiatives. Positive change may require a ground-up approach in addition to everyday practices.

When comparing institutions based on size, staff dynamics, and classification, large museums and museums with a conservator on staff are more likely to be actively discussing sustainability. However, there was no significant difference between the classification of museums. *See Appendix 3*

When incorporating loans into these conversations, there was no major difference between the size of the museums. Still, loans were more likely to be included in sustainability conversations among art museums and those with conservators on staff. A relatively low number of institutions were discussing loans in sustainability conversations; therefore, this connection between these conversations and classification could be correlational. *See Appendix 4*

Museums with conservators on staff were more inclined to have sustainability conversations. This demonstrates that there are larger implications regarding the importance of funding and resources. Since conservators are more likely to work at larger institutions, often with larger budgets and consequently larger carbon footprints, these conversations may be more abundant. This does not suggest that smaller museums are not invested in sustainable practice but may have fewer resources for bigger-picture conversations. Alternatively, these findings may suggest that sustainability conversations are initiated as a result of necessity. Larger institutions that have larger carbon footprints may have a responsibility to counteract their environmental impact.

Overall, it is clear that sustainability is an important topic for many institutions. Most museums are actively discussing sustainability or would like to be actively discussing how they can incorporate greener practices into their work. However, large scale changes may require high levels of resources and funding.

Expanded ranges and Collections Environments:

As initially expected, the industry standard of 70° +/- 5° and 50% +/- 5% relative humidity was still the common environmental set points for most museums, with only four museums having some type of expanded range, and only two of those following the Bizot Group recommendations. Even though many museums were still guided by the current industry standard, a majority of the institutions had discussed the possibility of expanding their ranges or were at least aware of the concept. Unsurprisingly, loaning from another institution was a major consideration for museums maintaining the industry standard.

These findings align with a previous survey that found that approximately only 25% of AIC members are very committed to adopting greener practices (De Silva Henderson, 2011). Although this study is not only focused on conservators, when looking at the data for those who have already taken steps to expand their ranges, only three or 27.3% of the museums interviewed had already expanded their ranges despite five museums or 45% saying it has been a topic of discussion but has yet to be enacted. There are multiple theories as to why this could be, but it could be connected to the comfort in what is known. Since current industry standards are widely accepted and known to preserve mixed collections of objects, some individuals may

not want to take risks by implementing new practices. New practices take risks that some individuals may not think are necessary. For the museum field, especially, new risks could mean irreversible damage to certain objects, which could be detrimental to the institution.

Furthermore, Taylor and Boersma (2018) stated that professionals are aware of the benefits of aligning interior climate with local climate but admit that loans are a barrier to this decision. The significant number of responses indicating that borrowing from other institutions was a factor in maintaining the current industry standard as well as the almost 75% acknowledgement of discussion to expand ranges occurring, show that the idea of expanding ranges is not ignored or dismissed by museums but perhaps strongly influenced by the opportunity to borrow objects. Since borrowing objects from other institutions is a significant component of special exhibits and, therefore, guest attendance, borrowing may be a factor that museums are not willing to risk, as it provides a significant income stream through engaging audiences and boosting visitor numbers.

When comparing the differences among size, staff, and type of museum, size and staff were not influential on the use of tighter ranges compared to the industry standard. However, art museums had a higher number of expanded ranges compared to natural history/anthropology museums. Museum classification may indicate flexibility surrounding temperature ranges. *See Appendix 5.*

Similarly, size and staff have little impact on the discussion of expanding the range. Museums with conservators on staff were slightly more likely to discuss expanding ranges, but there did not seem to be a significant difference overall. In contrast, art museums were much more likely to converse about range expansion within the institution. *See Appendix 6*

The finding that art museums were more inclined to discuss environmental ranges has no backing in the current literature. However, because the art institutions within this study are primarily larger and have conservators on staff, it could instead be an indicator of the influence of size and staff at an institution. The slight increase in conversations among museums with conservators on staff could also provide insight into the importance of funding and resources. Large guiding institutions are home to this movement's foundational researchers and encouragers. These institutions often have more flexible funding that allows for experimentation and dedicate staff to monitor these projects.

Large institutions such as the Getty Research Institute and the American Institute of Conservation have heavily researched and implemented the idea of expanded ranges, which is encouraged by other large governing institutions for museums. As conservation professionals might access resources and conferences put on by these institutions, they could potentially be more informed of recent findings. Additionally, since these professionals have a more intimate relationship with how materials react under certain conditions, they might be more open to the idea of expanded ranges due to their deeper understanding of the potential risks.

When discussing the impact of loan requirements on maintaining industry standards, there was an overwhelming agreement that loans influence the museum's practices; therefore, there was no major difference between museums. Larger institutions felt a slightly higher impact than smaller museums, but this could potentially be related to the possibly higher number of loans requested. The presence of a conservator on staff and the type of museums didn't impact the responses. Since the overall response to this question suggested that loans were influential in maintaining industry standards, this is likely a factor across the field, suggesting that loans could be one of the driving factors for maintaining industry standards, since there does not appear to be any significant difference between museums. *See Appendix 7*

It is clear through these responses that borrowing from other institutions is a considerable factor for maintaining an industry-standard environment. This is especially apparent in museums that have different galleries categorized by use. In one example, Permanent exhibits aligned with the Bizot recommendations, whereas special exhibit spaces, often associated with borrowed objects, continued to maintain the industry standard. The responses indicate that borrowing objects from other institutions aligns with Thomas' theory: that museums would eventually prescribe to one range for the ease of lending materials between institutions (Boersma et al., 2014; Taylor & Boersma, 2014).

Loan Practices:

Although loans were a considerable factor in maintaining current industry standards, it was surprising to see that every museum said they determine each loan on a case-by-case basis, and that most museums would consider sending a loan to an institution that did not meet ideal environments for sustainability purposes. Although some loan agreements had specific environmental guidelines, surprisingly,

many institutions did not necessarily suggest a fixed range. This appears to somewhat align with the Bizot Group's recommendation for institutions to remove the requirement of standard environmental conditions for loans (Boersma et al., 2014). This indicates that although loan agreements are important to any institution, they are willing to be flexible in some scenarios.

Considering that loans were not often involved in sustainability conversations it appears that institutions can and frequently do remove strict environmental guidelines and often evaluate objects according to their individual needs. By removing environmental set point requirements altogether, institutions can take a step towards sustainable practice and prioritize assessing the object's needs instead of focusing on the borrowing institution's capabilities. By looking at the individual object and not the institution, the loan eligibility can be determined by what the object can withstand and how those needs can be met, instead of automatic rejection due to the borrower not meeting exact requirements. In short, institutions must work together to determine what is best for the object while problem-solving and continuing to prioritize accessibility.

Regarding loan requirement flexibility, the majority of institutions also said they would consider lending an object to an institution that did not meet environmental requirements for sustainability purposes. Despite flexibility being offered, most institutions also stated that they had previously denied a loan request due to the requester not meeting the specified environmental standards. Of course, it is fair that in some scenarios, an object would significantly suffer in a particular environment. However, denial is still common among museums without considering other protection mechanisms. According to Atkinson (2014), the debate of sending loans to institutions with expanded ranges is focused on the concern about the variation of environments between the lending and borrowing institutions. In contrast, Atkinson (2014) actually suggests that in the past, there have been instances where loaned objects went to different environments and returned with minimal damage. To further the argument, Taylor and Boersma (2018) suggest that enforcing strict environmental requirements in loan agreements without justification can increase the object's risk if its usual environment is not as stringent.

In terms of differential climate and transportation considerations, no museum seems to be specifically concerned about objects being loaned to significantly different climates, as they theorized the object would be in climate-controlled areas at all times. Although this is true at the moment, if more museums begin to adopt environmental ranges

that align closer with their local climate, this seems like a consideration that museums should take.

As expected, the transportation of objects seemed relatively standard with the use of fine art shippers and air transport for further distance travel and museum-driven vehicles for shorter distances. These are all relatively common methods of transportation for lending objects, so it was not surprising that these were the top responses. Fine art shipping is necessary in some cases for more sensitive works and often makes the transportation aspects of loans much more streamlined and stress-free. The Bizot group suggests that museums prioritize using more energy-efficient transportation systems, such as trains and ships, but these transportation methods can be much riskier for collections. Although these methods are more carbon-intensive, considering consolidating shipments can create more eco-friendly practices (Groupe Bizot Group, 2023b)

When comparing loaning practices between size, staff, and classification considerations, a conservator on site or not does not impact the increase or decrease of loan rejects. Regarding classification, art museums seemed much more flexible when accepting loans. They were more likely to approve a loan request and work with the borrower to solve potential environmental concerns. Alternatively, larger museums were more likely to deny loan requests. However, this may be impacted by the scope of the collection and value of specific objects. Additionally, it could also be connected to the number of loan requests the institution might receive. Larger museums often have larger collections, so they may generate more requests and therefore deny more than smaller museums.

Building Envelope and Local Climate:

Overall, the building envelope, design, and local climate were universally cited as reasons for not meeting desired environmental ranges. Building design issues, such as large windows in galleries, large open spaces, and entryways that don't block outside air from easily reaching galleries, were all issues stressed during interviews. Additionally, the age of the building or mechanical systems was also a factor in struggling to meet these ranges.

Along with the local climate, the building envelope and design were also mentioned as significant factors for struggling to maintain desired ranges. Interestingly, the age of the building was brought up in multiple conversations. Many research articles suggested that older building

may be able to regulate their environment better due to non-mechanical features that help to buffer the interior environment from the exterior environment (Henry, 2007; Maekawa et al., 2015). The mention of older buildings being an issue seems to contradict these findings although other issues such as wear and tear and lack of modern implementations, such as draft proofing, could be contributing to these issues.

The local climate was cited in six different conversations and included topics such as temperature extremes and strong winds as factors that could not be kept up with. Surprisingly, these issues were brought up throughout museums along the West Coast; there did not seem to be one general region of climate where this was happening but instead felt by a range of institutions. This was unexpected due to the vast differences in local climate for the institutions investigated. Since some states have milder local climates while others have more variable ones, it would seem that those with more variation might be more impacted by the local climate.

Three participants also mentioned that older mechanical systems have difficulty keeping up with the demand. Unfortunately, the age of the system was not investigated for the purposes of this paper, but knowing the age of a system compared to the anticipated lifespan and whether this follows the theory proposed by Taylor and Beltran (2018) that museums must often keep systems in function much longer than recommended could provide a deeper insight into the issues faced. One museum stated that different departments have varying ages of HVAC systems, and the cost to replace the system includes not only installation, but also temporarily moving and storing collections during installation. Other museums stated that all the museums collection spaces relied on one HVAC system, sometimes struggling to meet the demand, especially on colder or rainy days.

Since each museum's building is unique, and there was a relatively unanimous response that the local climate and building envelope were issues in maintaining desired interior condition, there did not seem to be a need to compare museums' types, sizes, and presence of a conservator on staff due to the lack of variation in responses.

Research suggests that passive methods and building design choices can alleviate some of the above-mentioned issues without using expensive mechanical systems. Structural changes to the buildings, such as draft proofing and increased insulation, can be considered (De Silva & Henderson, 2011). Additionally, using resources outside the building can be beneficial for keeping interior spaces more stable.

Exterior support can include vegetation shade and lighter, less absorbent paint colors (Henry, 2007; Maekawa et al., 2015). Newer builds and renovations can look into building orientation and wall-to-window ratios (Maekawa et al., 2015). Furthermore, keeping collections in spaces that are buffered from exterior walls and allowing for cross ventilation can all impact the building's ability to better regulate interior conditions (Henry, 2007).

Although there is research and recommendations for how institutions can implement more sustainable practices into their work, it is important to note that many of these initiatives require a high initial investment that may not be feasible for many museums, especially smaller ones. Modifying buildings is not always possible, so relaxing environmental parameters to better fit the building and local climate can be an alternative solution (Groupe Bizot Group, 2023).

Following the theme of the overall analysis, building design and renovations require a large investment and approval by executive and board members. Their support in these matters is essential to making more sustainable changes.

Time In Range:

When discussing how often museums could maintain their desired ranges, almost every museum was able to maintain their desired range above 80% of the time on-site but had lower percentage ranges at off-site locations. This shows that on-site, the desired range is kept most of the time, but there are still instances where it falls out of range.

Although it is unclear under what conditions falling out of range occurs or what is happening, it provides a transparent look into how often specific set points can be maintained. The results of this study show that no museum is perfect and will ultimately fall outside of its desired range multiple times throughout the year, even if an institution has a 95% success rate, which would still result in approximately nine instances a year where the desired environmental set points are not being maintained.

The finding that on-site storage and galleries are in a much higher accuracy range than off could be related to loaning. Since most objects borrowed from other institutions are not held at off-site storage facilities, the priority of keeping these spaces in the desired range is likely lower since they have little impact on the loaning process. Although loans are one possibility for why these ranges are lower, it could also be related to the fact that some off-site facilities are not

designed with collection storage in mind. These spaces are also often a later addition to museums' real estate, meaning they often have to work with what is available, oftentimes not ideal for collection storage.

This is by no means to indicate failure among museums, but instead to open up a dialogue for institutions to see that maintaining these strict standards is almost impossible. As the climate changes and temperatures and storms become more extreme, we can only expect these percentages to continue to decrease.

The amount of time outside the desired range is often a taboo topic among institutions because it is associated with failure and inability to properly steward collections. Unfortunately, not discussing these problems, especially in loan agreements, will ultimately lead to false information among both the lending and borrowing institutions (Bickerseth, 2014; Taylor & Boersma, 2018). This concept was also brought up in the interview with Margalit, who discussed museums often not wanting to discuss their deficiencies, impacting the ability to formulate solutions to alleviate these issues.

Ultimately, museums that do not meet their desired ranges but continue to act as they do and require it in their loan agreements are not benefiting the collections or the museum field more generally. If objects are not being kept in ideal conditions, why should they be expected to be in borrowing institutions? An 80+% success rate is incredibly impressive, but it still has room for error, and it is unfair to expect other institutions to live up to consistent and specific environmental parameters when the lending institution itself cannot fully maintain these expectations.

By expanding environmental set points, more museums would fall within the desired range at a higher percentage, and the objects in those collections could adapt and manage in other environments much more easily. With expanded ranges, the expectations would be much more achievable and allow the objects a bigger breath in what they can endure. Additionally, in cases where systems were to fail, an expanded range closer to the local environment would allow more time to remedy the problem before the objects experienced extreme fluctuations.

The biggest risk or challenge to expanded ranges:

The question regarding some of the most significant risks or challenges to expanding climate set points was one of the leading questions of this research. Overall, the top three concerns included increased

deterioration of objects, rapid fluctuation, and unsuitable conditions for mixed collections. These concerns align with Atkinson's (2014) statement that the current debate concerns whether objects will suffer if exposed to wider ranges than the current value. These are all valid concerns as they directly relate to the reaction between objects and their environment. Despite these concerns, there is substantial research that indicates the risk is not as high as many individuals assume.

Starting with rapid fluctuations, the Bizot Protocol advises no more than a 10% fluctuation in a 24-hour period to reduce the risk of damage, but it should be noted that other studies have also investigated how constant fluctuation can impact collections.

We can ensure that objects are not as susceptible to damage from fluctuation through a study conducted by Stefan Michalski, who established the term "proofed fluctuation," the idea that an object's history plays into its ability to withstand temperature and relative humidity extremes. "Proofed fluctuation" is the idea that an object is unlikely to be mechanically damaged if it has previously been exposed to a more extreme RH or temperature value (Ahern, 2024a; Atkinson, 2014).

Additionally, it has been found that decreased temperatures also play a critical role in the chemical degradation of objects (Atkinson, 2014). Michalski (2002) found that for every 5° decrease in temperature, the lifespan of an object doubles; alternatively, for every 5° increase, the object's lifespan halves. Although the obvious solution to these findings would be to keep collections and exhibit spaces cooler, human comfort greatly impacts a museum's ability to do this (Ashley-Smith, 2018). Besides rapid deterioration being a concern for expanded ranges, human comfort is also an obstacle museum must consider (Ashley-Smith, 2018; Atkinson, 2014; Groupe Bizot Group, 2023a).

Despite the findings that wider ranges and relatively low ranges of fluctuation are rarely harmful to stable collections, there is also the concern regarding how many small fluctuations an object can undergo over its lifespan. Michalski (2007) investigated this concept and found that fatigue fractures occur between one and ten million fluctuation cycles. This indicates that fluctuations within a relatively safe range do not pose a significant threat to objects for a substantial period of time. If less than a 10% fluctuation is recommended in a 24-hour period, that would imply that damage would likely not occur to an object for 2,739 years.

Some professionals even suggested that items long acclimatized to their environment could be at risk. This is incredibly important because museums often strive to meet the industry standard, but these changes could be more detrimental to the collection. Atkinson (2014) and Taylor and Beltron (2018) both suggest that industry standards could potentially harm collections that have long been adapted to their local climate or environment, may not adjust well to their relocation into an ideal climate, and therefore, the object could suffer extensively within the ideal conditions.

Alternative Solutions:

After expressing challenges or concern to expanded environmental ranges, interviewees were then asked what other mitigation methods or alternative solutions could be used to address the various concerns. The most common and obvious answer was the use of microclimates, often in the form of individually climatized cases that can be manipulated for the needs of a specific item. Microclimates are an incredible solution and provide a safe, individualized, and stable environment for more sensitive objects (Groupe Bizot Group, 2023a). Along with microclimates, there are a lot of other alternative methods to mechanical intervention that are both effective and cost-efficient, which should ultimately be used as a first defense option (Atkinson, 2014; Bizot's Refreshed Green Protocol, 2023).

Starting with the outside of the building, many exterior factors can be used to the advantage of the museum to help better buffer and stabilize the interior temperature and humidity. When constructing the museum, considering aspects such as the wall-to-window ratio and the building orientation can help to reduce outside influence (Group Bizot Group, 2023a; Maekawa et al., 2015). Light exterior paint colors and reflective coating can also regulate the thermal absorbance of the building (Maekawa et al., 2015). As mentioned in one interview, the landscaping can also highly benefit climate regulation. Large trees and vegetation can shade the building during warmer months. Additionally, soil and moisture control strategies, such as gutters, can assist with moisture uptake and help control relative humidity (Maekawa et al., 2015).

The building design can also greatly influence temperature fluctuations. Creating microclimate spaces for certain exhibits or collection types can prevent the need to meticulously condition large spaces (Ford et al., 2012). Additionally, it is important to be conscious of where collection spaces are located and their proximity to exterior walls. Creating buffer

spaces between these areas can allow for minimized influence from the outside climate (Maekawa et al., 2015). Using fans and allowing room for cross ventilation can also be beneficial for quickly cooling a space (Henry, 2007).

Other passive methods can include the presence of window coverings such as shutters, curtains, awnings, and more (Ford et al., 2012). Additionally, in a paper written by Mal Ahern (2024a), she suggested that hygroscopic material in the display area can help regulate relative humidity by absorbing and admitting moisture. The quick switch to LED lights can also have significant energy savings and reduce the heat put off by older light styles (De Silva & Henderson, 2011).

Although passive methods can be instrumental, they also require more human effort. Opening and closing window shades requires someone to perform those duties (Ahern, 2024a). Beyond that, more complex skills are more labor-intensive practices require staff investment in knowledge and skills (Ahern, 2024a). Additionally, institutions would need dedicated staff members to oversee these practices and monitor the condition of the objects to ensure that no damage is occurring.

Passive methods are the best frontline defense but, with the current climate extremes, museums must have mechanical systems to supplement beyond what non-mechanical systems can accomplish. One-way museums can lower their energy consumption with HVAC use is to consider seasonal shifts, meaning that in the winter, the temperature can stay a little cooler, and in the summer months, it can be slightly warmer. Seasonal adjustments are widely used in areas with greater seasonal fluctuations (Bickersteth, 2014). Of course, these numbers still need to be within safe ranges, but it gives the museums much more flexibility to work with the local climate. For exhibitions, this means that more sensitive objects should be displayed during winter and those less sensitive should be out over summer (ARoS, 2024; Ford et al., 2012).

Another method museums have recently tested is overnight or periodic HVAC shutdowns when conditions are favorable. These shutdowns can not only reduce energy consumption by 8-10% (Aros,2024; De Silva & Henderson, 2011) or 27% (Anthony, 2014) but can also expand the lifespan of the mechanical system (ARoS, 2024). Unfortunately, during visitor hours, the airflow must meet specific health requirements, making shutdowns more challenging, but these changes could be implemented in areas of lower traffic, such as collection vaults (Ford et al., 2012; Maekawa et al, 2007). Additionally, using time entry tickets

can diffuse times of heavy traffic and can help to lessen the required amount of fresh air being circulated.

How the HVAC system is set up can also increase overall efficiency. HVAC systems work best when organized into zones with similar needs (Taylor & Beltran, 2023). When HVAC systems are supplied to many different spaces with contrasting specifications, these requirements can often contradict each other, making it difficult to condition the space as one would like (Maekawa et al., 2015). Therefore, zoning the HVAC to supply air to areas with similar needs can lead to better results and a more efficient system.

With the above findings and alternative solutions to controlling interior environments, there should be no denial that more energy-efficient and eco-friendly practices should be taking place. However, as the trend of this analysis continues, the research and implementation of these findings take significant staff and financial investment, often much more than the institution is willing or can accommodate. Furthermore, without the support of higher-level decision makers, these changes can be difficult to make.

As indicated in the interview with a private conservator at Pearl Preservation LLC, getting board members to accept changes can be difficult. Sometimes, the benefits of these changes have to be explained in ways that are understandable to those unfamiliar with collection practices. Margalit shared one example: They framed the problem to the board as a comparison with other similar institutions, and if the institution wanted to stay up to date and be a leader in the field, it had to prioritize making changes. This was well understood by the board; therefore, changes were approved and able to move forward.

Re-Evaluating environmental standards and the big picture:

Looking at the bigger picture, museums seem open to the idea of re-evaluating environmental standards. As Atkinson (2014) and Boersma et al. (2014) found, nobody seemed to disagree that reducing energy consumption and improving sustainability is bad, but many were concerned about the cost of collection preservation. This statement sums up the thinking behind this debate incredibly well. Based on the findings of this study, this seems to ring true. Every institution agreed that improving sustainability is important, but there was still a bit of hesitancy regarding collection deterioration and the gaps in the research.

There are still some reservations about the idea of expanded set points, which is perfectly understandable. Some museums stated that not enough research has been done to fully determine if this is a beneficial switch. Other museums were also unsure if such minor changes would really lead to significant energy savings. As studies have found ranges all over the place from energy savings such as +/- 2% to +/7% could result in a 55% reduction in energy costs (Framer et al., 2015) Other studies have found that alternative methods to mechanical climate control could result in an 80-90% reduction in operating costs (Maekawa & Beltran, 2007), It is fair not to see the true benefit.

Finally, as expected, many museums stated that resources and costs were a large factor in not going forward with such a large change. Some professionals were concerned that this might be a short-term trend, while others said they did not have the staff available to monitor the changes within collections during such a large transition. Researchers such as Staniforth (2014) have noted that the research justifying these changes is out there. However, it takes significant staff time and dedication to find and read the literature to make an informed choice about what works best for their museums.

Implications

Researching the hesitation among museum professionals is incredibly important to understand how the field can move forward in creating a more sustainable future. In the recent political landscape focused on cutting foundational funding for cultural institutions nationwide, now is an imperative time for museums to re-evaluate how they can reduce costs. As loans, exhibitions, and facilities operations are some of the most expensive aspects of museums, more sustainable practices must be evaluated and incorporated into everyday practices.

The data collected in this study allows a more transparent understanding of the capacity of many West Coast museums. Many interviewees stated that the local climate and building envelope were factors in the struggle to maintain their desired range. Additionally, several responses suggested that funding and limited staff capacity made going beyond standard museum practices challenging. These factors continue to impact many museums worldwide, and a more transparent conversation about the real struggles museums face can allow the field to work together to find solutions and become stronger.

Museum policy:

One of the significant implications of this research is that it might encourage museum professionals to reevaluate their policies, primarily through loan agreements and collections environments. By providing a detailed account of the research that has previously been conducted, as well as expanding the findings to include real experiences, the hope is to provide an updated and realistic look into the idea of expanding museum environment set points. Through updates in museum policy, questions about who decides what the safe range is can also be established. This concept is approached differently from different expertise's which might conflict with each other. Identifying individuals responsible in making this choice can help the field move into a more collaborative direction.

Professional Practice:

An additional implication of this research is to encourage dialogue among museum professionals about incorporating best, sustainable practices into their institutions. As mentioned above, no museum can stay perfectly within the ranges set by the industry standard. Making this information more available can show that this is not a problem to be ashamed of, but an obstacle that we must work around.

Transparency of this data is essential for allowing museums to see that they are not alone in the struggle of maintaining their collection environments in the ideal range. Many museums stated that the building envelope and local climate were factors in struggling to keep ideal ranges. As the climate continues to change, this will continue to be an issue, and as professionals, we must work to find new solutions to these issues, such as relaxing standards.

This study aimed to determine the challenges and concerns surrounding re-evaluating environmental set points in storage spaces, exhibit galleries, and loan agreements. Guided by the question below:

- I. Are museums discussing sustainability and energy consumption topics when looking at ways to improve their practices? If so, how?
- II. How do West Coast museums decide their collection and display climate controls? Do they use a standardized approach or an individual approach?
- III. Do artifact loans impact how museums set their environmental standards?

- IV. Do museums consider the local climate when determining temperature and humidity levels?
- V. Does the size, type, location, or staff structure change the approach to the collection environment and loaning practices?

Conclusion

Overall, the results indicated that West Coast museums are interested in incorporating sustainable practices, but many professionals are reluctant to take the leap of expanding their climate ranges. Findings suggested that museum professionals agree that sustainability is an important aspect of the field, but is often pushed aside to accommodate other, more urgent needs. Additionally, there are still many concerns regarding expanded environmental set points, which can prevent changes from happening. Professionals are especially concerned about expanded ranges potentially contributing to rapid deterioration, rapid fluctuations, and being unsuitable for mixed collections. Loan agreements and the ability to borrow from other institutions further complicates the willingness to expand environmental set points as it appears to be a driving factor in the decision to maintain industry standard conditions. Challenges such as building design, borrowing from other institutions, and bureaucratic institutions also impede the ability to make headway on exploring expanded climate set points.

Fundamentally, implementing more sustainable practices boils down to funding and available resources, nonexistent discourse, as well as support from governing boards and decision makers. Larger, more influential museums with the financial backing and support of this initiative who begin to transform their collection and loan practices and discuss the challenges they face in their own institutions may result in a new standard industry practice. Recognition and implementation from larger institutions may encourage smaller institutions to follow in their footsteps. This change may also create a more transparent dialogue among the field to openly discuss the challenges institutions might face in collection and display spaces.

As museum staff are already spread thin, and implementing new practices requires extensive staff investment, not only to put the work into action but also to conduct the research ahead of time and observe the reactions to change, higher-level staff must begin to support these initiatives. Although significant energy reduction and therefore costs are associated with expanded climate standards, the initial investment to implement these changes can be costly and difficult to get approved.

This results in a cyclical reaction where high energy use, steep facilities costs, and levels of bureaucracy are often preferred and easier to justify than investing in staff knowledge and skills. The common consensus is that museums' practices are outdated and unsustainable, yet many barriers must be overcome to move forward.

Whether a museum decides to expand its range or keep the current industry standard is entirely up to them and should be guided by what is best for the individual collection and external factors. There are many resources that indicate these changes are safe and are financially and ecologically beneficial. Museums wishing to update their practices to incorporate more sustainable practices with reduced energy consumption should consider re-evaluating their collection environments and loan agreements.

In the bigger picture, it may not seem as though museums are a primary contributor to the climate crisis, but as a widely trusted entity, institutions must be doing their part to prevent the climate crisis from further intensifying. Many museums are in a position to educate the public about the ongoing impacts of global warming, and these initiatives must also be put into action. As politics continue to polarize people and publicly funded institutions become more censored in the information they can discuss, it is important for institutions that can continue to advocate for more sustainable and eco-friendly practices do so and implement it into their own practices to create better future for the following generation to continue enjoying the collections we work so hard to preserve.

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Appendix 1

Instrument

1. **Is your institution actively thinking about sustainable practices/discussing ways to reduce its energy consumption and carbon footprint?**
 - a. If so, who is having these conversations? And who is able to make the changes? Conservators, Registrars, Collection Managers, Museum Directors, Board Members? A joint effort?
 - b. If not, do you think this could be a conversation eventually? Is there a reason it doesn't get discussed? Do you think the size, type, location, or staff dynamic of your institution impact these discussions?
 - c. Do loans fall into these discussions?
2. **What requirements does your institution require for another institution to loan an object?**
 - a. Do all artifacts have the same requirements, or is it based on a case-by-case basis?
 - i. If case-by-case, what factors do you consider? Material? Condition? Age? What type of Institution is it going to? What will it be used for?
 - b. Does your institution use the industry standard 70° F ± 5° and 50% ± 5% relative humidity
 - i. If so, has there ever been discussion about expanding these ranges?
 - ii. If not, what are your standards? And how did your institution come to those standards?
 1. Where does your institution get these standards? (AAM, AIC, Other)
 2. Are loaning objects from other institutions a factor in this decision?
 - c. What percentage of the time would you say your collections environments fall within your required conditions?
 - i. If low, how do you respond to changes in your institution's collections climate
 - ii. Is the local climate or building envelope a factor in not meeting these requirements
 - d. How often does your Institution update or revise their loan agreements to incorporate new recommendations?
3. **Do you think your institution would consider approving a loan for a museum who may not meet the standard environment controls due to sustainability efforts?**
 - a. Have you ever denied a loan request because a museum cannot or does not meet your institution's specified standards?
4. **How does your museum approach loaning objects to a museum in a different climate? Tropical to desert, hot to cold, ect.**
 - a. How does transportation look for these items?
 - b. What about acclimation?
5. **What do you think might be the biggest challenges or risks to expanding climatology ranges?**

- a. Are there other ways to mitigate these risks that don't require strict environmental controls?
- 6. Do you think that institutions re-evaluating museum environmental standards/requirements to reduce the institution's energy consumption and carbon footprint is a good or achievable change? Why or why not?**

Appendix 2

Interview with Pearl Preservation LLC

The interview with primary conservator Margalit Schindler (They/Them) at Pearl Preservation LLC focused on looking at larger picture implications of sustainable museums practice. Although this interview did not contribute to the overall findings of the study, the conversation has been woven into aspects of the analysis and conclusion and provided a deeper insight into understanding sustainability within the museum field.

During the conversation with Margalit, they discussed how conservators often abide by strict environmental set points due to their training and the idea that damage to artifacts within their care has often been considered their fault. The idea of expanding ranges has been acknowledged as being unsustainable yet expanding climate ranges comes with careful consideration of other deterioration factors.

Margalit continued by discussing how museums often view sustainability very narrowly. Many of the practices to reduce carbon footprint still come at a cost, particularly in the case of staff investment and material use. Climate controls can be reduced, but the construction of a microclimate or the use of silica gel may be necessary, which is still contributing to the overall larger carbon footprint.

In one example provided by Margalit, they discussed how recently they worked with a large institution to highlight issues facing the collection. They suggested that hiring a specialized preventative conservator to oversee these issues would solve these problems. The museums remained hesitant to add this new role, but through comparison with other similar institutions, they were faced with an ultimatum to either stay ahead of the curve by aligning with other museums that had already hired a preventative conservator and were utilizing the Bizot Protocol or fall behind. Ultimately, after the fear of falling behind, the museums decided to hire a specialized individual. Overall, Margalit suggested that sometimes highlighting issues in a way that isn't necessarily why you need something but discussing it on a level that executive staff can understand and resonate with, can be beneficial.

When discussing how not falling in desired ranges can impact museums there was a clear acknowledgment that there is a stigma around institutions not meeting the industry standard. Although museums try to hide this fact, Margalit emphasized how if museums are not transparent about these issues it can be more detrimental in the long term. There are creative solutions to these problems that can only be fixed by being honest.

Ultimately, Margalit stated that contact decision-making is incredibly critical. Standard recommendations across the board are not reasonable and unsustainable. Museums must use their local climate and make decisions that are right for their individual climate.

Appendix 3:

Museum Comparison and Sustainability Discussions:

Figure 1:

Museum Classification and Actively Thinking About/Discussing Sustainability

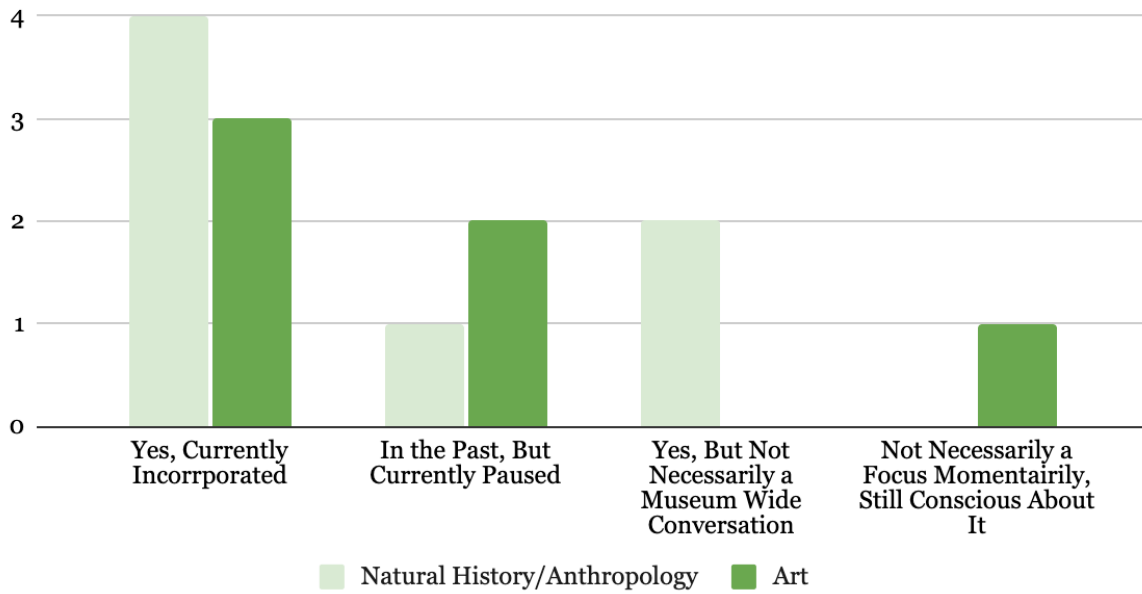


Figure 2

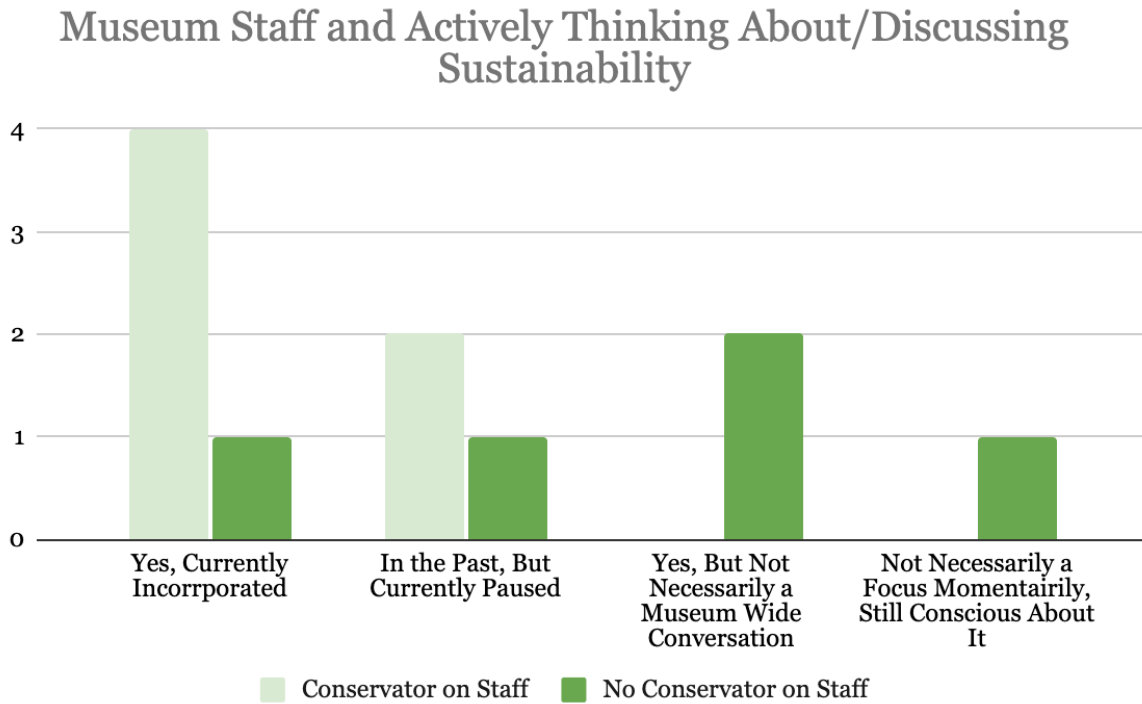
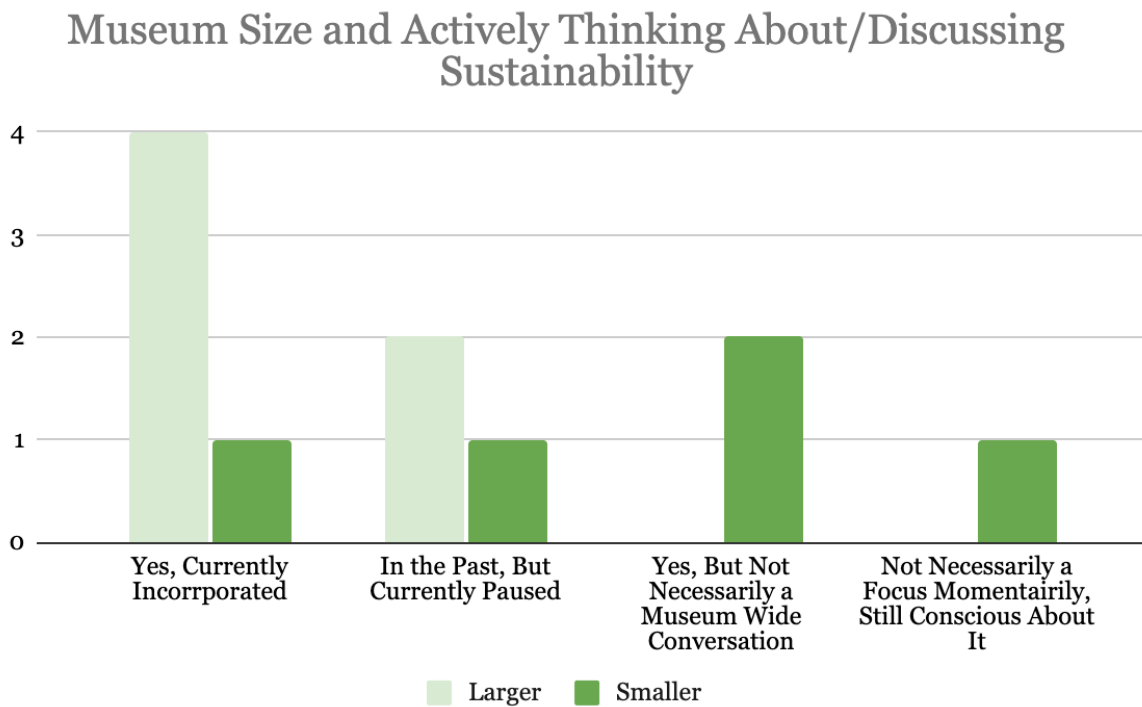


Figure 3



Appendix 4:
Comparison of Loan Incorporation in Sustainability Conversation

Figure 1:

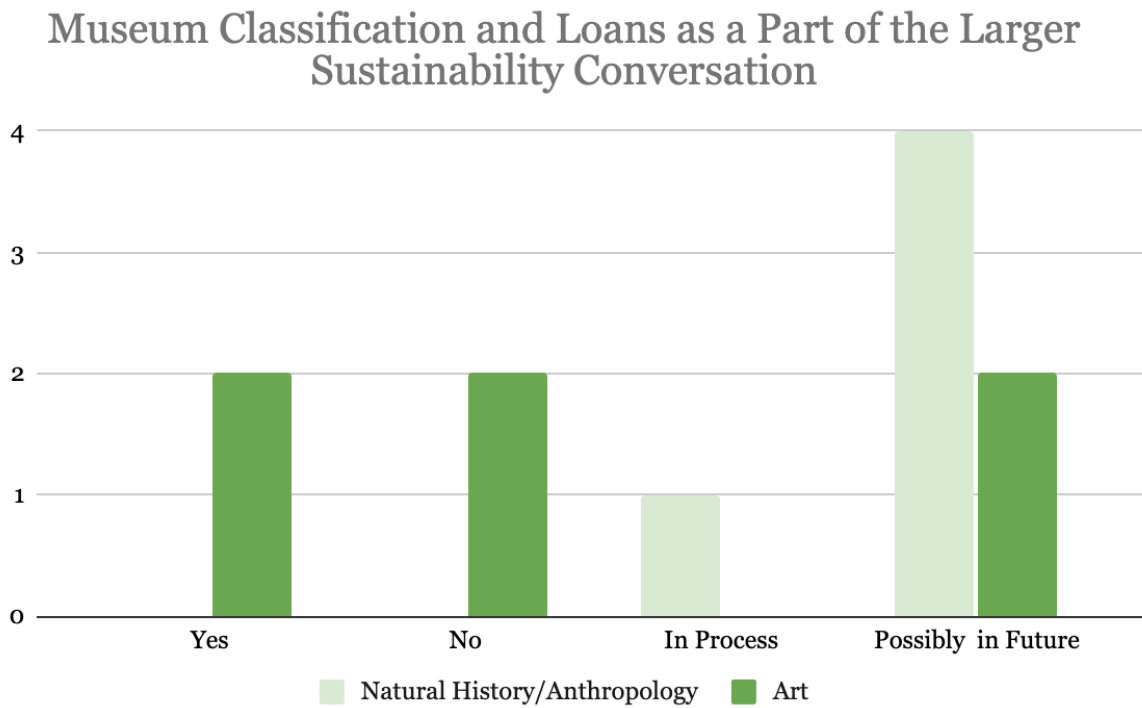


Figure 2:

Museum Staff and Loans as a Part of the Larger Sustainability Conversation

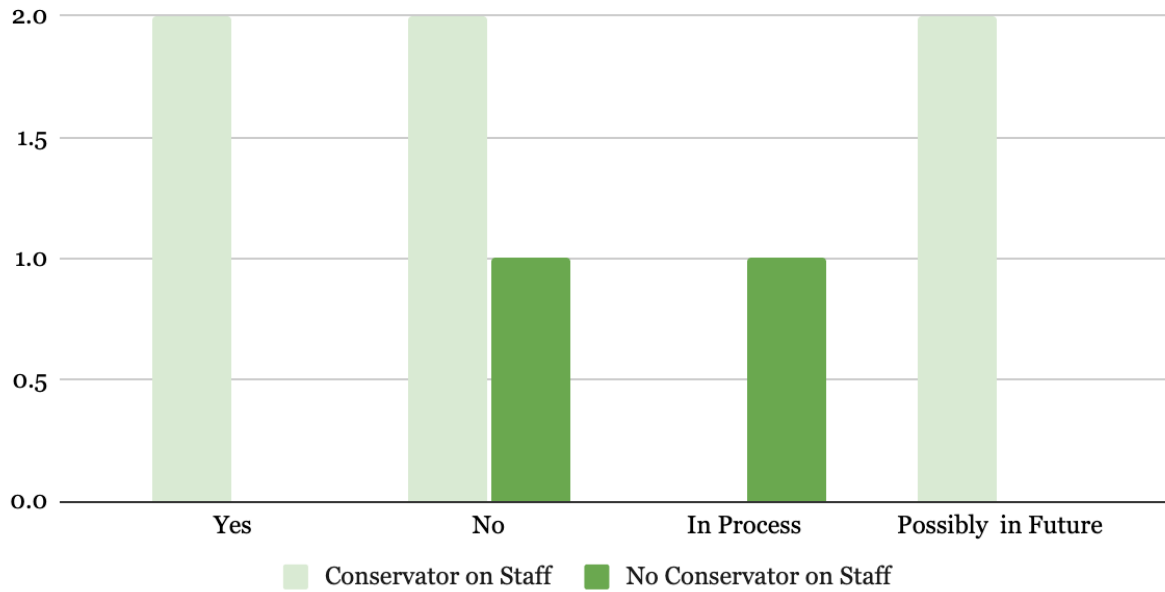
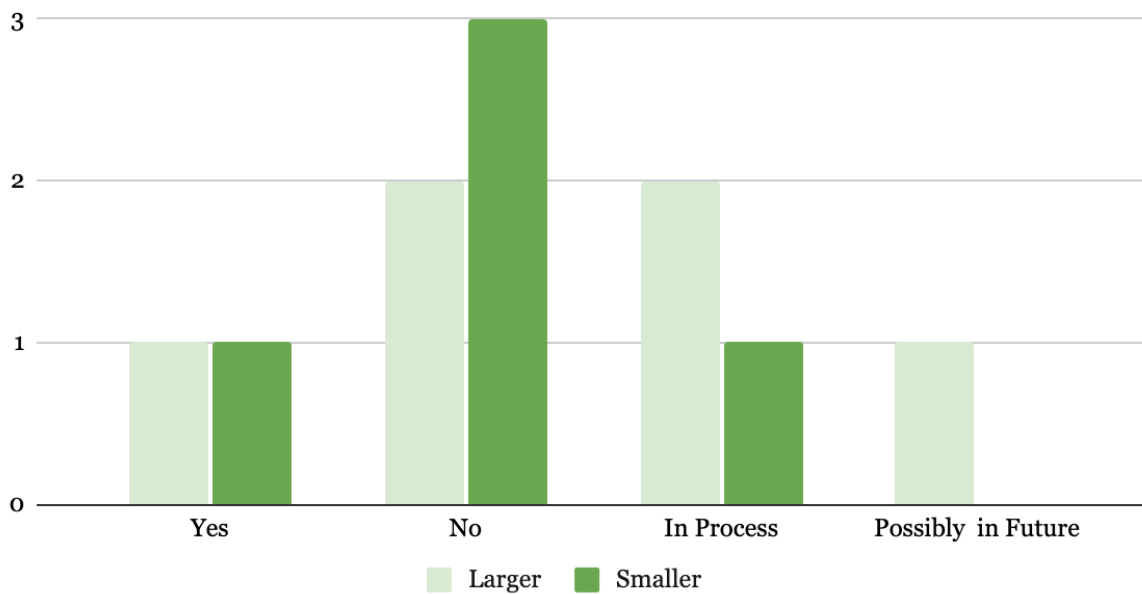


Figure 3:

Museum Size and Loans as a Part of the Larger Sustainability Conversation



**Appendix 5:
Comparing the Use of Industry Standard**

Figure 1:

Museum Classification and Maintaining Industry Standard

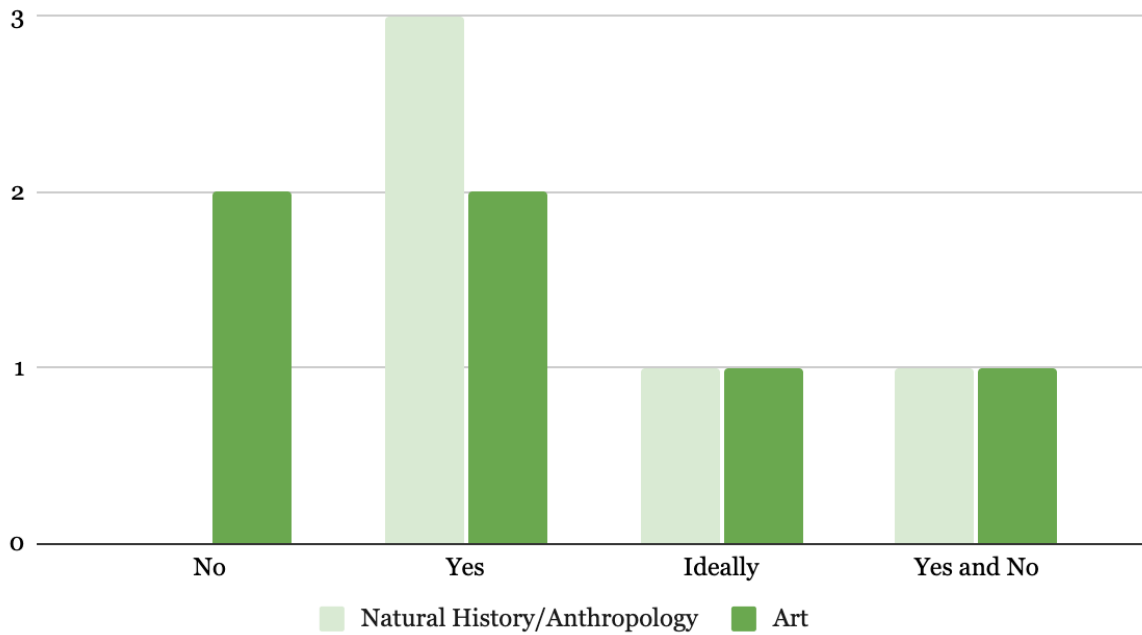


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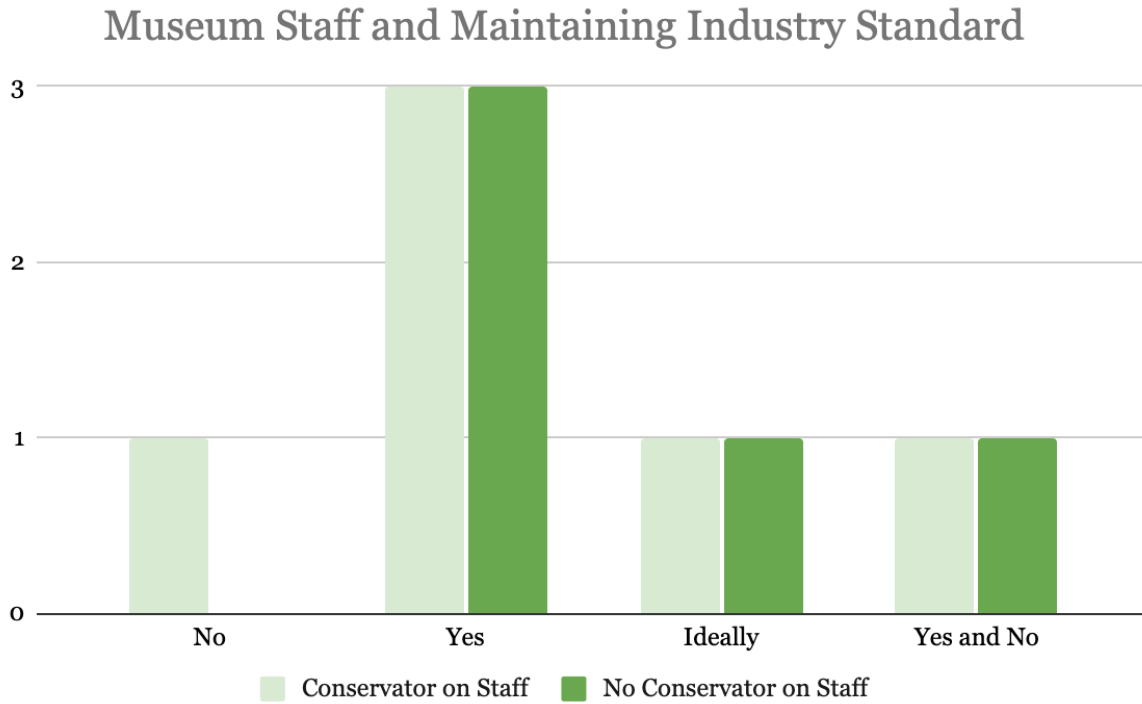
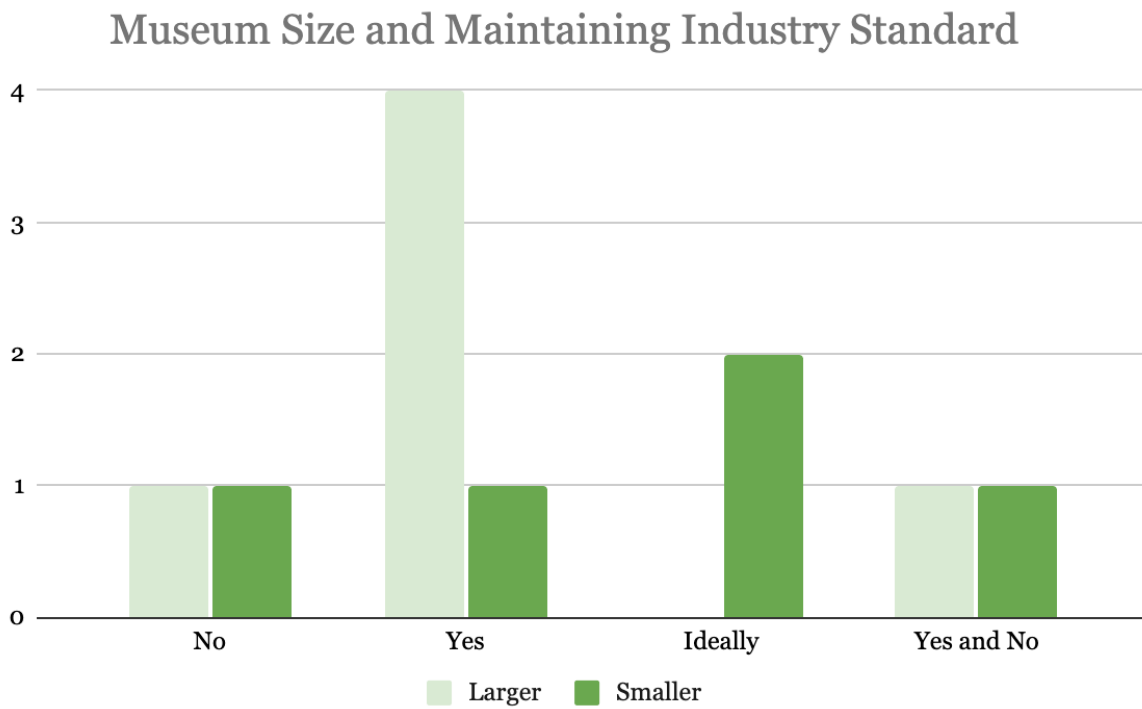


Figure 3:



Appendix 6:

Comparison and Industry Standard Being a Consideration for Borrowing from Another Institutions

Figure 1:

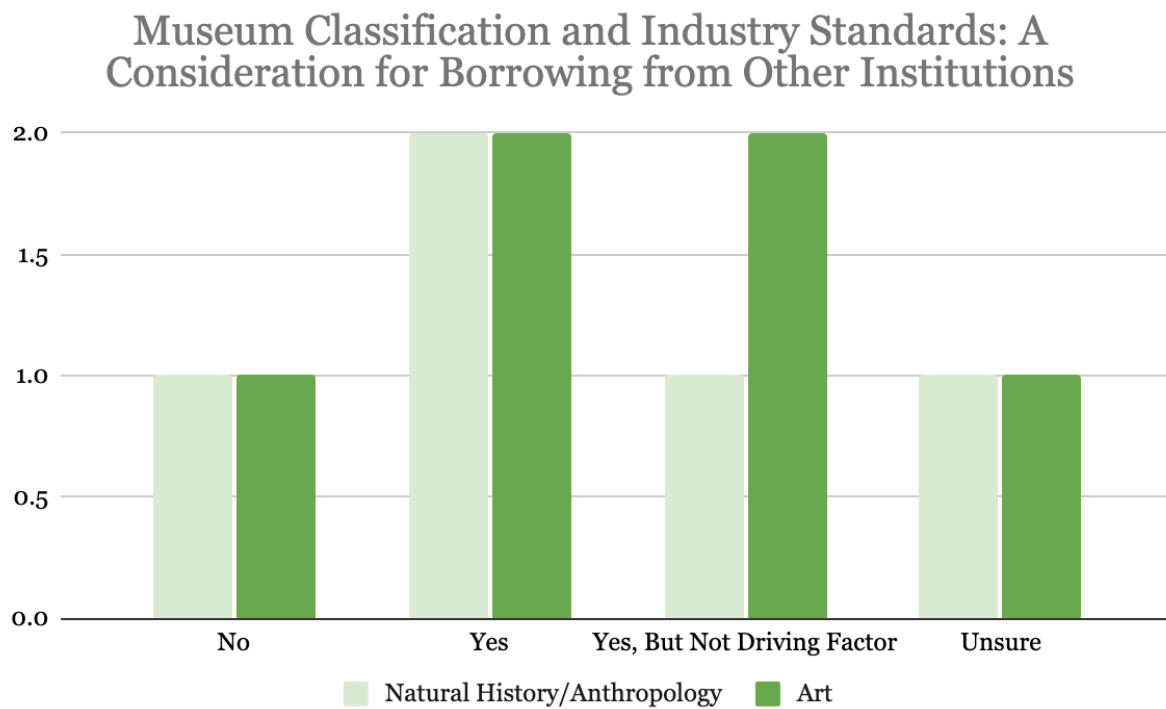


Figure 2:

Museum Staff and Industry Standards: A Consideration for Borrowing from Other Institutions

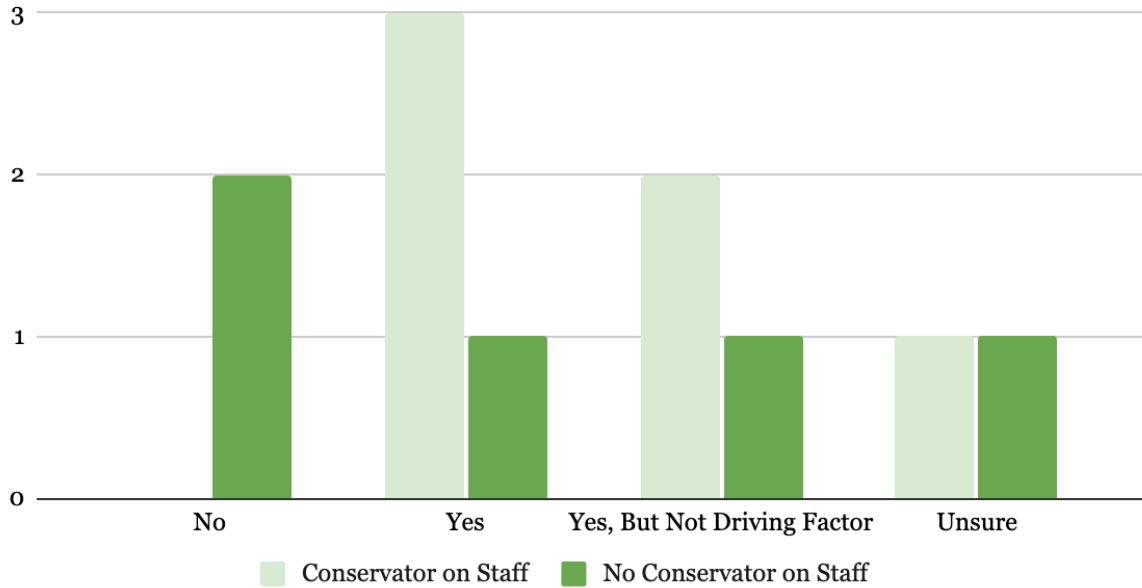
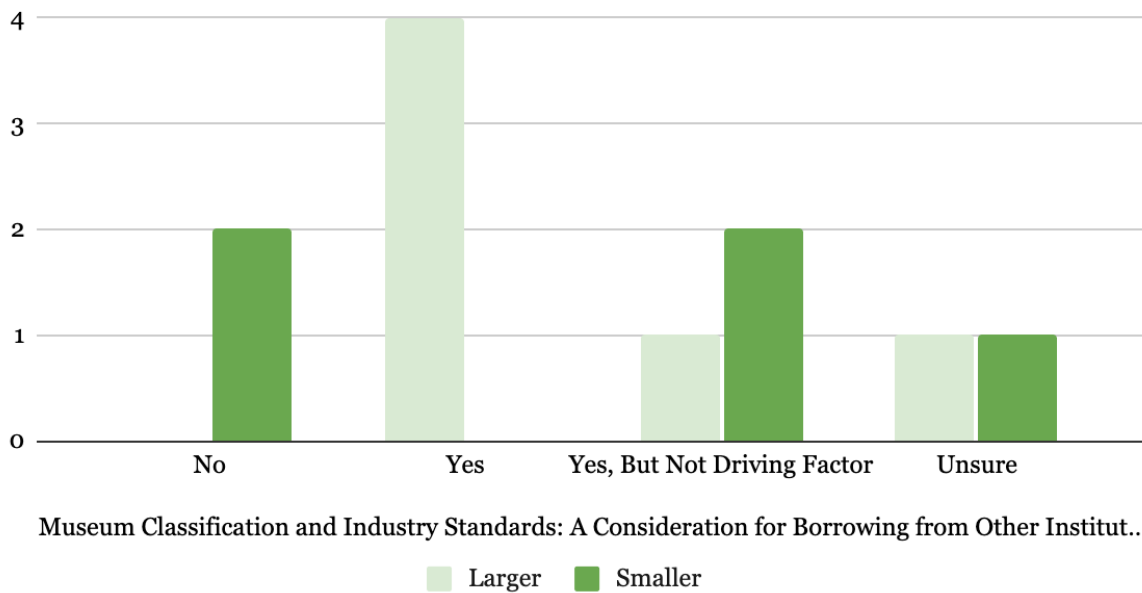


Figure 3:

Museum Size and Industry Standards: A Consideration for Borrowing from Other Institutions



Appendix 7:
Comparison and Discussing Set Point Expansion

Figure 1:

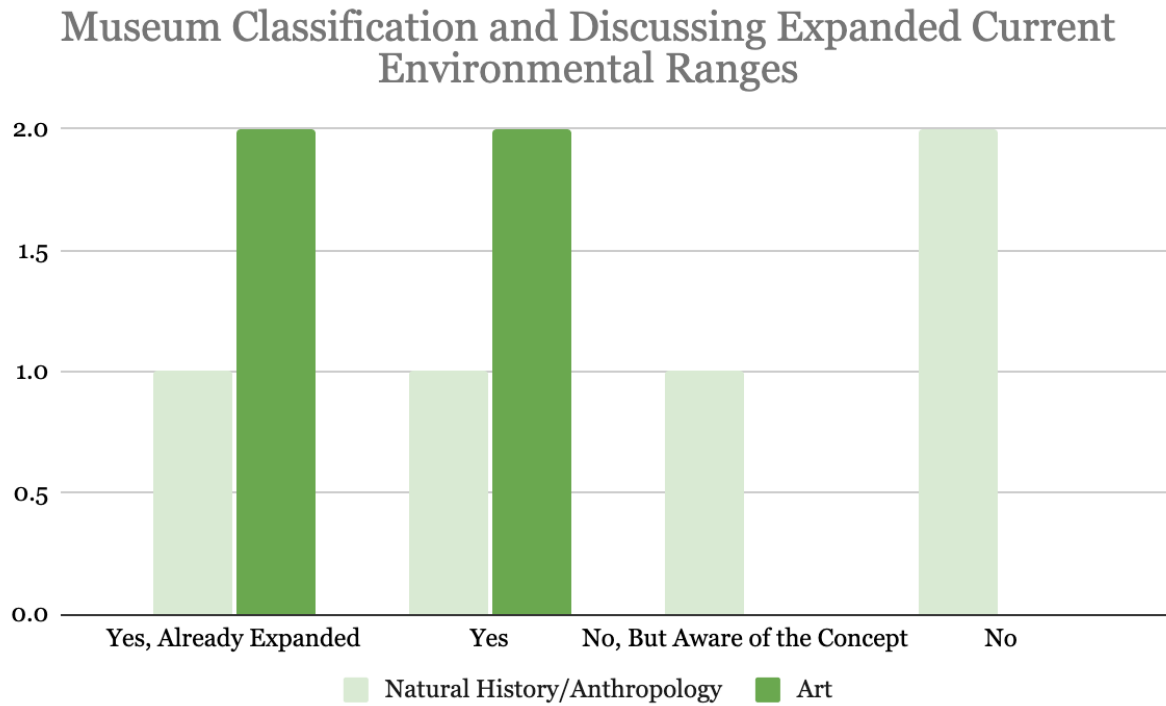


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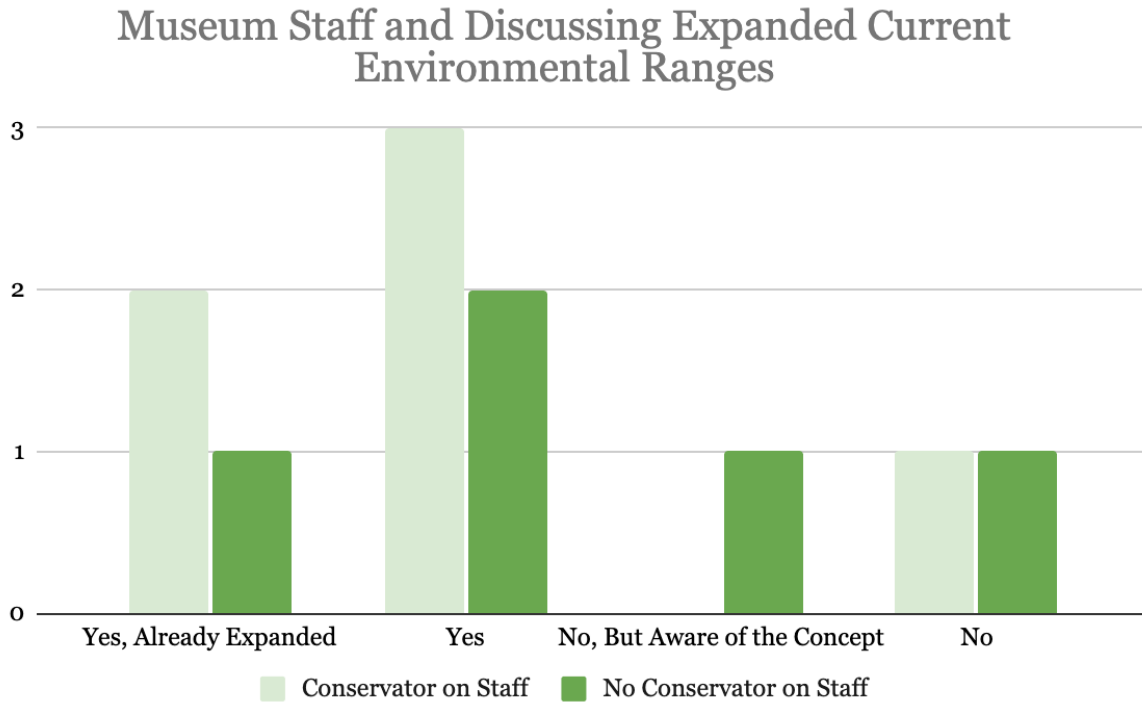
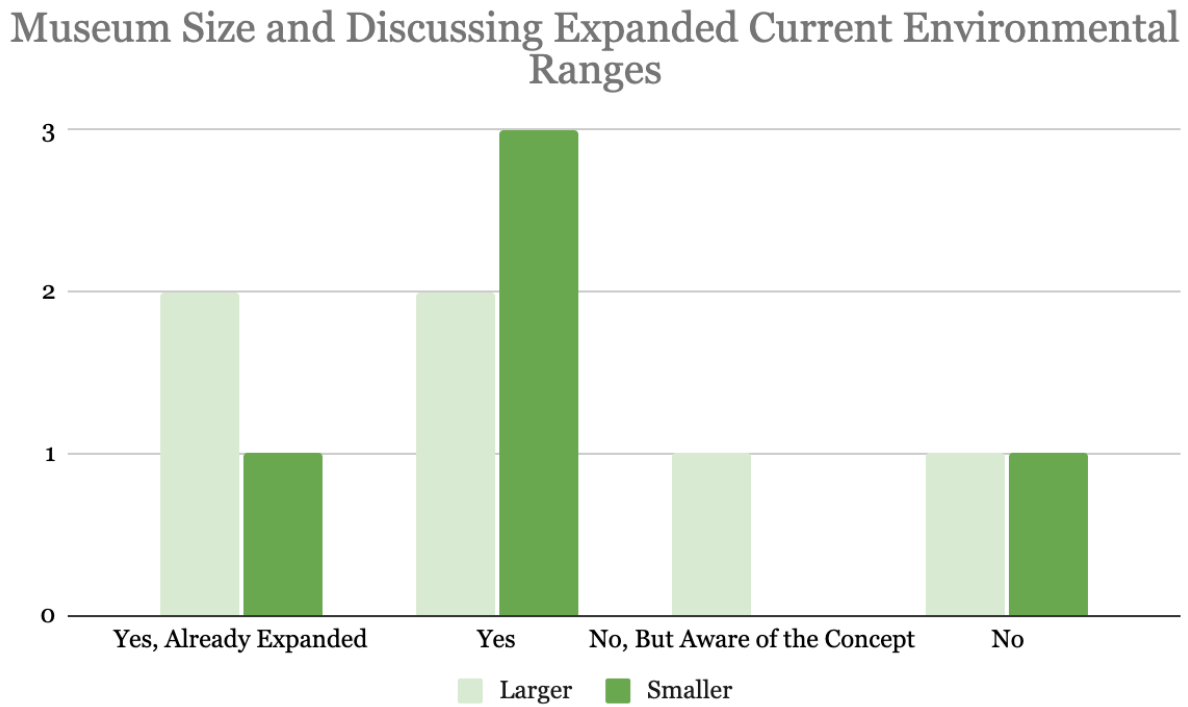


Figure 3:



Appendix 8:
Museum Comparison and Previous Denial of a Loan

Figure 1:

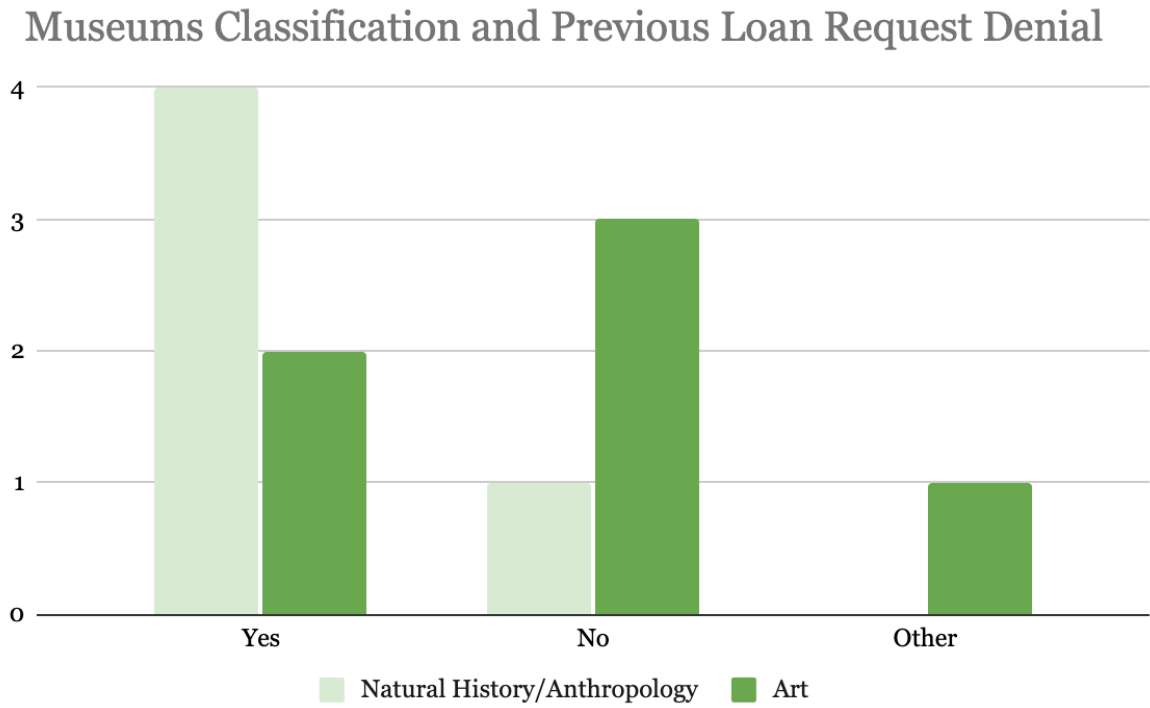


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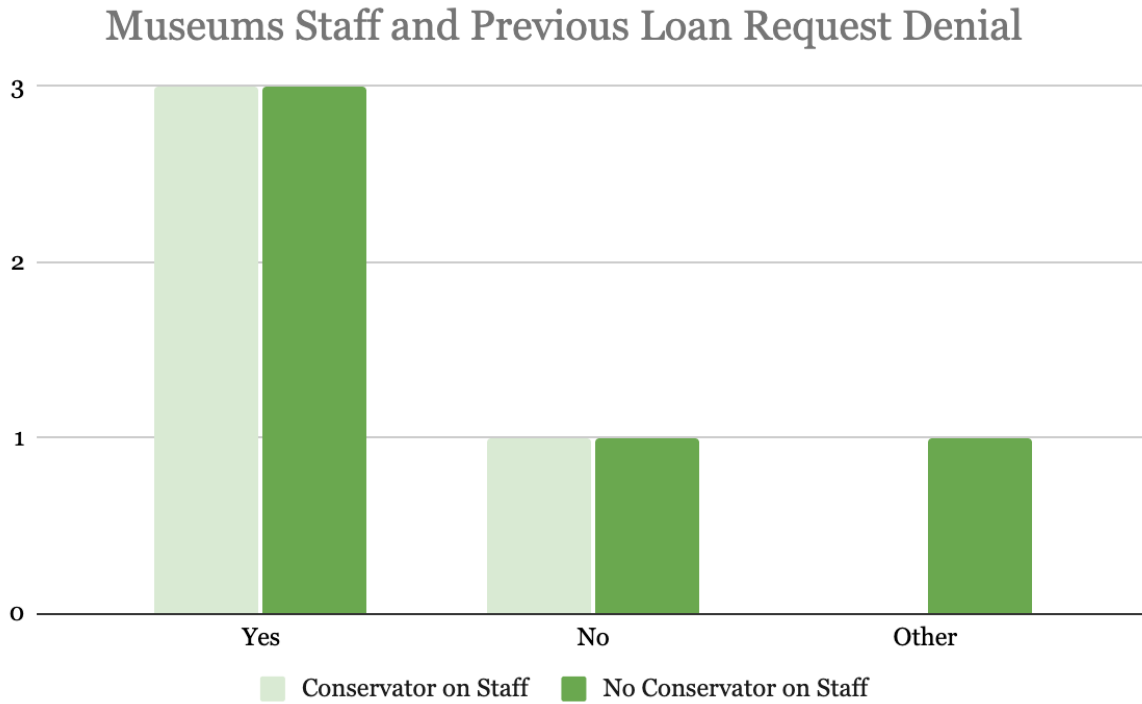


Figure 3:

