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Evaluating the Effectiveness of Biological Artifact Collection Management

Zuria Butler
Environmental Studies Department
The University of North Carolina Asheville
One University Heights
Asheville, North Carolina 28804 USA

Faculty Advisor: Dr. Andrew Laughlin

Abstract

As many informal science institutions are preparing to reopen to the public, it is essential that biological artifact (biofact) collections remain active and adapt to changes related to COVID-19. As a McCullough Fellow, I worked with my community partner, the Western North Carolina (WNC) Nature Center, to determine more resilient methods of biofact collection management and use in education programs. Project goals included the following: understanding staff and volunteer use of biofacts, creating a digital catalog of specimens in the biofact collection, and updating standard operating procedures (SOPs) for specimen sanitation and digitization. I created a survey to document staff and volunteer interactions with biological specimens to complete a comprehensive analysis of the perceptions and use of the biofact collection. I researched common collection management practices for sanitation and digitization to design new SOPs for the nature center's biofact collection. These SOPs can also be applied to biofact collections at other informal science institutions. The findings from this project are expected to strengthen the accessibility of the biological artifact collection as well as provide the WNC Nature Center's Education Department with recommendations on the future use of the specimens.

1. Introduction

Informal science institutions like the Western North Carolina (WNC) Nature Center play a large role in the education of their visitors. In a three-year nationwide study, Falk et al. researched the meaningfulness of zoos and aquariums through their immediate and prolonged impact on visitors[1]. The study focused on institutions accredited by the Association of Zoos and Aquariums (AZA). Institutions that are members of the AZA are evaluated on not only animal care but also conservation efforts and education programs. An overarching finding highlighted that visitors are aware of the educational and conservational value of zoos and aquariums. Therefore, it is important to understand the factors involved in the sustainability and resilience of such institutions.

Focusing on the WNC Nature Center's nonliving biological artifact (biofact) collection, this study aims to answer the following questions: (1) What are the WNC Nature Center staff/volunteer's perceptions of the biofact collection and its use? and (2) What are the most efficient standard operating procedures for databasing and sanitation of the WNC Nature Center's biofact collection? This introduction will address what collection curation and management means for a biofact collection, as well as sanitation practices for biofacts.

1.2. Nonliving Biological Artifact Collection Curation

Access to the collections of informal science institutions is usually restricted to curators, collection managers, and academic researchers. Collection curators are responsible for deciding what objects are relevant to the collection and support the values and goals of the institution as a whole. Whereas collection managers must implement procedures to preserve the condition of the collection while maintaining its organization and ease of use. However, public

perception and use are other vital components in the survival of the collection[2]. This is especially true for the WNC Nature Center's biofact collection as the preserved items or models of living organisms are often used in public education programs that focus on fostering environmental awareness. Consequently, the curation of a collection must be developed to fulfill the overall mission of the institution, including the needs of both the staff and visitors.

A relevant public collection must understand what meaning the specimens evoke for visitors[3]. Curating a collection addresses an array of questions including: (1) what is the specimen's value?; (2) how does the specimen fit in the collection?; (3) what is the scientific/ecological background of the specimen?; (4) how can the natural history, biodiversity, and conservation of the specimen be interpreted?; and (5) how can visitors interact with the specimen[4]? Robert Janes references the concept of 'ecological selves' – "the wider sense of identity that emerges when one's self-interest includes the natural world" – and outlines its importance in the process of museum curation[5]. He argues that to survive sustainably a collection must have a broader identity, one which includes nature in the self-interests of a larger institution, and thus, engages in "social ecology."

Curation begins with basing the selection and categorization criteria for objects on the identity of the institution housing the collection. Trevor Jones claims that specimens will not be useful in supporting the mission of an organization if they are not curated with those values in mind[6]. He notes that tiering is not just about the deaccession (official removal from the collection) of objects, although the process of tiering will help curators understand if their collection must be downsized. Techniques of tiering will be further discussed in the methods section of this paper. It is important to understand this process is ever-changing and must be adapted to current issues affecting the collection.

Ranking an artifact into a certain tier depends on many factors, including the physical condition and the public feelings associated with the object. While the physical quality and quantity of an object in the collection can be evaluated systematically, the meaning of an object is more conceptual. Janes emphasizes the importance of presenting an object with its contextual story[5]. For biofacts, this may mean recording the natural history of a species in addition to its biological and ecological characteristics. It is also important to acknowledge the community's personal relationship with the specimen[5]. In this manner, the organization and use of the collection are first built upon the goals of the institution and its connection to the public as a whole.

A database is a useful tool to document these physical and conceptual characteristics of objects in a collection. Stone outlines the characteristics of a database into the following categories: language, identities and communities, access and authority, and functionality[7]. Each of these traits is critical in maximizing the support a collection brings to its institution. Stone indicates that databases, while they may seem to be objective records, can have bias depending on how the information is presented, who can access the information, and whether the full 'story' of an object is described. Also, depending on the types of specimens, digitization of the collection in a database may be useful, especially when public access to the collection itself is limited.

1.3. Nonliving Biological Artifact Sanitation

Moving past curation into collection management, there is one issue that takes precedence at this time – how can we properly sanitize and disinfect objects to reduce the possible spread of infectious diseases like COVID-19? The CDC is providing information on the logistics of sanitation to help organizations and households determine the best way to clean, disinfect, and sterilize public spaces and objects. The CDC breaks sanitation down into three steps: develop your plan, implement, and maintain and revise[8]. They have provided a simple flowchart (Figure 1) for basic cleaning and disinfection procedures. Most collections are indoors, occupied within seven days, and house frequently touch surfaces and objects. Therefore, the non-porous and porous materials in the collection must be sanitized regularly.

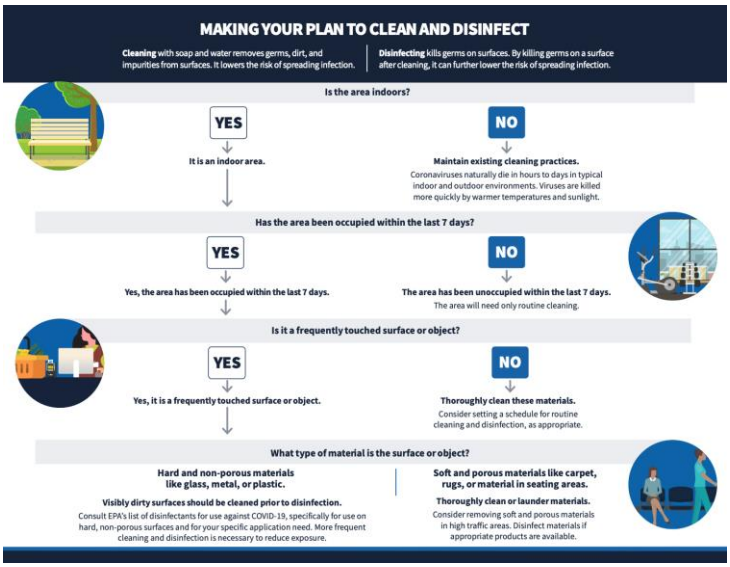

Figure 1. CDC Sanitation Flowchart[8]

It is also important to distinguish between cleaning, disinfecting, and sterilization. The CDC defines cleaning as "the removal of foreign material from objects and is normally accomplished using water with detergents or enzymatic products."[9] Cleaning must be done before disinfection, which uses a chemical to kill a majority of microorganisms, or sterilization, which kills all microorganisms. The success of a disinfectant depends not only on the chemical itself but the concentration and exposure time as well[10].

A review by Kampf et al. showed that strains of coronavirus can persist on inanimate objects for five to twelve days[10]. This insight brings into question what sanitation methods are best for nonliving biofacts. The method of sanitation varies depending on the type of biofact. In most instances, some level of disinfection has taken place during preservation (e.g. ethyl alcohol, isopropyl alcohol, and formaldehyde are common taxidermy chemicals as well as chemical disinfectants in healthcare facilities)[9]. Objects can also be sterilized by being frozen or placed in an autoclave machine which exposes them to pressurized steam. Plastic models or replicas are easily cleaned and disinfected but authentic biofacts, which are the remains of living organisms, risk permanent damage from chemicals[11]. For authentic objects, the best practice for sanitation is isolating the objects from people for six to nine days. This is an instance in which duplicates of an object are useful, and alternating scheduling of education programs is necessary. Personal protective wear including gloves, masks, and safety glasses/goggles are also important when disinfecting objects and surfaces.[11]

2. Methods

2.1. Study Site

The WNC Nature Center is an AZA-accredited zoological park with a mission to connect people with plants and animals found in the Southern Appalachians Mountain region[12]. The WNC Nature Center was opened in 1976 and is managed by the City of Asheville's Parks and Recreation Department. The Friends of the WNC Nature Center is a non-profit organization specializing in outreach and financial support for the park. In a 2008 survey, the Friends found that 85 percent of the Asheville residents "felt the Nature Center was very important to the community" and 73 percent "felt that it was very important for the Nature Center to expand and/or improve"[12].

In addition to the 60 species of animals and hundreds of species of plants living on-site, the WNC Nature Center houses a collection of nonliving biological artifacts. The education team uses biofacts to teach visitors about the ecology and conservation of Southern Appalachian animals. There are approximately 300 inventoried biofacts in the collection, which are categorized into the following types: whole mounts and mounted specimens, skeletons and shells, animal skins and pelts, teeth and jaws, feet, eggs, wings, feathers, fossils, plastic models, and laminated photos. Staff

and volunteers at the WNC Nature Center manage the biofact collection according to federal and state laws and regulations.

2.2. Survey of Staff and Volunteers

To better understand how the education team perceives the use, management, and sanitation of the biofact collection, I created an anonymous survey with the collaboration of Alayna Schmidt, the Education Specialist and Young Naturalist Coordinator at the WNC Nature Center. This survey focused on ranking types of biofacts by their significance, quantity, and quality. Questions in the survey also evaluated current practices for preservation, use, and sanitation. I based the ranking strategy used in the survey on the criteria the Collection Committee of the Kentucky Historical Society outlined for a tiering grid that separates qualifying factors into significance, quantity, quality, and usefulness[6]. The survey was distributed on July 6, 2020, to six WNC Nature Center education staff by Eli Strull, the Curator of Education and Guest Services. The survey was also sent to ten volunteers on July 7, 2020, by Candace Poolton, Volunteer & Community Outreach Coordinator for Friends of the WNC Nature Center. Responses were collected until July 17, 2020, with a total of 12 received. Eight participants were volunteers and four were staff members. A majority of the participants have worked at the WNC Nature Center and with the biofact collection for 1-4 years.

2.3. Standard Operating Procedure for Biofact Collection Management

Based on the results of the survey and the inventory list of biofacts, I updated the collection's master list into a new database for specimen information using Google Sheets. In the database, I recorded available specimen information including database number, item name, biofact type, animal classification, storage location, container type, quantity, quality, and recommended sanitation procedure. I digitized the collection by photographing the cataloged biofacts and uploading photos to the database. Once complete, this Google Sheets database will be shared with the WNC Nature Center's education team. I will also meet with the education team to teach them how to edit the database for future biofact cataloging. As an additional resource, I created a standard operating procedure (SOP) that details this databasing and digitization procedure.

I also designed a specimen sanitation SOP based on recommendations from the Centers for Disease Control and Prevention[9], the National Center for Preservation Technology and Training[11], the Society for the Preservation of Natural History Collections[13], and Melissa Fuentes the Vertebrate Collection Curator at the Campbell Museum of Natural History[14]. The SOP addresses multiple methods of sanitation, focusing on the concerns voiced by survey participants. Hardcopies of both the SOP on databasing and digitization as well as sanitation were distributed to the education team for their reference.

3. Results

3.1. Biofact Quality

Participants were asked to describe the condition for each type of biofact as either "very good," "good," "fair," "poor," or "very poor." I quantified these five responses on a scale from 2 to -2, equating "fair" to a value of 0. I then averaged the values for each biofact type (Figure 2). All biofacts received a positive average quality value. Laminated photos and plastic models were described to be in the best condition with the majority of responses stating they were in "very good" condition. The lowest-ranked biofact types were wings as well as teeth and jaws. No biofact type was described to be in "very poor" condition. One participant commented, "The biofacts in poorer condition tend to be so because of their fragility and frequent use; that being said, they are replaced often enough that they don't often fall into a condition I'd rate below fair." Another participant attributed wear to biofacts from "use and storage."

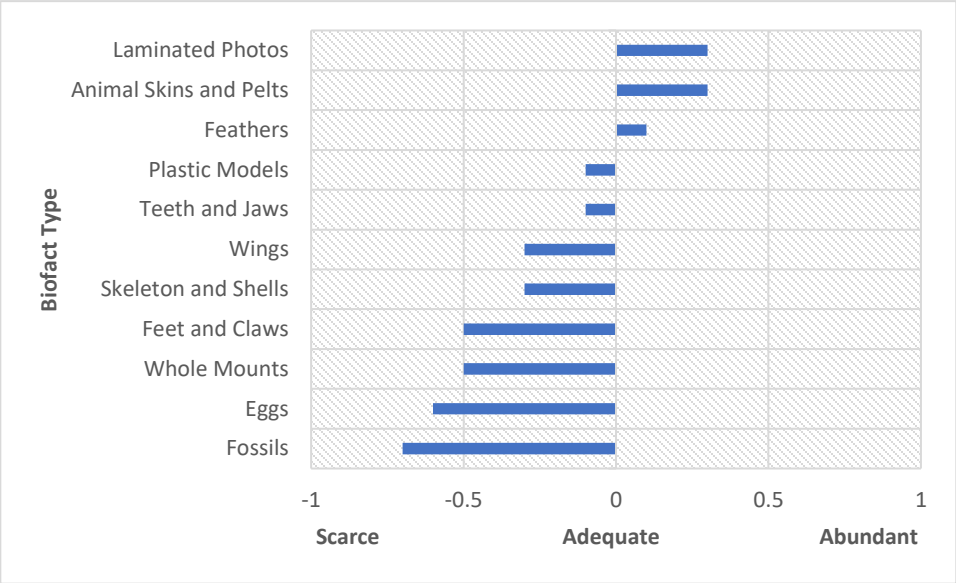

Figure 2. Average biofact quality value

3.3. Biofact Quantity

Participants were asked to rank the quantity for each biofact type as "scarce," "adequate," or "abundant." I quantified these three rankings on a scale from -1 to 1, with "adequate" equaling 0. I calculated the average quantity values for each biofact type (Figure 3). Most of the biofacts received a negative average quantity ranking. Eggs and fossils were described as the scarcest. Laminate photos, animal skins and pelts, and feathers scored positive average quantity values.

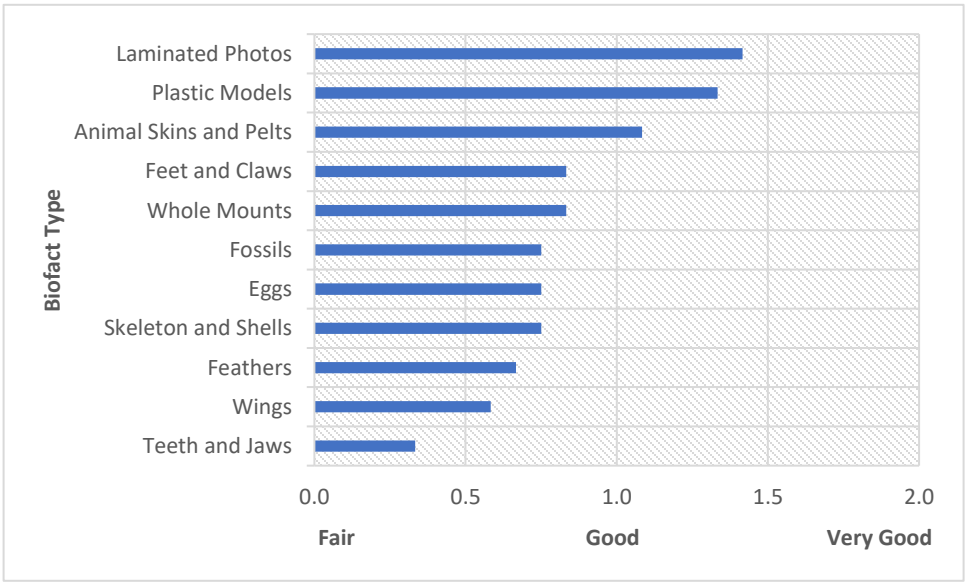

Figure 2. Average biofact type quantity value

Participants also ranked the commonality and replaceability of biofact types. Participants were able to describe the biofact types on a scale ranging from "rare and likely irreplaceable" to "common and easily replaceable." I quantified the rankings as follows: "rare and likely irreplaceable" = -2, "uncommon and difficult to replace" = -1, "somewhat

common and moderately difficult to replace" = 1, and "common and easily replaceable" = 2. For each biofact type, I calculated their average commonality and replaceability value (Figure 4). Feet and claws, animal skins and pelts, fossils, and whole mounts and mounted specimens received negative average commonality and replaceability values. The only biofact type which the majority of the participants described as "rare and likely irreplaceable" were animal skins and pelts. Laminated photos, plastic models, and feathers ranked the highest in commonality and replaceability.

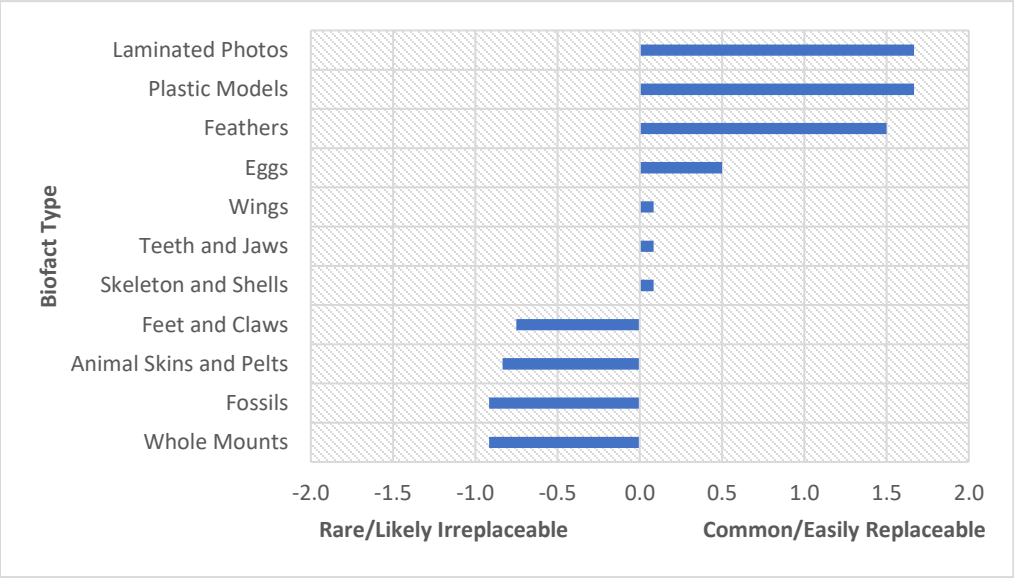

Figure 3. Average biofact type commonality/replaceability value

3.4. Biofact Use

The survey asked participants to select approximately how many on-site and/or off-site education programs each biofact type was used in. The majority of participants reported using skeletons and shells, animal skins and pelts, teeth and jaws, plastic models, and laminated photos in 10 or more programs. Whole mounts and mounted specimens, fossils, and eggs were the only biofact types which participants reported not using in programs. The approximate length of time participants reported using biofacts during on-site and off-site education programs as well as park tours varied. Expanding on biofact use, one participant commented, "Items that can be touched bring a 'wow' factor that helps participants build a connection to the animal."

3.5. Biofact Sanitation

Participants ranked their satisfaction with the sanitation routine for each biofact type on a scale ranging from "very satisfied" to "very dissatisfied." I quantified the rankings for each biofact type from -2 to 2, equating "neither satisfied nor dissatisfied" to 0. I then averaged the satisfaction values for each biofact type (Figure 5). The majority of biofact types received negative average sanitation satisfaction values. Only laminated photos and plastic models received positive average sanitation satisfaction values. However, the average values only ranged from -0.4 to 0.3, indicating the most participants feel "neither satisfied nor dissatisfied" with the current sanitation routines at the WNC Nature Center. One participant commented that the WNC Nature Center does not "currently have a system for sanitization." While another addressed the initial sanitation processes such as freezing and autoclaving in the comments section.

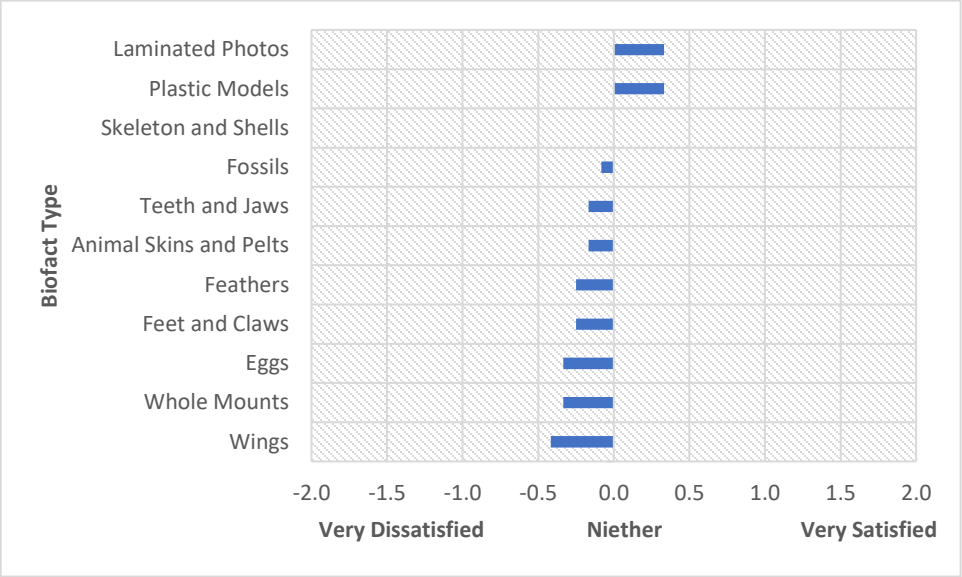

Figure 4. Average biofact type sanitation satisfaction value

Eight participants reported that regularly handled biofacts are left in isolation for either "1-4 days" or "5-9 days" after use (Figure 6). Three reported leaving biofacts in isolation for "less than a day." One participant commented that isolation time "varies greatly based on a multitude of moving parts." Another participant elaborated on the impacts of COVID-19, commenting "items are rarely handled and incidentally are left in isolation 5-9 days or more" while the WNC Nature Center is closed to the public. This participant further explained, "Historically, hard items like skulls and plastic models would be wiped down periodically to clean and sanitize while soft items like pelts and feathers did not really get sanitized between use. Historically, regularly handled biofacts were handled multiple times a day during field trip seasons and typically at least once a day or every other day during other times of [the] year for public programs."

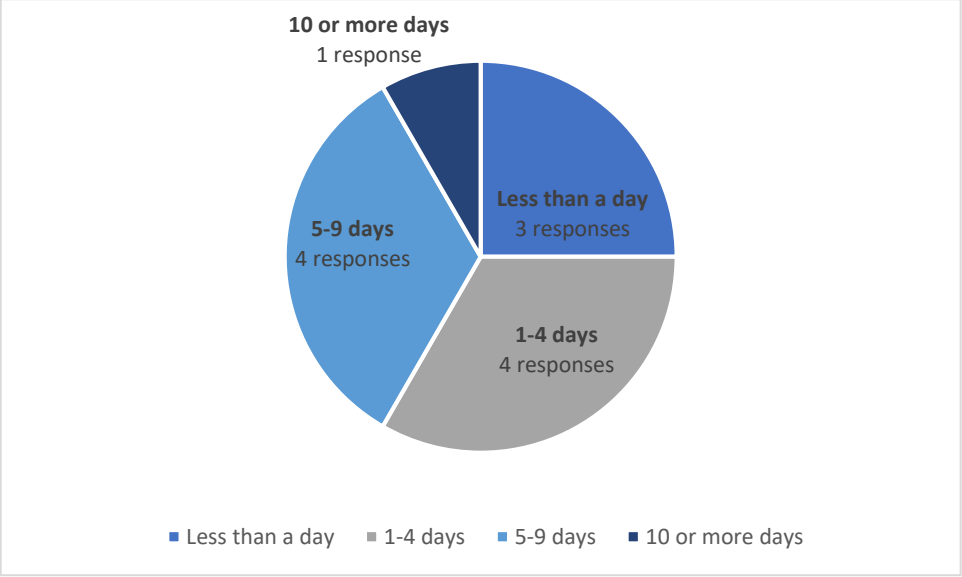

Figure 5. Time biofacts are left in isolation after use

3.6. Biofact Collections Management and Additional Comments from Participants

Participants were asked to rank their satisfaction with the database system and digitization of specimens. For all biofact types, the most common response was “neither satisfied nor dissatisfied.” Five participants commented that they did not know of a database system. A participant that reported they never interacted with a database system commented that it could be helpful to have “a number system that corresponds with a master list by species” for hard to identify biofacts. Another participant also proposed a database which staff and volunteers could “…use to quickly see which items are ‘checked out’ or ‘reserved’ for use (and by who) and where those items are located and should be returned to.”

Participants also commented on the biofact labeling system as well as the storage system concerning both the preservation and accessibility of specimens. One participant explained the need for “…a good labeling system for tagging individual biofacts that can be covered while in use…” This participant also acknowledged that the storage system “is not ideal for long-term maintenance of the collection as many items are placed into overfilled drawers and some items can get squished or caught as the drawer closes, degrading the item.”

3.7. Databasing and Sanitation Standard Operating Procedures

Below are abridged versions of the standard operating procedures I created for biofact databasing (Figure 7) and sanitation (Figure 8). For databasing procedures, the steps are as follows: (1) ensure a biofact aligns with the collection's goals and values by evaluating its quality, rarity or commonality, and usefulness in education programs; (2) gather as much information on the biofact as possible, such as species, locality, collection date, and collector of the object; (3) input each biofact along with all useful information into the database; (4) include a photo to digitize the biofact for virtual viewing; and (5) document whether a biofact is currently checked-in, checked-out, reserved, or in insolation, along with the date the status was changed and the name of the staff member or volunteer using the biofact. Sanitation procedures include the following steps: (1) wash hands when working with biofacts to prevent the spread of germs and as protection from any harsh chemicals on the specimens; (2) for biofacts that are too fragile or too rare to sanitize, use the specimen in observational education programs only; (3) separate isolated specimens in a room temperature environment for 6 - 9 days before re-storing in the collection or using in a program; (4) clean display cases, jars, and plastic models with disinfectant wipes; (5) spray soft, fragile biofacts with a fine 70% Isopropyl (rubbing alcohol) mist, which will kill most pathogens; (6) for biofacts infested with pests, freeze biofacts for 2 days, then leave at room temperature for 1 day, and finally freeze for 3 more days to kill insects; and (7) finally, regularly examine the condition of biofacts to help prevent the spread of contamination and irreversible damage to specimens. I have provided hardcopies of the unabridged SOPs to the WNC Nature Center’s education team.

Figure 6. Databasing SOP

Figure 7. Sanitation SOP

4. Discussion

4.1. Interpretation and Analysis of Survey Results

My research found, and other authors support, that collection evaluation must be based on methods that will result in clear, meaningful information that is of use to the specific institution[15]. The survey for this study addressed the main topics of concern to the WNC Nature Center's biofact collection staff. Because many participants were unaware of certain characteristics of the collection (i.e. whether certain biofact types were present or the existence of databasing, labeling, and sanitation procedures), their rankings may have been under- or overrated. This is common in collection evaluation as "there is a huge amount of unrealized information content"[16]. This discussion approaches the results in relation to the theoretical bases for collection management in which a collection is defined as a set of elements[17] such as specimens, drawers, or cabinets[18]. In the case of the WNC Nature Center, the elements are the different biofact types. Laminated photos and plastic models ranked high in quality, commonality and replaceability, and sanitation procedure satisfaction, indicating their valuableness to the collection. However, plastic models had a negative average quantity value which suggests that future accession of biofacts could focus on these two types. Currently, there are no recorded fossil specimens in the biofact inventory list. This explains the biofact type's overall low ranking, as many participants were uncertain how to evaluate a biofact type that is lacking in the collection.

4.1.2. biofact collection quality, quantity, and use

Common agents of deterioration can range from theft and vandalism to pests and incorrect environmental conditions (temperature and humidity of storage areas)[17]. For the WNC Nature Center, survey participants claimed physical use and curatorial neglect from improper storage were the causes of degraded quality. Overall, however, the staff and volunteers find their collection to be in relatively good condition. At the time of writing this paper, I have determined that approximately 85.5% of the cataloged biofacts are in "good" or "very good" condition.

The fact that many of the biofact types received negative average quantity values suggests that staff and volunteers see a need to expand the biofact collection. Mounted specimens and whole mounts, wings, and eggs were reported to be low in quantity and did not show significant use in programs. Determining the value of these biofact types in education programs requires further input from staff and volunteers before decisions can be made as to which biofact types they should add or remove from the collection.

4.2.2. collection management and sanitation of biofact collection

As many participants reported having a lack of knowledge of the existing database system or sanitation procedures, these two areas of collection management should be the main focus for the WNC Nature Center's education team. Whole mounts and mounted specimens, wings, and eggs likely received a lower ranking in sanitation satisfaction because they are more fragile and rarer than other biofact types and suffer deterioration from disinfectants. In contrast, the quality of plastic models and laminated photos are not dependent on regular disinfecting.

4.2. Composition of Standard Operating Procedures

As many survey participants reported not knowing of a database system, I found it vital to create a resource that would simplify the steps of the process. To create the SOP for biofact databasing and digitization, I summarized the steps I used while updating the database for the WNC Nature Center. The main focus of developing the database was to adhere to the needs of the institution. The updated biofact database was modeled after the existing master list inventory of biofacts in the collection, though it contains several new features. I added a column for database numbers as one participant noted having a unique number associated with each biofact would help distinguish hard-to-identify biofacts from each other. I also included an area to record the status of a biofact, addressing one participant's desire to be able to see if a biofact is checked in or out, reserved, or in isolation. There is also an area for photos of biofacts to be uploaded. Lastly, the proper sanitation procedure can be listed in the database.

The Sanitation SOP was also a necessary resource based on the survey. I included multiple sanitation options based on the biofact's susceptibility to degradation from regular disinfection. As recommended by Dr. Mary Striegel, a conservation scientist from the National Center for Preservation Technology and Training, items may be left in isolation for six to nine days if they are too fragile or rare for disinfection[11]. Additional suggestions for disinfecting with alcohol, freezing specimens with pests, and conducting routine inspections of biofact degradation were from Melissa Fuentes, the Vertebrate Collection Curator at the Campbell Museum of Natural History[14].

4.3. Constraints of the Study

Because this study took place during the COVID-19 pandemic, the chance to conduct an in-person open discussion with volunteers and staff on their perceptions of as well as suggestions and recommendations for biofact collection management was not possible. The survey was administered virtually, and I received more volunteer responses than staff responses. Many of the questions required information that volunteers were less knowledgeable about. Quarantine also prevented my ability to work on the grounds of the WNC Nature Center and complete the updated database and digitization of the collection in the summer of 2020, carrying that work into the fall season.

5. Conclusion

The final standard operating procedures and database format from this study can be applied to many nonliving biological artifact collections. It is critical to consider what information and values are most important to an institution before evaluating and adapting its collection. As educational collections of informal science institutions move into a post-COVID world, it is essential to continue asking: (1) Are the specimens compatible with the collection's overall mission?; (2) Does the database reflect the historical/ecological/cultural background of the specimen and full "story" of the collection?; and (3) Are education programs related to the collection adaptable to virtual experiences and/or more rigorous sanitation regulations? Future studies may seek to analyze routine collection evaluations with recorded databases of the specimens and education programs.

6. Acknowledgements

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