A guide to Ornithology and Mammalian Collections within Natural History Museums

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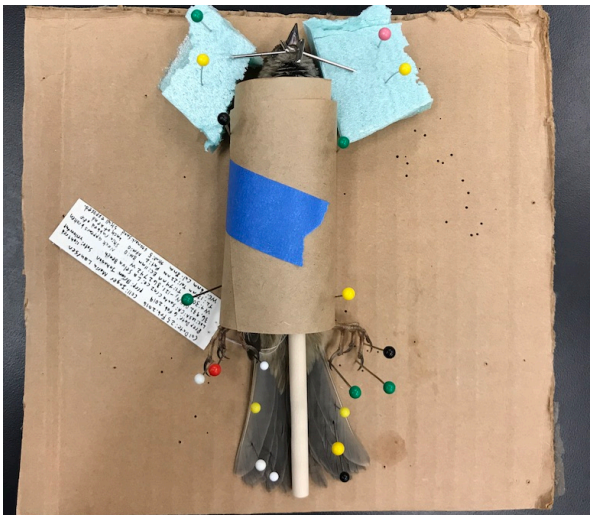
Introduction

This guide covers basic concepts and techniques used in the long term preservation of Ornithology and Mammalian collection. Natural history museums and their collections, provide science and society with innumerable benefits (Suarez et al. 2004). A few of these benefits include educational purposes, research, and forming the baseline of collected knowledge. Specimens along with their data can be used as important sources of information to evaluate anthropogenic impacts on environmental conditions (Cook et al. 2014). The long term preservation of specimens and their data provide irreplaceable insight into the conditions and biodiversity from where/when they came from. It is important to protect this record for future generations.

Specimen Collections

Natural history museums contain several different kinds of specimen collections. These can be organized in a variety of ways, but generally are organized by taxonomic groups or specimen storage requirements. Different taxonomic groups require different techniques for preservation. This section will review the most common kinds of specimen preservation techniques.



A *Zonotrichia atricapilla* (Golden-crowned sparrow) pinned to dry as a study skin. The data tag contains all its pre taxidermy measurements and available data related to the specimen.

Before any preservation of a specimen is conducted, it is important to record all data about the specimen as possible, including location, date, collector, size, shape, weight, color, cause of death, and any other relevant data. It is good practice to freeze the specimen prior to preservation to kill any unwanted pests from entering the museum or prep room. Pests found on a specimen should be noted with the specimen and preserved themselves. The pests should be noted and preserved for potential future research. Freezing also slows the deterioration of the specimen until there is sufficient time to process the specimen for introduction to the collection.

Study Skins

Study skins are a common preservation technique because of their simplicity and usefulness. Specimens can be preserved as a full specimen or a partial specimen based on what the specimen will be used for and how they were collected. Examples of partial specimens include wings, heads, feet, tails, or any other body part. This technique does not use chemicals, allows for easy compact storage, preserves color of fur and feathers, preserves general shape and size, and is more durable/accessible for research or teaching aids than other preservation techniques.

Tyto alba (Barn Owl) study skins stored in a museum cabinet along with other Ornithology study skins.

Study skins are specimens found within a collection used for research or teaching. These are preserved with extremities tight to the body allowing for easy storage within collection drawers. Study skins are preserved by skinning the specimen and then removing the carcass, most of the skeletal structure, and all soft tissue. Specimens are stuffed with cotton but traditionally were stuffed with straw, duff, or grasses. Sometimes a dowel is placed inside the body to provide structure, and then the specimen is sewn shut. The specimen is then pinned into place on its back, wings folded, toes spread, bills tied or glued closed, and dried. Once dried, specimens can be added into the collection.

Mounted specimens

Mounted specimens are those found within a museum diorama or life like display. Unlike a study skin mounted specimens represent an artistic rendering of the specimen by the taxidermist. These specimens are fantastic for public displays, but are less useful as research specimens. Mounted specimens are at a greater risk of being damaged while handling or in a collections storage than study skins. Storage of a mounted specimen is more difficult due to the varying size, shape, and additional materials used with the specimen.

Knowing how a mounted specimen was preserved can influence how it is cared for long term. There are two main techniques used for preparing mounted specimens: traditional and freeze-drying. Both techniques can be subdivided into many more specific techniques, which I do not discuss in detail here. Both methods use wires to attach the specimen to the mount,

A collection of taxidermy mounts showing specimens in life like poses.

often through the feet if the specimen is standing or for birds in flight the wire is exposed on the body.

Traditional mounts are prepared in similar fashion to that of a study skin. Specimens are skinned, the carcass, skeletal structure, and soft tissue are removed. The skin is laid on a formed body made from a pre-made foam mold, fiberglass, or clay. The other options is using wire as the rigid skeletal structure and a stuffing material usually cotton to form the body. In both methods the specimen is then sewed up and dried into position. Traditional methods in the past have incorporated different chemical baths or tannings to clean the skin, soften the skin, and deter pests. Traditional mounts take considerable skill and knowledge to produce a museum grade specimen. These types of mounts will have glass or plastic eyes and their mouths and feet may be painted to replicate natural colors or poses. Identifying a traditional mount can be done with close and careful observation. Traditional mounts will generally have a line or crease in the fur or feathers from the original incision and stitches closing up the skin. This is most often near the vent, belly, or chest area depending on the taxidermists' preference and how the mount is displayed hiding the area.

The line down the breast of this bird is from the traditional taxidermy process. This won't always be present but often is and will not be present on freeze dried specimens. The ring around the neck is from removing the head during the traditional process as to not rip the skin while cleaning the skull.

Freeze-dry mounts are the least invasive form of taxidermy. The freeze-drying process using freezers and vacuums to remove all the water from the frozen specimen. For this method the carcass and soft tissue are not remove. The eyes are removed and replaced with glass for cosmetic purposes. Once the specimen has been freeze-dried it is supported by its own skeletal structure, so no additional wires or frames are needed for structural

support. Wire is used to attach the specimen to its display mount were as the wire is inserted into the specimen prior to freeze-drying. Specimens of all sizes can be freeze dried. The greater the size of the specimen the longer the process takes. Making small holes in the specimen will increase the rate at which the specimen is preserved, however this may allow fat to rise to the surface on the specimen causing damage (Hendry, 1999). Freeze-dried specimens pose the greatest risk for pest infestation as they still contain soft tissue. Identifying a specimen that has been freeze-dried can be done with careful observation looking for the absence of an incision line or crease in fur and feathers.

Lepus californicus (Black Tailed Jackrabbit) as a fully articulated skeletal specimen.

Skeletal

Skeletal specimens or Osteology collections are bones ranging from a single bone chip, to skulls, or to fully articulated skeleton specimen. These specimens come from a wide range of taxonomic groups. Skeletal specimens are prepared using beetles to eat away all soft tissue, boiling away soft tissue, or burying outside letting them decompose naturally.

Fluid Preservation

Fluid preservation is the long term preservation of a specimen submerged within a fluid. Specimens preserved in this way will last hundreds of years. The only limit as to what can be preserved in this way is the size of the container and amount of fluid required. Specimens preserved in fluid lose their color and may swell or shrinking in size. Fluid preservation can be done with all taxonomic groups, it is commonly used to preserve Herpetology, aquatic invertebrate, and Ichthyology specimens (AMNH, n.d.). It is less commonly used to preserve Mammalian or Ornithological specimens.

Ichthyology specimens preserved in ethanol and stored in a flame proof museum cabinet.

The most common chemical used to preserve specimens is formaldehyde or a solution

of formaldehyde and water called formalin. Formalin stops the deterioration of the specimen before it is placed in a container, a process known as “fixing” the specimen. After fixing, the specimen is placed in an ethanol solution for long term storage. Glass jars that have a tight gasket seal limiting evaporation are usually used for storage. Larger specimens can be preserved in large glass tanks. Formalin was historically used as a long term preservative. Due to its acidity it is now seen as a poor long term preservative, so it is common practice for collections to switch specimens from formalin to ethanol (Conserve O Gram, 1993).

Safety

Safety for those working in the collection and safety of those who are in contact with collection specimens outside of the collection should always be the top priority. This guide discusses basic collections safety issues and concerns. For more detailed information, I suggest reading Curatorial Health and Safety, (2003), and always consult with a Health and Safety professional if you are unsure.

In the history of the preservation of natural history specimens people have used an array of chemicals and hazardous materials: Arsenic, Lead, Mercury, Formaldehyde, and many more. Therefore, it is important to limit your exposure to such hazards while working within a collection by wearing proper safety equipment. It is also important to wash your hands after handling a specimen, before eating or moving on to a new task, and to avoid touching your face or eyes. Marte et al. (2006) provide extensive information on arsenic usage and how to test for arsenic on specimens.

Gloves and lab coat/apron

It is good practice to wear gloves whenever handling a specimen. Nitrile gloves protect the user from chemicals or particulates found on the specimen. The gloves protect the specimen from oils or grime on the person that could cause damage.

One exception to this rule is specimens prepared without chemicals for use in teaching collections. It is exciting and engaging for outreach/education programs to have specimens people can touch or interact with. People should touch the specimen gently and with the back of the hand to introduce less oils and grime to the specimen.

One should wear a lab coat or apron when working with a collection to prevent contamination of clothing and the introduction of materials that may be found on the clothing to specimens. Contaminations maybe particulates, oils, glues, paints, food particles, pesticides, or other chemicals.

Face Mask and Ventilation

One should work in a well ventilated space to avoid breathing chemicals and hazardous particulates. Working in a well ventilated area isn't always an option and specialized masks may be needed depending on the task. Most tasks require a mask that protects against inhalation of particulates and should be worn when working within the collection or working on specimens treated with chemicals.

Handling

Specimens should always be handled with care and caution anytime a specimen is picked up or moved for any reason. Negligence in the handling can easily cause damage. As a precaution one should avoid excessive handling of specimens.

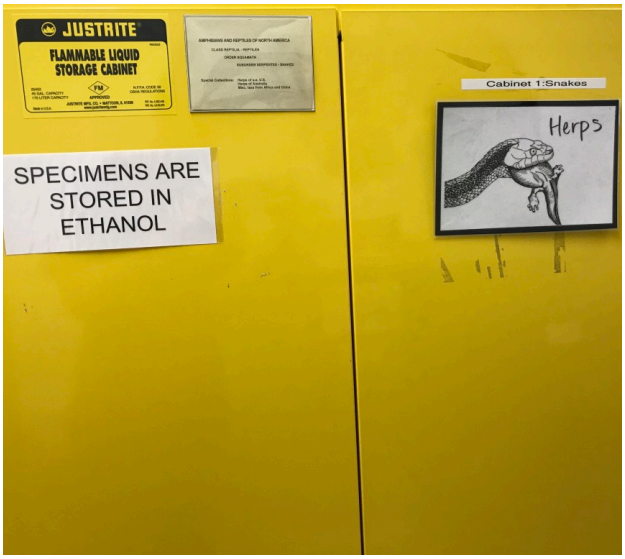
- *Don't rush* - Take your time and if you aren't sure ask for assistance.
- *Always use two hands* - Support the specimen and base, one hand on base one hand under specimen.
- *Don't slide* - Avoid sliding a specimen across a shelf, instead pick it up
- *Don't lift above your head* - If a specimen is on a shelf use a step stool to bring yourself to the height of the specimen before picking up
- *Have a plan* - Know where the specimen needs to be supported from. Know where it will be going and have the area setup. Make sure there aren't hazards along the way or have another person to handle them i.e. closed doors, chairs, people, etc…
- *Support loose parts* - Any part of a specimen that is loose or damaged may worsen if not supported while the specimen is handled.

Support the specimen and the base together when handling.

Temporary supports made using soft boxes and cotton rags. These will be used to support a specimen during cleaning and should be in place before the specimen is moved.

Storage

The majority of a museum's collection is in storage and will not leave storage except for special circumstances. It is crucial for a museum to maximize storage and safety of its collections. Museum cabinets are ideal for storage of specimens, but they are expensive and may not be an option for smaller, resource-limited museum. Fluid specimens are an exception and should be stored in flameproof cabinets given their flammable contains. Open shelving with the proper steps will provide almost comparable condition to museum cabinets. Open metal shelving will last longer and does not potentially leach chemical but is more expensive than open wood shelving. This section focuses on some of the simpler storage concepts with smaller resource demands. Additional information and storage ideas of specific specimens can be found in Rose and de Torres (2009).



Clearly labeled museum cabinet indicating chemicals and taxonomic group stored within.

Stabilization

Specimens should be stored in a position with support, to ensure they don't fall over or are damaged. Polyethylene foam board can be used to create boxes or a frame to support the specimens. Specimens whose base is not stable can be placed on a new base made of polyethylene foam board. Study skins stored in drawers should be placed in shallow boxes to prevent the specimens from sliding in the drawer when opened and closed. Pins or magnets can be used in drawers to stop boxes from sliding and proving an extra layer of support (Rose and de Torres, 2009).

Accessibility

Accessibility of a specimen or collection plays a key role in how something should be stored. Specimens used in a teaching collection will be more accessible than a type specimen. A type specimen, is a specimen that a species is described from. These are the most protected specimens in a collection. The more accessible a specimen is, the greater the risk of damage. On the other hand, if specimens are not accessible they lose their value to researchers and educators.

Bags

Polyethylene bags are a great way to protect specimens stored on open shelving. The bags should be sealable like a Ziplock™ or by twisting the open end of bagging and sealing tight with a metal twist tie. String and tape are not recommend for tying closed a bag because they are not reusable and difficult to remove. Using a heat sealed polyethylene bag is great but limits access to the specimen and the bag must be replaced when opened. Bags with holes should be replaced or have the holes taped over on both so the tape doesn't stick to the specimen. The bags limit leaching of chemicals from wood shelving into specimens. By not taking the air out of the bag one can create a safety bubble around a stable specimen on a full shelf. Using cardboard and wire to create a frame that is sealed in a polyethylene bag provides a more stable safety bubble. Bag can cause feathers to bend or crease over time if to small. Excess bag laying on fur to feathers may cause creasing from the weight over time.

Polyethylene bag is used to create a protective bubble barrier around a specimen.

Tissue Paper

Placing an acid free white tissue paper on the bottom of a shelf or drawer under the specimens can make it easier to identify signs of pest activity. The white color of the tissue paper gives a light even background to a wood or metal shelf unit.

White tissue paper on wooden shelves with specimens kept in polyethylene bags.

Light

UV light from sunlight or artificial lights cause specimens to fade. Fading can occur to all part of the specimen and base. Limiting specimen exposure to direct light will extend the life of a specimen (American Museum of Natural History, 2013). Insuring lights are turned off in collections rooms when not in use and storing specimens in closed shelves will limit light

exposure.

Moisture and Temperature

Moisture in a collection can cause many problems. If it is too dry specimens will crack. If it is too humid, mildew/microorganisms will destroy collection. For a multi use collections room a relative humidity of about 50% without too many fluctuations is ideal (American Museum of Natural History, 2013).

Controlling relative humidity within a collection can be very difficult and costly depending on the museums' location and available resources. A museum should monitor relative humidity and track seasonal fluctuations in order to maximize resource efficiency. This can be done using relative humidity and temperature loggers placed in various locations of the collection. The use of a dehumidifier in the collection is helpful to reduce the relative humidity and must be carefully emptied regularly.

Temperature in a mixed collections room should be <70 ºF without much fluctuation (American Museum of Natural History, 2013). Ideally having the temperature lower is better to reduce pests that are intolerant to cooler temperatures and reduce the relative humidity. Controlling temperature within collections can be costly.

Pest Management

A museum pest is a living organism that can cause damage to a specimen or collection. Pests can devastate a collection if they are not prevented from entering a collection (Prevention), or if pests are not dealt with immediately upon discovery (Response). Additional information regarding pest management can be found at the website www.museumpests.net.

Preventative pest management techniques should always be evaluated and updated to ensure effectiveness. Simple techniques include not having food around specimens, keeping areas with

(Figure #) Common museum pest. Image from www.insectslimited.com accessed on museumpests.net

specimens around clean, sealing cases and displays, closing doors and windows, and being vigilant. Preventive techniques that require more resources and time include quarantining new specimens before entering a collection, freezing all new specimens, and using traps.

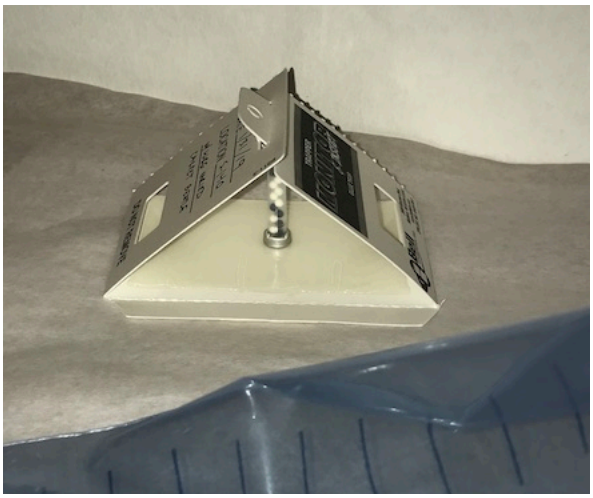
Responsive pest management relies on quick effective techniques once pests have been discovered. These techniques include removing specimens with pests, sealing specimens within bags so pests don't spread, and freezing specimens to kill any pests that are present. After specimens have been frozen, the specimen should be evaluated and cleaned to ensure all pest are removed and activity has stopped before re-entering a collection.

Visual Inspection

It is important to be vigilant about pests. Visual inspection of specimens and collections is one of the best ways to protect against pests. The more familiar a person is with the collection the easier it is for them to notice small changes or things out of place that can indicate and issue. Checking each shelf looking for signs of pests (cases, wings, webs, holes, discoloring, or other damage) can be done without disturbing the specimens by using a flashlight to look in dark corners otherwise not seen. Visual inspections should be done a minimum of twice a year. The more vigilant a collections staff can be the greater chance of catching pests early and minimizing damage.

Traps

Traps ideally catch pests before they get to specimens within the collection, however traps are more effective as an indicator as to which pests are active. Traps in a collection vary from sticky traps for insects to rodent traps. All traps should be periodically checked and replaced. Traps should be labeled with the exact location, data, bait (if used), and initialed. Pests caught in traps should be recorded along with the information from the trap. This information allows for a pest management plan to adjust resources to potential seasonal fluxes in the pest types. Traps should be placed in areas with high activity or access to the collection like near doors or vents. Sticky insect traps can be placed directly onto shelves and in



Sticky trap with lure at the back of an open shelf were specimens are stored in polyethylene bags. The trap is away from specimens and can easily be monitored for pests.

drawers. Theses should not come into contact with specimens and should be easily accessed for visual inspection or replacing, but should be back on the shelf where insects are likely to be. Traps should be checked at a minimum of four times a year. This should be done more often to insure the safety and mitigate damage of the collection.

Freezer

Freezing is an effective tool for killing pests. This should not be done as a routine pest prevention but should be used as an alternative to chemical treatments to eliminate pests. This technique should be used on dry specimens only. The cold temperatures do not freeze the specimen but freeze the water within the living pests (Conserve O Gram.1994). The hazards of freezing specimens include condensation during thawing, changes in the moisture content, and components that might react to the freezing temperature (e.g., paints, glue, waxes, metal, glass, or sensitive material).

A *Uria aalge* (Common Murre) In a sealed polyethylene bag that the air has been vacuumed out prior to going into a freezer.

Specimens can be frozen using a household upright or chest freezer with a minimum consistent temperature of -20ºC or -5ºF and that does not have a frost free cycle (Conserve O Gram.1994). Prior to freezing specimens should be sealed in an airtight polyethylene heat sealed or Ziplock™ bags. The bag should be large enough to not cause damage to the specimen; polyethylene sheeting can be used to create larger bags. A variable speed vacuum maybe used cautiously to remove excess air. Freezers likely will contain many other specimens and great care must be taken to ensure damage isn't inflicted on any of the specimens while placing a specimen. Specimens may rest on each other to maximize storage space but this must be done cautiously and must allow for proper airflow between bags to ensure freezing is through and even. A log should be maintained to keep track of specimens in the freezer cycle and as a record of treatments for specimens. Specimen freezer cycles (dates and times) should be recorded with the specimens catalog information.

The freezing cycle explained in this section is from (Conserve O Gram.1994) and consists of two freeze/thaw rotations. Once the specimen starts the cycle the bag should not be opened to minimize the risk of condensation and changes of moisture content. Sealed and

placed in the freezer, the specimen should be left at constant temperature for a minimum of 48 hours. After the minimum 48 hours the specimen should be removed from the freezer to thaw within the sealed bag for 24 hours, before going back in the freezer for another 48 hour minimum freezing. At this time the specimen should be removed and allowed to thaw for 24 hours before the bag is opened for inspection and cleaning the specimen.

Chemicals

Historically chemical pesticides have been used as both a prevention and response to pests. Arsenic soap was used in the taxidermy process up until the 1980s as a preventative pest management technique (Marte et al. 2006). Chemical fumigation is still used today with modern pesticides by some museums as a form of responsive pest management. Use of chemical pesticides as a pest management technique should be avoid if possible.

Evaluation

Evaluating a specimen is important in the preservation and longevity of an individual specimen and the collection. The goal is to have a detailed record of the specimens condition including: description, size, base, support, storage condition, mounting type, damage, highlights, cleaning history, grading scale, and any other relevant information. This record should be updated periodically during routine visual inspections and when the specimen is out or moved.

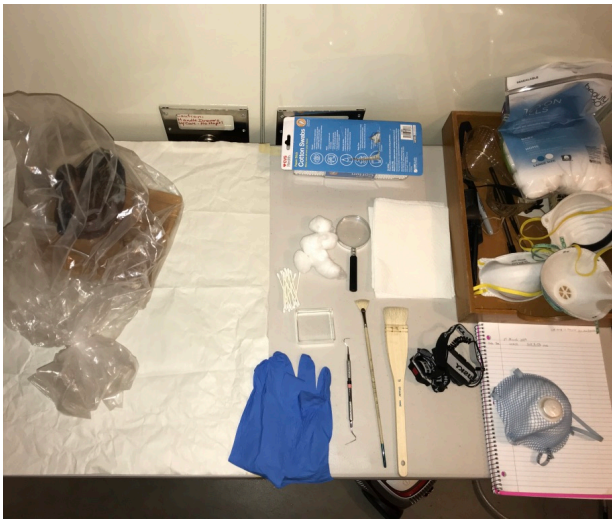


Table set up for specimen evaluation and cleaning.

Keeping a detailed and updated record of each specimen allows collections staff to monitor the condition of the specimen and collection as a whole. When staff performs visual inspections and notice an area on damage or disturbance, they are able to check the record if it is new damage or old. On shorter time scale, this record informs those not familiar with the particular specimen of any important issues prior to handling. For example, if the specimen is part of a teaching collection, it may have specific information on handling due to damage.

What to look for?

Taxidermied specimens are not always perfect and it can be difficult to identify the cause of damage found on a specimen. Specimens may have damage from its cause of death, the preservation process, or pests. When evaluating a specimen it is important to look at that whole specimen including its base. Bases are often made of wood and are not immune to pests, damage, or decomposition. Check to ensure the specimen is properly secure to base and not loose.

There are a few clues when looking at damage to determining the cause. First is there available information about the specimen? Information in the specimen's record about cause of death, pests, taxidermy technique, or anything else about damage. Second is looking for pest cases and or active pests on the specimen. A third source of information is where on the specimen is the damage located. Having some insight into how the specimen was preserved can also be helpful for this. For example, birds with large heads will often tear the skin around the neck or head during tradition taxidermy. If the skin doesn't tear it may still cause feathers to fall out. Fourth is looking at the size of the damage. Pests will attack specimens in areas around the mouth, eyes, feet, and vents making small holes to gain access inside the specimen. These hole are usually circular and maybe in tight groupings. In areas covered by fur or feathers theses hole may not be visible but the fur and feathers may appeared ruffled and chewed.

*Phasianus colchicus (*Ring-necked Pheasant) with damage by pests

Himantopus mexicanus (Black-necked Stilt) with damage caused during taxidermy

Tools

Recommended tools to evaluate a specimen for the first time. Additional tools may be needed for specific cases.

- *Light* - A head lamp or light stand proving additional light.
- *Magnification* - A hand lens or magnifying glass to look at closer at areas of interest or investigate debris.
- *Skewer* - A bamboo skewer or dental tools that allow the user to gently look under feathers or fur this can also help with removing debris found on the specimen.
- *Forceps* - To aid in looking under fur or feather and in gently removing debris from a specimen.
- *Ruler* - To measure the specimen. To measure areas of damage or debris
- *Notebook and writing utensil* - To take notes on the specimen. These notes should be later transcribed into the specimen's record.

Scale

Excellent	No damage. No evidence of pests. Feather or fur unfaded and not ruffled. Stabilized within mount. Pristine/Display condition.
Great	Very little surface damage to fur or feathers cosmetic only. No evidence of pests. Display condition with slight cosmetic fixes.Stabilized on mount.
Good	Minor damage. No active pests but evidence may be present. Missing feathers or fur in small areas. Loose on mount. Minor repairs but more than just cosmetic before display.
Fair	Damaged. Active pests and cases. Repairs needed for stabilization and before display. May only be displayed showing one side of specimen. If not treated and stabilized will continue to deteriorate.
Poor	Severely damaged. Extensive pests present. Not in display condition. May need to be deaccessioned if damage can't be fixed or stabilized. Consult with collections manager before action taken for deaccessioning.

Repair

Even under the best storage conditions specimens will still be at risk of damage. Repairing damaged specimens extends the longevity of the specimen. The necessary repairs required by a damaged specimen are often as unique as the specimen. While techniques maybe similar, each repair must be tailor designed for the specimen. Repairs fall into two categories depending on the use of the specimen: Restoration and Preservation. The type of repair needed should focus on the specimens use and amount of resources can be dedicated to the specimen.

Restoration

Restoration repairs are those made to a specimen to restore its natural look. These types of repairs tend to be done on specimens that are part of a diorama display or displayed on their own. Repairs in this manor tend to be invasive, require a lot of skill, artistic ability, and creativity. Examples of these repairs include: glueing new feathers to birds, painting/airbrushing color back into fur or facial features, using pieces of other specimens to fill in or replace damaged areas to the displayed specimen, or creating new body parts with wax or plastic to replace the damaged area. These techniques are great at recreating a scene for a display but they damage future research potential.

Preservation

Preservation repairs focus on preserving the specimen from further deterioration in the least invasive way a possible. These repairs are made to specimens not on display and are of more value as a research specimen. Examples of these repairs include: filling small holes with museum wax, replacing pins or adding addition structure and support, or using glue /tape to put toes back into place. Repairs in this manor don't require the high level of artistic ability or skill needed for restoration repairs.

Material

This materials list applies to repairs and cleaning.

- *Vacuum* - Vacuums can be small compact, household, or backpack styled it is a personal presence given work space. Must have varying speed control with HEPA filtration to catch particulates and prevent recirculation.
- *Screen* - Used on feathers or fur when vacuuming. Soft and flexible like nylon, polyester, or a composite like window screens.

- *Brushes* - A variety of small paint or craft brushes with varying bristols types soft to stiff and fine to fan shaped.
- *Cotton* - Cotton pads, balls, and swabs
- *Lights* - External lights either light stand or a headlamp
- *Magnifier* - A magnifying glass or hand lens
- *Skewers* - Bamboo skewers or Dental tools
- *Compressed air* - A can of compressed air with long narrow nozzle.
- *Forceps* - Varying tips can be handy for different tasks sharpe, rounded, or squared.
- *Water Soluble PVA Glue* - Used to glue pieces back together. This should be used sparingly and cautiously.
- *Museum wax* - Is tacky and good for filling holes.
- *Polyethylene foam* - Can be used to make a new base for mounted specimens.

Cleaning

Cleaning specimens will prolong the usefulness of the specimen. Without the disturbance from pests, dust and small particulate debris will be the majority of cleaning. The dust and small particulate debris can provide a food source for pests, adding weight to the specimen, and leaching chemicals or oils.

Cleaning a specimen using a vacuum and brush to remove dust. This is being done in a closed room to avoid potential pests from entering the collection.

<u>Timeline</u>

The cleaning timeline should be determined by needs of the institution and specimen. Specimens properly stored within a collections room should need minimal cleaning for a couple years if undisturbed by pests. Specimens on display require a more regular cleaning cycle and this cycle depends on how dusty a museum is. Scheduling a cleaning once a year for open display specimens will be sufficient but can be adjusted on frequency with visual inspections.

Techniques

Always clean a small test area first. This should be done in a spot that is not very visible to test how the specimen will react. Cleaning can easily cause damage if not done carefully. Cleaning should not be rushed and should be done with purpose. Insure specimens are supported in cleaning. This means having a flexible system in place that can support specimens moved for cleaning. Primary, secondary, and tail feathers need to be supported from underneath with a hand while cleaning. Cleaning should always start with the least intense technique. The greater the intensity of a technique the greater the risk of damage. If a lower intensity technique doesn't work then to a more intense one. Greater intensity cleaning should be spot oriented.

Using a vacuum with screen on the nozzle to dust a wing.

Dusting is the most common and routinely performed cleaning. Using a combination of brushes, vacuum, and compressed air one can easily clean dust/debris off a specimen. Soft bristle brushes are used on feathers and fur to brush away dust/debris. Brushing should always be done in the same direction as the feathers and fur. Stiff bristle brushes can be used in the same manor on feet, bills, horns, noses, bases, or other hard surfaces. Brushing into the nozzle of a vacuum will eliminate the dust/debris for becoming airborne and settling out elsewhere. Compressed air can be used in moderation to blow across or in hard to brush areas like in the mouth or closed talons. Compressed air is more intense on specimens than brushing and will blow dust/debris airborne. Direct vacuuming on stable specimens works better and faster than brushing but has a greater risk. The vacuum should be on the lowest setting and have a small hose nozzle. In order to prevent feathers or fur from getting sucked off the specimen, a small piece of screen can be either laid flat on the specimen or covering the nozzle. Vacuuming should follow the direction of feathers or fur.

Stains/residue can be frustrating to clean and takes patience. This step should be done after dusting is completed and should focus on just the stained/residue area. Stains/residue can come from the specimen itself like oils, fat, or blood, but can also be a result of external sources like pests, paint splatter, or oils. Stains/residue can be cleaned with a dampened cotton swap. The dampened cotton swab is used to hydrate the stain/residue. The stain/

Cleaning of a glass eye with a dampened cotton swab.

residue should be gone over with cotton swabs varying damp and dry until stain/ residue is gone. If the stain/residue does not come off or for example water foul's oily feet, one can use a small amount of diluted dawn soap. This should be followed by dampened cotton swabs until stain/residue and soap are gone. If soap is used it should be noted in the specimen record. Using forceps stains/ residue that has built up and is stuck to feathers or fur can be carefully scraped once hydrated. In this case the area should be cleaned with damp cotton swamps as well.

Glass eyes should be cleaned using a damp cotton swap followed by a dry cotton swab to ensure water from the eyes don't hydrate the skin around them. For specimens regularly dusted this may not be necessary, however specimens that are particularly dirty may require an extra step. Using dampened cotton balls or cotton pads to swipe off the specimen in the same direction of the fur or feathers. This removes any residual dust and allows the cleaner to primp feathers or fur that may be ruffled. Specimens should not be wet but feathers or fur will have moisture in them after cleaning and should be allowed to fully dry before returning to storage.

Digitalization/Data Preservation

With advances in technology our way of preserving specimen data has changed. Catalog cards and ledgers are being digitized and linked with larger digital databases. Databases allow for easy access to information on a specimen or collection for the museum, researchers, or the public. The database can be linked with other institutions database's building a larger collection of available information. It is important to maintain the physical record as well as the digital record to ensure the longevity of information. Scans should be made of catalog cards and information should be entered into a spreadsheet. The information should be attached to images of the specimen so that in the event a specimen is lost a digital version of the specimen still exists. Photos of damage or areas of concern should be photographed so they may be compared to the specimen in the future. Some institutions have the resources and have begun capturing 3D images of specimens.

Conclusion

This guide is designed to be an introduction into the broader world of collections management and how collections are maintained. Long term preservation of natural history collections is a continuous and never ending responsibility. It is crucial we do not let these collections become neglected and allowed to fade away. The practice should be continuously re-examined for more efficient, safer, and less resource demanding solutions.

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