DEVELOPING A WILDLIFE TEACHING COLLECTION

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This paper is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Environmental Science with and Environmental Studies at Paul Smith's College.

Abstract

Wildlife specimens hold significant scientific and educational value at Paul Smith's College through the preservation of essential biological information. Specimens allow for the better understanding of the past and present conditions of a species, and are a valuable teaching tool for comprehensive wildlife education. Accumulation of wildlife specimens is insufficient at PSC due to a lack of education surrounding the preservation of specimens and methods pertaining to the development of a specimen collection. Over the duration of three years, specimen preparation methods used at Paul Smith's College have significantly improved, along with a steady contribution of specimens to the collection. The current specimen preparation system at Paul Smith's College was analyzed, and adjusted for best method practices tailored specifically to the institution's needs. In response, procedural framework for standard specimen preparation was developed and documented in the form of a comprehensive manual, serving as a functional guide for preparing specimens. The document offers a top to bottom approach for effective handling, preservation, and storage of a variety of educational wildlife specimens, such as skin, wing, leg, and skeletal preparations. The useful qualities of specimens can last a century or greater when properly prepared. To continue to grow the collection properly I suggest best management practices are followed with proper research as a guide.

Acknowledgements

We would like to thank Dr. Janet Mihuc for her hard work, valuable experience and dedication to creating this capstone.

We further would like to thank Dr. Janet Mihuc and Dr. Celia Evans for assisting the creation of this capstone with your beneficial guidance and experience, assessment and dedication.

In addition, a great deal of gratitude goes out to Dr. Ross Conover for coming up with ideas for this capstone and assisting us with writing, grammar, and organization.

Furthermore, we would like to acknowledge Dr. Deborah Naybor for her assistance in interviewing professionals, and guidance in perfecting the email interviews.

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Introduction

Specimens play an imperative role in deepening our understanding of wildlife through the preservation of important biological information which is valuable to scientific research and education (Winker, 2000; Sweet 2010; Causey & Trimble, 2013). Specimens allow for a better understanding of past and present conditions of entire species. Loss of biodiversity and the threat of extinction delegates collected wildlife as ambassadors of their species. Extinction events often leave the last example of an entire species stowed away among museums. These specimens act as an invaluable asset to scientific research. Specimen preparation is the preservation of animal remains that are skeletal, dermal, or tissue (Winker, 2000; Causey & Trimble, 2005; Shoffner & Brittingham, 2013). Specimen preparation necessitates skillful use of a variety of techniques such as: data recording, skinning, cleaning, preservative application, as well as the manipulative upholstery of skin simulate a lifelike appearance in preserved specimens. The use of animal is dependent upon condition of the specimen, what can be salvages, and the purpose it is intended to serve (Winker, 2000; Causey & Trimble, 2005).

Specimen preparation may elicit negative responses in people. Negative responses towards specimens are often the focal point of perception and opinion, with a disregard for the biological data, and the paramount conservation role that specimens perform through education (Winker et al. 2010). Philosophical inquiries concerning the ethics of specimen preparation of other sentient beings is a salient issue. Many opponents express concern and discontent for rare or extinct species. Proponents argued that information obtained from specimens may provide knowledge, and generate appreciation to protect a whole species (Kaplan & Moyer, 2015).

Specimen preparation is a well-developed, growing scientific practice for preserving data, and retaining voucher specimens for educational purposes (Winker, 1998; Sweet, 2010) (Kaplan & Moyer, 2015). Many methods exist for specimen preparation depending on the intended use, such as: osteological specimens, skin specimens, wing and feet specimens, and freeze-dried specimens (Winker, 2000; Causey & Trimble, 2005; Shoffner & Brittingham, 2005). Depending on the use of the specimens' certain methods are preferred over other methods. Additionally, another factor for consideration is the storage requirements of certain specimens. Certain specimens may need to be stored differently to reduce exposure to

potentially deteriorating environmental conditions, such as freeze dried specimens to high humidity conditions (Shoffner & Brittingham, 2005). Specimens such as snowy owls (*Bubo scandiacus*) or hooded- mergansers (*Lophodytes cucullatus*) need additional due to their high fat content. The removal of fatty tissue is essential in order to mitigate deterioration and preserve the longevity of specimens. Without attentiveness to detail during the skinning process, specimens are susceptible to decay, and the loss is inevitable.

Specimens utilized for research or education should be properly labeled and recorded (Winker, 2000; Cardiff, et al. 2011) to preserve scientific value, as well as for compliance with state and federal regulations pertaining to wildlife salvage. Labels on specimens are considered by scientists in most cases to be the most significant asset of a scientific specimen. A specimen with incorrect information, or illegible handwriting may be considered invaluable to scientific research (Cardiff et al. 2011). Information such as species, locality and date found, cause of death, and other pertinent facts are most crucial in the determination of numerous biological trends. In addition, the differences between collecting specimens and salvaging specimens should be noted. Specimen collection, in short, is the process extracting deceased animals from the wild with the purpose of providing more accurate description, without vagueness of data, and facts (Cardiff, et al. 2011). Salvage is acquiring birds/mammals that expired as a result of anthropogenic influences, disease, or natural causes. Specimens acquired through salvage often lack important data, or are found in poor condition due to the cause of death or temporal decay (Sweet, 2010).

The wildlife collection and museum at Paul Smith's College consists of bird and mammal orders of study skins, taxidermy, and osteological specimens. The study skins are housed between five display cases, separating study skins, skulls, wings, and miscellaneous specimens. Taxidermy and osteological specimens are housed in display cases. Currently the collection stores an estimated 20 orders of avian species with an accumulation of roughly 100 study specimens. The bird collection outweighs the mammal collection, partly due to the challenges faced with specimen preparing mammals, and the increased risk of transmission of zoonotic diseases. The collection is used exclusively for education in classrooms, seminars, open houses, and other related wildlife experiential learning. The birds and mammals prior to

the preparatory process are retained in freezers with a register of the species collected. All activities are conducted adherent to New York State and Federal laws, with involved individuals possessing permits for activities performed. Animals are obtained through salvage, most of which are acquired from the nearby rehabilitation center or are found/hit on the road. Currently there are three individuals at the college who are permitted to legally salvage expired wildlife.

The goal of this research is to develop a protocol to not only expand and accelerate the growth of knowledge about specimen preparation at Paul Smith's College, but to also provide students with an exceptional resource to develop and grow skills and knowledge. This will be accomplished through the comprehensive analysis of numerous documented procedural guidelines pertaining to the preservation of wildlife specimens. This will include the steps from start to finish such as: useful specimen documentation, thorough preservation methods for bird and mammals, procedural guidelines for removing flesh and deteriorating fats, and the differentiating of techniques between birds and mammals. The protocol will discuss proper collection of specimens, safety guidelines in a laboratory setting, storage of specimens before and after preparation, and the fundamental applications of wildlife specimens. Additionally, the creation of an online database will generate improvements in efficiency and effectiveness of the wildlife teaching collection at Paul Smith's College. Each specimen in the collection will be given a call number to establish organization and ease of access. Also, the database will serve as resource for student research, as well as a viable teaching aid.

Methods

Paul Smith's College Specimen Preparation and Storage

The wildlife educational collection is housed at Paul Smith's College in the Freer Academic building. Paul Smith's College is located in Paul Smith's, New York at route 86 and route 30 junction.

Paul Smith College's Natural Sciences Department Museum houses a considerable educational collection of avian and mammalian species. These voucher specimens hold substantial educational, research, and historical value. A well formulated wildlife museum provides unique research and educational opportunities; therefore, use of the collection is encouraged. However, it is important to create a balance between use and the long-term preservation of these specimens.

Record Keeping

The majority birds and mammals are protected under federal and state laws, and require special permits and documentation to be possessed for educational purposes. It is important that Paul Smith's college remains in compliance with State and Federal laws in order to continue acquiring, and utilizing wildlife specimens to promote natural science education. To guarantee the longevity of the wildlife teaching collection at Paul Smith's college, information was gathered pertaining to important legal requirements to remain in compliance with State and Federal regulation. Acquiring and housing protected bird species requires a federal Fish and Wildlife Department permit for migratory birds, and an accompanying state permit, specific to the state activities are conducted within. The state permit may pertain to both birds and mammals; however, the federal permit only pertains to migratory bird species. Three individuals at Paul Smith's college each possess a state permit, and are granted authority to operate under a single federal permit, held by the license holder of the institution.

In order to fulfill requirements of the state and federal permits information on all collected species must be kept. Information such as species, locality and date found, cause of death, and other pertinent facts must be kept with the specimen, before and after preparation, and should be recorded in a digital log. Labels for each specimen are created and kept with them at all times, with additional information recorded in a digital log.

Techniques

The usage of proper techniques is critical for the establishment of a teaching or scientific bird and mammal specimen collection. Techniques used by educational institutions are different typically for each institution. Information was collected from journal articles and books concerning all procedural measures surrounding specimen preparation. Information was also acquired through professional interviews. All interviewees had a strong background in the processing of deceased wildlife for use in exhibits, education, scientific research, or other. An S.W.O.T analysis was also conducted to determine strengths, weaknesses, opportunities, and threats pertaining to the implementation of differing techniques from the responses. The decision to use S.W.O.T analysis was met with evidence that it would be effective assisting in preliminary decision making as a precursor to future strategic planning (Balamuralikrishna & Dugger, 1995). The goal was to find the most efficient technique for creating educational value, integrity, and longevity, as well as the best handling practices for the preservation of wildlife specimens. Through comprehensive literature analysis, the objective was to design a series of functional procedural measures in order to ensure that all specimens preserved at Paul Smith's College are produced with longevity and scientific value in mind. To obtain valuable additional information, interviews were conducted to gather professional knowledge including; tips, tricks, problem solving, and advice from individuals who have worked fields pertaining to wildlife specimen preparation. Questions relating to the preparation process aimed to link professional knowledge with current procedures taken at Paul Smith's College, and create newfound knowledge and techniques that will enhance the quality of the collection.

Storage Options

Proper storage is integral to the longevity of specimens and organization in a wildlife teaching collection. Research was conducted to discover the different methods of storage that exist, and recommended organization methods. Information acquired was then analyzed using a S.W.O.T analysis and cost analysis. A list of storage systems possessing important safeguard features was formulated to ensure the long-term health of the collection as it continues to grow. This list can be found in the appendix No. 4.

Instructional Manual & Useful Resources

Information collected through research using journal articles, books or magazines, and interviews with professionals was analyzed to determine the most effective methods of preparation and organization for Paul Smith's College's educational wildlife museum that can be found in appendix no.3. After determining most effective measures ensuring the longevity and ease of adherence to methods, a manual with recommended protocols was created from the information. The protocols provide vital information on how to prepare wildlife specimens, as well as, detailed information pertinent the creation of a well-organized and effective teaching collection. The addition of appendices created space for innovativeness, and further resources for creating quality wildlife specimens.

Results and Discussion

Interview SWOT Analysis

We conducted interviews with Bradley Walker from the Cornell laboratory of Ornithology, Joseph Bopp from the American Natural History Museum, and Steve Rogers from the Carnegie Natural History Museum, all of which have experience and knowledge of the specimen preparation process. Our responses will remain anonymous in the best interest of the interviewee. Every email was sent out in the same format to standardize the interview process. The responses to the questions below can be found in appendix No. 5.

Question 1: What steps and precautions do you take to ensure a clean, safe workplace for dealing with deceased animals?

Strengths- Not using gloves increases dexterity. Using dish soap to clean is cost effective.

Weaknesses- Not using gloves in the above steps increases exposure to zoonotic diseases, additionally cleaning with a dish solution does not kill all bacteria. Using gloves decreases precision and can result in unaware self-harm.

Opportunities- By not wearing gloves, smaller specimens can be prepared with less restriction.

Threats- Zoonotic diseases, and unsanitary working conditions

Question 2: When accepting deceased animals, what information do you view to be the most important? Would you consider the date of decease, the cause of death, the condition it was found in etc..?

Strengths: Recording the locality and date of collection, allows bird to be used in research.

Weaknesses: In response 3, the measurements of gonads, fat score and molt on various areas, can be subject to different interpretation, depending on the collector. The majority of specimens obtained come from people who are untrained.

Opportunities: Knowing that date and locality are the most highly regarded among these responses, allows us to prioritize that information when collection. Also, knowing the body temperature of the specimen at the approximate time of salvage can be beneficial in determining the quality of the specimen. Specimens are acquired in a broad spectrum of conditions, knowing a general history of the specimen at the time of salvage may prevent wasting time on a specimen in the lab. Having an understanding of cause of death, temperature, and level of visible deterioration at the time of salvage with most likely determine success and the overall longevity of the specimen.

Threats: Locality and date may be the only information recorded, with disregard for other pertinent information. The extra information may not be correct, depending on the recorder.

Question 3: What is the best way to wrap an animal for the freezer?

Strengths – Specimens are often frozen for a long period of time before they are processed. Protection of the specimen starts with minimizing exposure to subzero temperatures. A plastic bag is often enough, however at Paul Smiths College, we use paper towels as an extra layer of protection in preventing freezer burn. The extra layer of protection is also efficient at preventing puncture of the bag (talons, claws, needles). Compromised bags will cause specimens to quickly dry out, becoming challenging to work with.

Weaknesses – Smaller specimens require significant attention as they are more susceptible to losing moisture. Without wrapping these specimens, they may only be viable for a short amount of time.

Opportunities – Opportunity for proper sorting, and organized freezer space. Specimens should be sorted by size and vulnerability. Some species are higher priority than others, and should be given attention in a timely manner.

Threats – Improper storage will create unviable specimens. Consistency is important when receiving and storing salvaged specimens.

Question 4: Do you believe your profession aids conservation efforts, if at all, if so how?

Strengths: Specimens help to showcase diversity, and through education, are intended to inspire people to protect wildlife in the wild. Specimens are also used in census studies, to investigate change in populations over time. Wildlife specimens are a tangible archive of biological information, and can be used to determine relative population numbers, range, and distributions.

Weaknesses: Without the existence of wildlife specimen collection, it would be more difficult to assess regional diversity changes from the past.

Opportunities: Innovations in research continue to unlock the potential and value of specimens to science. Specimens may be used in the future to assist in the mitigation of present and future environmental issues. Further information may be acquired by sending specimens out for lab tests. Cause of death, and determining whether a specimen was a carrier of disease may be determined.

Threats: Underutilized Specimens or a lack of funding. Additionally, critical components of information for research can be lost.

Question 5: Do you have any experience working with dermestid beetles for the creation of osteological specimens? If so, have you had any struggles maintaining the colony, and what suggestions do you have in order to eliminate challenges?

Strengths: Dermestids at Paul Smith's College are kept far away from the specimen collection. We have not had any incidents with released dermestid beetles.

Weaknesses: Improper climate control can be detrimental to colony development. Fluctuations in temperature and humidity may influence the productivity and growth of dermestid colonies.

Opportunities: Opportunities for improvement in climate regulation.

Threats: Dermestids must be kept away from study skin collections. Also, it is important that you use a secure location for the colony. Escaped beetles will cause irreversible damage to entire collections, if possible, resulting in loss of thousands of dollars.

Question 6: Do you have any experience keeping or maintaining an online database for records? What suggestions do you have for creating a functional online record keeping system?

Strengths – Large specimen collections are hard to navigate without an adequate organization system. For Paul Smith's College, where our collection is primarily birds, we sort our specimens by family and species. In addition to organizing cabinet drawers by scientific designation, keeping an online spreadsheet will assist in accessibility. Each drawer and specimen is then assigned a unique number that placement is recorded in the spreadsheet.

Weaknesses – Online databases must be kept up with to maintain functionality. If not kept up with, specimens may be looked over and lost within the collection.

Opportunity – The collection at Paul Smith's College was designed as an aid for teaching and research, however there is tremendous opportunity in the adoption of an online public database system. There are numerous online cataloging systems that allow for the organization of collections, but also aid in national wildlife research.

Threats – It is of great importance to back up your spreadsheets to a cloud storage system to eliminate the possibility of losing data.

Question 7: What do you consider the most important tools for your profession?

Strengths – Specimen preparation has evolved over the years, and at Paul Smith's College. We have acquired and designed techniques that suit our needs. The most important tool we regard are our hands and knowledge of anatomy.

Weaknesses – Currently, we do not keep a data book. We write all the valuable information on a piece of paper and tag it to the drying specimen, later to be transferred to a permanent tag.

Keeping a data book will improve organization and make it easier to catalogue specimens when it comes time to submit information to the NYS DEC.

Opportunities – There is a large opportunity to improve the tools we use for preparing specimens. We have been able to get by with the basics; scissors, forceps, and a simple probing device. We avoid using scalpels due to their limited access and dullness. Quality tools are important to quality study specimens, such as sharpened scalpels, de-fleshing wheels for cleaning skins, and tumblers for drying birds in saw dust.

Threats – Inadequate tools may prevent you from creating a functional specimen, as well and decrease efficiency. Records may be displaced or lost without the use of a designated data keeping book.

Question 8: What is a challenge you faced while skinning or preparing a bird or mammal, which have you learned from?

Strengths – Salvaged specimens are received on a broad temporal scale that ranges from recently deceased to months old. At Paul Smith's College, level of deterioration is something we pay close attention to. The work ability of a specimen depends heavily on the quality of the specimen before preparation. An emaciated, visibly compromised specimen will require a different level of attentiveness than that of a fresh healthy specimen that died under unfortunate circumstances. It is important to know whether the specimen is workable or not, and whether it will be worth your time.

Weaknesses – Failure is unpredictable but can be limited by being receptive to detail. It is important to manage your time wisely and prioritize better quality specimens.

Opportunities – Specimens are received in a wide range of conditions from broken limbs, contusions, lacerations, bruises, and compaction. Delicate specimens should be prepared as soon as possible, so they will remain in the best quality, and not diminish from freezer conditions. Salvaged specimens that do not possess the potential to become a functional study skin can be dismantled and separated into several educational specimens (skull/wings/feet).

Threats – Time wasted attempting to prepare specimens, that fall apart or loose quality during processes.

Question 9: Do you have a special technique intended to avoid stretching the neck of a bird you're skinning?

Strengths – Stretching the neck of birds during the skinning process is seemingly unavoidable, however it can be minimized. Time is generally the primary determinant of quality. When skinning the neck, a large amount of time is set aside to carefully separate skin from flesh. Pulling should be minimized in attempt to mitigate stretching.

Weaknesses – A stretched neck will make it more challenging to precisely capture physical features of a specimen. However, appearances can be restored through the use proper pinning methods, as well as attentiveness to detail when adding cotton.

Opportunities – It would be beneficial to set aside more time to skin birds that are vulnerable to neck stretch. Also, investing in a de-fleshing wire wheel for birds will allow for more efficient fat removal, resulting in a more effective skin de-greasing.

Threats – A poorly attended neck will most likely threaten the overall aesthetic of a study skin.

Question 10: Do you have any suggestions for protecting specimen collections from insects?

Strengths – There are numerous different products available for preventing potentially harmful pests from entering a wildlife specimen collection. Having proper cabinetry is incredible important for the mitigation of pest outbreaks. Paul Smith's College currently uses Vapona pest strips to control Clothes moth and dermestid outbreaks.

Weaknesses – Pest outbreaks are unpredictable and highly detrimental. It begins with a failure to do periodic inspections, leading to irreversible damage to the collection. Proper prevention starts with knowing the key signs of an outbreak, during periodic inspections. Key signs are larvae casings, frass, or reduced animal organic matter, and observable larvae.

Opportunities –Paul Smith's College wildlife teaching collection has lost specimens to common clothes moths (*Tineola bisselliella*). Routine inspections of the teaching collection to ensure that the cabinets are free of damaging pests is highly recommended.

Threats – Without a procedure in place to mitigate the chance of a pest outbreak the viability and longevity of the collection is at serious risk. A single outbreak may lead to complete loss of a collection.

To gain additional and insight into the procedural measures employed at other institutions, 10 focused interview questions were administered to several professionals. A S.W.O.T analysis was performed with the intention of identifying procedural similarities, differences, as well as potential negative implications. The S.W.O.T. analysis provided us with information used to determine the most effective procedural guidelines and techniques, as well as helped establish better efficiency, quality, and care of the teaching collection at Paul Smith's College. The information collected from the interviews increased our understanding and appreciation for specimen data. Responses led to the creation of a functional database that serves as a reference for education and research. Maintaining a proper database on an excel spreadsheet is fundamental for proper management, ensuring specimens are not underutilized, or at lost in drawers. Backing-up spreadsheets on multi-user online data storage ensures that the data can be accessed, and shared easily by authorized individuals. We inferred from our S.W.O.T. analysis that keeping a datebook would help ensure information is not lost, and provide another back-up storage option. Currently, individual specimen records are written and stored with the specimens on paper tags. Although effective, loss of data is possible due to the potential of delay of entry, or improper record keeping.

At Paul Smith's College, a super solvent degreaser is used to remove fat on bird skins. This method is very helpful, but fat may not be removed in its entirety. A de-fleshing wire wheel would accelerate the process, and help produce better quality specimens, giving comparable quality results to other more established institutions. The interview S.W.O.T analysis also helped us determine what precautions other institutions take to preserve their workspace. Common results included the use of soap and water to wash workplace and equipment, and wearing gloves with some specimens to avoid exposure to harmful bacteria and potential skin irritants used in the preparation process. Interview responses also led us to the determination of best practices for the storage of salvaged specimens. Upon arrival, specimens need to be stored in the freezer for extended periods at a time before preparation, and wrapping them correctly can ensure quality is preserved. From interview responses we determined the most effective method is to wrap specimens in plastic or paper towels, followed by their placement into properly labeled zip lock

bags. It was suggested that we put the labels in bags to avoid contamination and exposure to excreted fluids, which could potentially render them indiscernible. Our findings from the S.W.O.T. analysis will continue to aid us in the determination of best practices pertaining to proper maintenance of the collection, and promoting its growth for many years to come. The findings from the S.W.O.T. analysis also allowed us to evaluate our preparation system, and gain insight into how similar our system is to other institutions.

Manual

The creation of a specimen preparation manual specific to Paul Smith's College is integral for the continuation of growth for the museum (Appendix No.1). Training on proper techniques used allows students to produce durable specimens that last long. The manual is sectioned into bird techniques and mammal techniques that follows the whole process in detail. The sections were written with the intent of focusing on the process as much as possible to reduce ambiguities for the reader. Birds were incorporated into the manual before mammals, because birds are the predominant specimen prepared at Paul Smith's College. Hyperlinks for the sources of the informational documents can be found in appendix no. 3, accompanied by a succinctly written article content description. The manual will be permanently stored on OneDrive accessible to faculty, as well as on a public drive for the college. Paul Smith's College currently owns, maintains, and contributes to the growth of a wildlife teaching collection. The teaching collection is composed of over 200 bird specimens, consisting of study skins, skulls, and several miscellaneous bird parts. The contents of the collection is stored among three collection grade cabinets that regulate the collections exposure to potential pests or other damaging conditions. The specimens are used to teach about the identification, life history, anatomy, and evolution of wildlife. Also, there are credible applications for the use of specimens in exploring research topics. Specimens enrich educational experiences by offering a unique, in-classroom opportunity to have an up-close encounter. The unique experience of comparing multiple species of birds and taxa at once, and doing research on them, can be met using specimens. The creation of a taxidermy collection at Paul Smith's College is offering newfound opportunities for students to learn about birds from a different observational perspective, and to see them in a less morbid lens, with a total loss of value.

Library research on specimen preparation involved the evaluation of sources pertaining to all aspects of wildlife natural history, and the usefulness of sources was judged through our collective specimen preparation experience. An appendix of useful sources with a succinct, informative synopsis for each source was created with the intention of providing new students interested in specimen preparation with guide to assist in the learning process (Appendix 3). Much of the compiled information in appendix no.3 has guided us through the meticulous process of specimen preparation; such as valuable techniques present in Winker et al. (1998). We learned effective techniques for the specimen preparation of birds, such as measuring, skinning, re-forming, the pinning of birds for drying, permitting and legal information, as well as the top to bottom preparation process from initial salvage to the storage of the completed specimen. We adapted the various skinning techniques to our current preparation system. Additionally, reading Sweet (2010) was useful for determining where we could collect birds from. Sweet (2010) mentioned wildlife rehabilitators as a main source for salvage of bird specimens, as well as, other sources such as oil spills, cat catches, and window collisions. Carter & Walker (1999) provided knowledge regarding commonly used skin preservatives, such as borax. However, we did not use the listed chemicals due to experienced ineffectiveness. We were also able to identify the importance degreasing birds in preserving longevity in study specimens. We responded by purchasing a solvent that allows us to remove dirt and debris, as well as mitigate the amount of grease present on completed study specimens.

Database

A specimen database was created using Microsoft Excel to store museum specimen information, in a readily, accessible, easy to read format (appendix No.2). For each specimen we listed the following information. Order, Family, Scientific name, sex, locality of origin, date collected, collector, specimen prepared on, preparer and cause of death. The excel document should serve to organize the collection better, and create new labels if the original labels are destroyed. The database shall be stored on OneDrive, available for faculty access, edits, and additions.

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Specimen Preparation Manual - Appendix No.1
Paul Smith's College

Purpose of Museum and Ethical Arguments

The wildlife educational collection is housed at Paul Smith's College in the Freer Science building. Paul Smith's College's address is 7777 NY-30, Paul Smith's, New York, 12970.

Paul Smith College houses a considerable collection of avian and mammalian species. These voucher specimens hold substantial educational, research, as well as historical value. A well formulated wildlife museum provides unique research opportunities to the education community, and use of the collection is encouraged. However, it is important to create a balance between use and the long-term preservation of these specimens. Wildlife museums continue to increase in value as we experience biodiversity loss and extinction events. Despite their notable importance, collecting voucher specimens for research continues to experience resistance. Advances in research techniques and technology has lessened the value of specimen collections (Clemann et al., 2014). Technology and research technique advancement has led to alternative ways of conducting wildlife research that is not as invasive, or resulting in the death of the animal to obtain data. Although specimen collections have some negative consequences, it can be argued that the biological data contained in collections, and ability to conduct historical research on species exceeds the negative implications.

Creating a manual for specimen preparation written for Paul Smith's College, it is believed, will provide a guide for the proper training for new wildlife specimen preparation employees and classroom students, and serve as a record of knowledge for methods used to preserve the current specimens in the wildlife teaching collection. Without a manual, key knowledge gained through hours of experimentation with various techniques, is at risk of being forgotten or altered indiscriminately in reform, with no prior context to refer to. Through experiential trial and error, certain methods of preservation, and skinning were written concisely, but broadly enough to be applicable, and adjusted for the contrasting anatomy of the myriad of bird and mammal orders. Also, the creation of procedural subsections for birds and mammals made practical sense, largely because the techniques vary greatly between them.

In addition to the creation procedural protocols, there are several other things that can be done in order to enhance the framework of specimen preparation at Paul Smith's College. Future recommendations for improving this project are: adding further species documentation to the database, creating a log book for specimens, interviewing professionals in person and documenting their systems more specifically, and creating an organized plan for wildlife specimen preparation that includes but not limited to: tools used, room used, dermestid beetle care, locations of items required, and additional protocols specific to species requiring adjusted techniques for preparation.

Specimen Preparation Techniques

Specimen preparation employs a variety of techniques specific to the type of specimen intended to create. At Paul Smith's College osteology specimens, taxidermy mounts and study skins are preserved for the collection

Birds

Record Keeping

Preparing study skins begins by logging data. Pertinent information is recorded onto the freezer where the specimen is stored, on where it was found (town, county, state), when it was found, and who salvaged the specimen, in addition a piece of paper or tag should be kept with the specimen at all time with all information given. Putting the tag into a plastic baggie minimizes contamination and deterioration of the tag.

Skinning Process

Initial Incision

The process for skinning birds begins by making an incision with a scalpel or scissors straight from just below the keel downward almost to the beginning of the tail feathers. A proper incision should not be too deep to avoid cutting into the body cavity, but enough to allow separation of the skin. Size of the incision is dependent on the length of the specimen; larger specimens such as a Great Horned Owl (*Bubo virginianus)* may require an incision of 10 centimeters, while smaller birds such as a Horned Lark (*Eremophila alpestris*) will require an incision of four centimeters. Subsequently following the incision, a scalpel or sharp utensil is used to sever the membrane between the skin and body. Following along the body on either side the legs will be reached, towards the back of the bird is the body cavity containing organs.

Legs

When sufficient skin is separated revealing the legs, using tweezers or fingers, the leg can be extracted with attentiveness to strain, at a point where the revealed bone at the knee joint between the tibiotarsus and femur bones can be cut using scissors or bone snips. After detaching the leg bones from the body, not the skin, flesh is removed down to the tibiotarsus, with the leg bones inverting. At this point both leg bones should be severed, and skinning should continue down to the tail, but not all the way. It is important to leave section of skin between the tail and start of the incision, providing space for proper fitting of the form.

Tail

The tail is attached at the base to the vertebrae, which will need to be severed. By using attentiveness and caution not to cut the inferior umbilicus, or sever the skin below the body, put scissors underneath the bird and cut through the spine. At this point the tail should be free with feathers still attached to the skin.

Wings

Skinning should now continue along the body up to the wings. At the base of the wings, humorous should be severed close to the body, and the flesh should be removed from wings up to the ulna, being careful not to cut the inferior umbilicus from the skin. After complete removal of flesh, the wings can be inverted.

Neck & Skull

At this point skinning should start towards the neck of the bird. Skinning from the neck should start at the beginning of the cervical vertebrae and extend all the way up to the base of the skull. When skinning the skull, the vertebrae attached to the body may seem better to leave attached, so it is easier to work with having tension. Separation of skin should occur up to the beginning of the maxilla or nostrils of the bird. At this point the head should be inverted, and the vertebrae can be severed at base of skull. A small incision is now made to the base of skull where vertebrae are detached, rendering the body and neck separated from the skull. Tweezers are used with wadded cotton to remove brain matter until the cotton begins to come out clean. The eyes of the bird are removed by carefully prying with a pair of tweezers. Once the eyes are completely removed the inside of the skull should be completely clean. The tongue on the bottom of the skull should also be removed by prying with tweezers. Following removal, the skull is then inverted into the skin, and the skin is ready for cleaning. To more effectively invert the skull back into the skin, water mixed with dish soap can be used to lubricate the skull. Also by using fingers to liberally apply pressure to the base of the skull evenly, the skull can invert into the skin more effectively.

Degreasing

Cleaning of the skin requires a degreaser such as dawn dish soap or a taxidermy supplied degreaser. At Paul Smith's College the super solvent degreaser purchased from Vandyke's Taxidermy Supply is used. The degreaser using warm water in the calculated amounts in proportion to the size of the container is put in, and the skin is completely submerged. The submerge time can be 15-30 minutes. After submersion the skin is taken out of the solution, and washed with cold water. The skin is then drained of water either through compression or sitting to drain, and placed into a container with sawdust. The sawdust can be hardwood or softwood, and can be obtained from a sawmill, woodshop, or worksite, but must be dry. At Paul Smith's College sawdust is obtained from the sawmill and woodshop. The skin is then tumbled until almost dry in the sawdust. After drying, the feather should be re-aligned, and the specimen should be blow-dried. When sufficiently dry the preparation, process can begin.

Form & Preservation

Creating a Form

A body form is created to replace what was taken out of the specimen. Typically, the form is created from foam material, mimicking the shape of the original body. A good alternative is to use a small stick with a series of cotton wraps to achieve adequate body size and shape. Foam used to make forms can be salvaged (ship foam, insulation, packaging materials), or it may be purchased online from a taxidermy supply company listed as foam carving foam. Pre-carved foam bodies may also be purchased online from a taxidermy supply company. At Paul Smith's College Vandyke's Taxidermy Supply Co. is used to acquire supplies. It is important to note that the new foam or cotton body should be slightly smaller then what was taken out of the animal, typically to avoid stretching.

Preservative Application

After creation of the body form, preservative should be applied in order to dry and preserve the skin, as well as to prevent destruction from insects. The preservative used at Paul Smith's College is Van Dyke's dry preservative. Preservative shall be applied to as much skin as possible, gently working it into the skin, always using gloves. Working on bigger birds, can create more dust, and a dust mask is highly recommended, along with wet methods for clean-up. Before applying preservative all limbs of the animal should be inverted. It is important to apply a generous amount of preservative to these areas as there may be residual flesh.

Stuffing

After preservation, the limbs should be wrapped with cotton to simulate the mass that was removed with flesh removal. Tape or thread can be used to secure the cotton to the bones. Next, the limbs are reverted, and the body form is placed inside of the skin. At this point the skull should be inverted and cotton is put in the skull cavity, and eye sockets. When the skull is reverted, straight neck foam containing a wire looped at the end going into the head is inserted in the neck. The neck foam is pre-cut in size proportion to the neck. The neck foam used is purchased online from Vandyke's Taxidermy Supply Co, and is bought in a size that can be trimmed down to the diameter of the bird neck. The wire should be cut with an extension for the foam body at the end. Next, the foam body is put into the wire at the end for the neck, and the end of the wire is looped into the foam body for secureness. Almost always there will be spaces around the body form, where cotton or another filler material is used to make the body look proportional. When the specimen appears to be close to its original shape, it is ready to be stitched.

Closing up

The animal can be stitched from either ends of the incision using 100% polyester thread or monofilament fishing line. For greasy specimens; typically, birds and fatty mammals, monofilament fishing line is used. This technique was adopted at Paul Smith's College after it was noticed that this material is more resistant and holds up against deteriorating fatty oils. The stitch should be a baseball or cross over stitch, given special attention to tension. Stitching too tight will put the specimen at risk for tears when drying and a stitch too lose will drastically reduce the specimen's shelf life.

Finishing Details & Pinning

After stitching, the beak of the animal should be secured shut. Securing is accomplished by taking a needle with line or thread inserting it through one nostril, through the skin between the mandibles, and back to make a loop, in which a knot is tied. Wings can either be stitched to the side of the bird or back. Thread or line is put through the skin near the humorous, to the body, and back out the same spot, then tightened so it is firmly pressed against the body. The next step is injecting the feet to avoid decay. At Paul Smith's College, Knobloch's bird feet injection fluid is used. The fluid is injected through the tips of the toes using a 5mm or 20mm syringe, dependent on the size of the bird feet. Below the tibiotarsus of the bird should also be injected, where it was not skinned, and flesh not removed. Next the bird is blow dried to straighten feathers again, then pinned. The bird should be placed upon a foam board, so it slides forward, and the direction of the back feathers is set in a natural position. Pins should go on either side of the neck and beak, so the back of the head is completely straight back. Pins should also go on either side of the body, halfway down the wings, and between the legs. The feet of the bird can be spread out to show foot topography, by pinning them to foam board or if they are talons, sticking them into a wad of cotton. The feet, and body should dry out given sufficient time. To keep the feathers in place a thin sheet of cotton can be draped across the exposed front of the bird. The time required for birds to dry is completely dependent on temperature, humidity and other environmental factors.

Mammals

Initial Incision

For the most part, the process of specimen preparing a mammal is entirely the same to that of a bird. The process starts with a shallow midline incision from the pelvis, anterior to the genital region, up towards the sternum, ensuring not to cut into the intestinal cavity. A rupture into the chest cavity will make it difficult to separate the flesh from the skin of the animal. Mammals generally produce more blood than birds during the preparation process. Many collectors use sawdust or white cornmeal to absorb excess blood during the skinning process. However, in smaller mammals this method may cause the skin to display a lumpy texture. Paper towels can used as an alternative if blood begins to obscure visibility.

Limbs

Once the incision is made, a scalpel or probe is used to separate the membrane between the skin and body. Following along the body until the hip and shoulder joints of the mammal are reached. At this point you can pull the legs from the skin using tweezers or your fingers. However, it is crucial to extract with attentiveness to strain, you want to avoid stretching or tearing the skin in this area. The legs should then be snipped at the joint closest to the body and left inverted, after detaching the legs from the body. Flesh is removed from the bone down to the carpus and tarsus of front and back limbs. At this point both legs should be severed, and skinning should extend down to the tail.

Tail
On birds the tail is severed at the last vertebrae, however on mammals the tail should be pulled completely from the skin, being careful to avoid tearing the skin. During the stuffing process the tail will be splayed to highlight this feature of the mammal.

Neck & Skull
Attention should now be turned towards the head of the mammal by skinning towards the neck. Skinning from the neck should start at the beginning of the cervical vertebral column and extend all the way up to the base of the skull. Once the neck is fully exposed you can severe it where it meets the body. The neck can be used to hold the skull steady while skinning. The skinning should proceed from the base of the skull, and exceed passed the eyes, to the base of the maxilla (jaw). At this point the head should be inverted, and the vertebrae can be severed at base of skull. The skull is then skinned all the way to the mouth, and removed from the body.

De-fleshing & Tanning
Afterwards all the flesh and fat are removed from the skin on the legs in the lower extremities, and from the skin using a scraper, being careful not to tear a hole in the skin. The specimen will require tanning when de-fleshed and fat removed, that can be accomplished by shipping the skin to a tanning company or using a home tanning kit, or through primitive methods of tanning.

Preservative Application & Stuffing
After the skin is tanned and cleaned, a preservative, such as Van dyke's dry preservative used at Paul Smith's College, is used to protect against insects. Like birds, a foam body acquired from cutting and forming a durable shipping foam or caving foam, is used to shape the original body. Wire is inserted into the legs, wrapped with cotton to simulate flesh removed. Neck foam acquired from a taxidermy supply company is used to simulate the neck, and a form simulating the skull is inserted with a wire attaching it to the body. When a form is fitted, and a glue or caulk is used to fit the skin to the specimen. The specimen is stitched and dried in a desirable position, with feet splayed out, and the head flat.

Dermestid Beetle Care

Dermestid beetles are flesh eating beetles that only feed on the flesh of deceased organisms. They are utilized by many institutions globally to clean bones and skeletons. At Paul Smith's College the colony of dermestid beetles was acquired from Carolina Biological and brought to the college on January 22nd, 2015. Information to keep the colony was gathered from using the maintenance supplied by Carolina biological, online forums, and using information extracted from Sommer G. H. & Anderson. S. (1974). The colony is maintained in a five-gallon glass tank, with light sawdust bedding. The tank is lined with black colored paper to minimize light exposure, and, an additional mesh top is superglued on to ensure no beetles escape. The tank is climate controlled, with an occasional misting when moisture conditions become too low, where desiccation is believed to be an issue. Too much moisture will create mold, and the beetles perform better in drier conditions. A vacuum filtration enclosure surrounds the tank to provide airflow when interacting with the colony, without an enclosure the emanating smell would be much heavier. The colony is fed skulls and bones from birds and mammals, however, on the rare occasions the colony does not have enough sustenance, cat food and goldfish crackers are supplemented. The colony has cleaned over 40 avian skulls for the college, creating an avian

skull collection, as well as, numerous mammal skulls, bones and skeletons. Without the dermestid beetles many great additions to the collection would not have been possible. Their voracious nature poses a risk to the establishment of the collection. If only a few beetles, or one escaped they could destroy or damage potentially all of specimens, along with damaging some of the building materials. Precautions of securing the beetles are taken with the utmost seriousness and precision to avoid spreading eggs or larvae outside the security of the tank. All objects entering the aquarium must be decontaminated with hot water was dish soap. Skulls are either boiled or washed with dish soap and essential oils several times, before deemed clean of unwanted material. Adhesive tape is kept around the vacuum filtration enclosure to ensure if some beetles breached they would become stuck. Leaving papers on exposed surface area within the vacuum filtration enclosure further ensures no escape, through the hope they will seek refuge under a dark place if all other safeguards fail. Routine inspections of the workplace for their presence also ensure they have not countered other safeguards. Dermestid beetles are extremely helpful but must be taken very seriously, and regarded as a potential hazard to the collection.

Valued Literature

Simmons, N. B., and R. S. Voss. In press. Collection, preparation, and fixation of specimens and tissues. In: Ecological and behavioral methods for the study of bats, 2nd Edition (T. H. Kunz and S. Parsons, eds.). Johns Hopkins University Press.

Sommer G. H. & Anderson. S. (1974, December), Cleaning skeletons with dermestid beetles. *Curator*. 290 – 298. Retrieved from https://research.amnh.org/vz/ichthyology/congo/Curator1974.pdf

Winker, K. (2000). Obtaining, preserving, and preparing bird specimens. Journal of Field Ornithology, *71*(2), 250-297.

Avian Collections Database - Appendix No. 2
20/ 184 entries Displayed

Call No.	Order	Family	Species	Sex	Locality	State	Date collected	Collector	Date Prepared	Preparer	Cause of death	Cabinet No.	Drawer No.
1	Acciptriformes	Pandionidae	*Pandion hailaetus*	Female	Adirondack Wildlife Rehabilitation	New York	11/30/2015	Adirondack Wildlife Rehabilitation	12/8/2015	Benjamin Wrazen	Natural Cause	1	1
2	Acciptriformes	Pandionidae	*Pandion hailaetus*	Male	Adirondack Wildlife Rehabilitation	New York	unknown	Adirondack Wildlife Rehabilitation	12/1/2015	Benjamin Wrazen	Natural Cause	1	1
3	Acciptriformes	Accipitridae	*Buteo jamaicensis*	unknown	unknown	New York	unknown	unknown	4/22/2015	Benjamin Wrazen	unknown	1	1
4	Acciptriformes	Accipitridae	*Buteo jamaicensis*	unknown	unknown	New York	unknown	unknown	unknown	unknown	unknown	1	1
5	Falconiformes	Falconidae	*Falco peregrinus*	Female	Adirondack Wildlife Rehabilitation	New York	2/1/2016	Adirondack Wildlife Rehabilitation	2/2/2016	Benjamin Wrazen	Natural Cause	1	1
6	Acciptriformes	Accipitridae	Accipter cooperii	Male	Otisco, NY	New York	1/5/2013	Ashley Evans	4/22/2015	Benjamin Wrazen	Natural Cause	1	1
7	Acciptriformes	Accipitridae	*Buteo platypterus*	unknown	Saranac Lake	New York	8/30/2014	unknown	11/19/2014	Benjamin Wrazen	unknown	1	1
8	Acciptriformes	Accipitridae	*Buteo platypterus*	unknown	unknown	New York	unknown	unknown	11/19/2014	Benjamin Wrazen	unknown	1	1
9	Strigiformes	Stringidae	*Strix varia*	unknown	unknown	New York	unknown	unknown	3/21/2013	unknown	unknown	1	2
10	Strigiformes	Stringidae	*Strix varia*	unknown	unknown	New York	unknown	unknown	unknown	unknown	unknown	1	2
11	Strigiformes	Stringidae	*Strix varia*	unknown	unknown	New York	unknown	unknown	unknown	unknown	unknown	1	2
12	Strigiformes	Stringidae	*Strix varia*	unknown	unknown	New York	2/15/2012	unknown	3/27/2014	PSC Ornithology lab	unknown	1	2
13	Strigiformes	Stringidae	*Strix varia*	unknown	Adirondack Wildlife Rehabilitation	New York	11/1/2016	Adirondack Wildlife Rehabilitation	11/3/2016	Benjamin Wrazen	car strike	1	2
14	Strigiformes	Stringidae	*Bubo virginiaus*	unknown	unknown	New York	unknown	unknown	unknown	unknown	unknown	1	2
15	Strigiformes	Stringidae	*Bubo virginianus*	Female	Norfolk	New York	2/1/2017	Benjamin Wrazen	2/2/2017	Benjamin Wrazen	car strike	1	2
16	Strigiformes	Stringidae	*Bubo virginianus*	Male	unknown	New York	unknown	unknown	3/24/2015	Benjamin Wrazen	unknown	1	2
17	Galliformes	Phansianidae	*Meleagris gallopavo*	Male	Ostego	New York	11/1/1985	John A. Feranchuk	unknown	unknown	hunted	1	3
18	Galliformes	Phansianidae	*Meleagris gallopavo*	Female	Adirondack Wildlife Rehabilitation	New York	9/10/2016	Adirondack Wildlife Rehabilitation	1/23/2017	Jacob McCourt	Unknown	1	3
19	Galliformes	Phansianidae	*Colinus virginianus*	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	1	3
20	Galliformes	Phansianidae	*Colinus virginianus*	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	1	3

Useful Resources – Appendix No. 3

Amadon, D. (1958). The use of scientific study skins of birds. ***Curator: The Museum Journal,*** **1, 77–80. doi:10.1111/j.2151-6952.1958.tb01655.x**

This article discusses the different uses for bird study skins. It delineates use between educational usage and scientific usage of bird specimens, giving ideas for how to use the specimens. The content in this article is useful for planning the best use of specimens in the collection.

Armenta, J., Dunn, P., Whittingham, L. (2008) Effects of specimen age on plumage color. ***Auk 125*****(4), 803-808.**

This article provides an insight into color change in specimens over time, and which specimens are most likely to experience color change. I find this useful to use because color change in the specimens has been a worry of mine. It is good to know the color won't fade within a couple of years on the specimens, backed up with factual data. This article also highlights where colors most likely fade on birds.

Asma, T. (2001). ***Stuffed animals and pickled heads: the culture and evolution of natural history museums.*** **Oxford University Press, USA.**

Stuffed Animals and Pickled Heads offers acts provides fueled investigation into wet and dry specimen preparation techniques. However, Asma's academic investigation of the role natural history museums hold is more substantial. Specimens act as both artifacts and architects of scientific epistemology.

Beaty Biodiversity Museum (n.d) Working with birds. [Power Point Slides] ***Preparing bird specimens*****. Retrieved from http://beatymuseum.ubc.ca/research-2/collections/cowan-tetrapod-collection/working-with-birds/**

This power point presentation, utilizes picture slides with captions to show the skinning and preparation process from the beginning to the end. It contains content rich slides detailing: preparing skeletons, sexing birds, recording fat levels, cleaning fat, determination of cause of death, other methods for preservation, among other useful sections. The pictures in this source offer a great explanation of execution of methods that present a difficulty explaining.

Carter, D. & Walker, A. (eds). (1999). ***Collection environment***

Oxford: Butterwoth Heinemann.

This source contains in-depth information about specimen preparation and methods used. It provides a history of different preservatives used, providing insight into the positive and negative aspects of the different preservatives. This article would be useful for researching preservatives used on older specimens, and learning about the positive and negative consequences.

Capainolo, P., Kenney, S., Sweet, P. (2007) ***Extended-wing preparation made from a 117-year-old Ivory-billed Woodpecker (Campephilus principalis) specimen*****. Auk 124(2), 705-709.**

This article provides a very in-depth detail on the processed used to do a wing extension on a very rare, and old specimen. Some steps of the process would provide usefulness when repairing damaged specimens. I believe the content in this article concerning extinct birds is very noteworthy adding into the article because not only does it give a sense of wonderment when dealing with an old specimen, but additionally it illustrates the importance of specimen collecting.

Cardiff, S, Remsen, J & Dittman, D. (2011). ***Bird curatorial manual – Preparation and labeling guidelines*****. Retrieved from University of British Columbia, British Columbia, zoology website: www.zoology.ubc.ca/~ildiko/files/LSUBirdLabManual.doc**

This source contains labeling guidelines for specimens. The labels used by the college now lack adequate information for conducting avian research. This resource can be used to develop the collection to have a greater function for research, and acting in a way as a census for species diversity.

Corriveau, K. (n.d.) What makes a perfect specimen? *The mammal* edition. Retrieved from University of Berkely, San Francisco, The Museum ofo Vertebrate Zoology. At Berkely website http://mvz.berkeley.edu/Newsletter/newsletter_files/201408/PerfectSpecimenMammal.php

The process of specimen preparation and preferred methods used, and attributes of animals' imperative for data are summarized in this article. The content in this article can be used for developing better specimens for research, with reference for certain qualities of specimens sought after in research. This is an important source to use for development of better labels, and preserving certain qualities in birds.

Douglas Causey and Jeremiah Trimble. (2005) Old Bones in New Boxes: Osteology Collections in the New Millennium. The Auk 122:3, 971-979. Online publication date: 24-Jan-2009.

This source explains the benefits and dilemmas of Osteology collections. I find the material in this article very relevant and useful for my capstone because it has two sections about curation, and future research for collection. Albeit the material is not completely relevant to the educational collecting, it can provide a contrast that will help guide as a boundary or limitation for activities conducted.

Fallon, A. Radke, W. & Klandorf, H. (2006) Stability of pentosidine concentrations in museum study skins. *Auk 123*(1), 148-152.

This article explains the use of pentosidine (in skin collagen) for aging birds. Surprisingly this can be used to assess the age of birds without banding data, however using that method is highly variable among specimens. The information in this article can be useful for aging birds in the collection.

Fuller, T. (1992). Storage methods for taxidermy specimens. WAAC *Newsletter, 14*(2), 18-23. Retrieved from http://cool.conservation-us.org/waac/wn/wn14/wn14-2/wn14-205.html

This short article is about how to store specimens and taxidermy mounts, improving their longevity, while reducing potential threats. The ideas in the article were principally developed from research projects. Taxidermy mounts that are no longer desired as a taxidermy mount are referred to as "demounts" in the article, which details solutions for how to store them. This article identifies threats to specimens, and solutions for circumventing threats.

Kaplan, S., & Moyer, J. W. (2015, October 17). *Scientist under attack after he kills bird that took decades to find, "The guardian"*. Retrieved from https://www.theguardian.com/science/2015/oct/17/rare-bird-killed-saving-species

The Moustached Kingfisher, a rare bird that has not been seen in years was killed for scientific study, causing outcry from the public and other wildlife professionals. This article offers great ethical arguments for the preservation of species through scientific collections, as well as, the benefits that collections can provide. Information extracted from this article can provide insight for the benefits collections can provide, and why collections are established and maintained in the first place.

Ramotnik, C.A., (2006). Handling and care of dry mammal and bird specimens. *Conserve O Gram, 11*(9) Retrieved from https://www.nps.gov/museum/publications/conserveogram/11-09.pdf

How we care for and handle wildlife specimens will directly influence their significant and usefulness in the future. Specimens new and old share similar storage and Maintenance needs. This article outlines proper organization, storage, and maintenance techniques for keeping a healthy voucher specimen collection.

Shoffner, A. & Brittingham, M. (2013). *Freeze-drying to preserve birds for teaching collections*. *Northeastern Naturalist 20*(3).

This article provides an in-depth very informative description of the process of freeze drying museum specimens. Freeze-drying has been discussed before here but now it can be

looked at further as a viable alternative to specimen preparation. The article provides information on what was used to freeze dry, with additional detail into its effectiveness.

Simmons, N. B., and R. S. Voss. In press. Collection, preparation, and fixation of specimens and tissues. In: Ecological and behavioral methods for the study of bats, 2nd Edition (T. H. Kunz and S. Parsons, eds.). Johns Hopkins University Press.

This piece of literature serves as a taxonomical handbook for the identification of bats. Including accurate illustrations, diagnostic external measurements, and authoritative descriptions of key characters that allow scientific names to be associated with ecological, physiological, or behavioral data. This article also offers methods on preserving voucher specimens and how to maximize their useful scientific life.

Sommer G. H. & Anderson. S. (1974, December), Cleaning skeletons with dermestid beetles. *curator*. 290 – 298.. Retrieved from https://research.amnh.org/vz/ichthyology/congo/Curator1974.pdf

There many different methods for cleaning the skulls and skeletons of specimens. Cooking my bacterial maceration, chemical treatment, and the use of dermestid beetles are among the most common methods. This article discusses each method in depth and provides useful feedback on the effectiveness of each method.

Standards in the care of skins and taxidermy collections. (2013, January, 23-24.). *Conservation and collections care.* Retrieved from http://conservation.myspecies.info/node/32

This article summarizes health and safety concerns in the laboratory, specimen handling and storage, deterioration, among much more. It is of value for trouble shooting issues, and creating an outline for protocols, and additional research. This article I believe has the best value for further establishment of the collection and laboratory practices in small increments.

Strang, T. (1992). ***A review of published temperatures for the control of pest insects in museums. Collection Forum 8*****(2). Retrieved from http://www.spnhc.org/media/assets/cofo_1992_V8N2.pdf**

This article discusses the effectiveness of thermal insect pest control. Thermal pest control regulates the temperature of a specimen collection to influence the breeding success of damaging pests. Also, this piece of literature discusses the importance of adequate pest control in creating longevity in natural history collections.

Sweet, P.R. (2010). ***Collection building through salvage.*** **a review, in: Presented at the proceedings of the 5th international meeting of european bird curators. Natural History Museum of Vienna, Vienna, Austria.**

This article explains in depth how to create a collection through salvaging animals. The information in this article summarizes how we acquire here at Paul Smith's College and is a useful resource to use for acquiring specimens. It summarizes necessary permitting procedures, content necessary in recordkeeping, main sources of salvage, among other necessary information.

White, C.L., and Dusek, R.J., (2015), ***Wildlife specimen collection, preservation, and shipment*****. Retrieved from United States Geological Survey website: https://dx.doi.org/10.3133/tm15c4**

This article discusses the opportunity for wildlife disease research in specimen collection. Specimens can be used to provide supporting information leading to the determination of the cause of disease or death in wildlife and for disease monitoring or surveillance.

Winker, K. (2000). Obtaining, preserving, and preparing bird specimens. Journal of Field Ornithology, ***71*****(2), 250-297.**

This article contains in depth material on specimen preparation practices and proper acquisition of specimens. At Paul Smith's College, the skinning, and stuffing methods mentioned in this article have been customized for better preparation, which were mainly derived from this article. The article outlines preserving the skin, partial skeleton and stomach contents of birds, along with recording other data. It also summarizes the procedures, but does not go too in-depth with the execution of certain methods.

Winker, K., Reed, J., Escalante, P., Askins, R., Cicero, C., Hough, G., & Bates, J. (2010). The importance, effects, and ethics of bird collecting. *Auk, 127*(3), 690-695. doi:10.1525/auk.2010.09199

This article discusses the ethics behind specimen collections and their importance. Ethics of specimen preparing are often discussed routinely when acquiring specimens donated, or that were hunted. This article offers practical ideas and supportive arguments for why specimen preparation is important, and its function, from purposes.

Xu, D. J. (2011, March, 29). The art of stuffed animals. *The Harvard Crimson, 29*(3). Retrieved from http://www.thecrimson.com/article/2011/3/29/animals-taxidermy-nbsp-specimens/

This article expresses the history and evolution of traditional taxidermy. Historically taxidermy served as an art medium, capturing lifelike characteristics. Today, this art has transformed into a tool for education. The lifelike appearance of today's taxidermy pieces give the public a unique perspective of wildlife, almost as if they were still alive. This article also talks about the teaching opportunities that taxidermy offers to the public, as well as their importance to universities.

Appendix No. 4

Storage of Wildlife Specimens

For most of the collection, a well-sealed cabinet is necessary to protect against agents of deterioration that may threaten the longevity of wildlife specimens.

Effective cabinets:

- Deter Pests
- Eliminate Theft
- Eliminate damage from:
  - Water leaks
  - Air particulates
  - Light
  - Physical damages
  - Humidity fluctuations

Preferred Cabinet Features:

- Steel construction or heavy gauge aluminum
- Gloss or powder finish
- Easy to clean
- Exterior surfaces that are flush (except handles)
- Interchangeable shelving (easily rearranged)
- Locking doors
- Caster wheels (movability)

Manufacturers:

Delta Designs LTD - 785-234-2244

MODEL DD201

- Cabinet Dimensions:46-1/2" wide x 42" high x 28" deep
- Full Width Trays

MODEL DD202

- Cabinet Dimensions: 46-1/2" wide x 42" high x 28" deep v
- Half Width Trays

MONTEL Mobile Shelving – 877-935-0236
Lane Science Equipment Corp. – 212-563-0663
MODEL 201 – For large Skins
Cabinet Dimensions: 42 1/16" Height x 46 1/2" Width x 28 1/32" Depth
MODEL 202 – For Small Skins (same dimensions a Model 201)

Capstone Interview Responses – Appendix No. 5

Bradley Walker

Question 1: What steps and precautions do you take to ensure a clean, safe workplace for dealing with deceased animals?

Make sure to wash your tools at the end of the work session. Just using dish soap is fine. It's not too important to wipe down every surface, unless there was a big spill of blood or some other fluid from the bird. Gloves should be worn if the preparator has open wounds on their hands, but they're usually not required. If you suspect the bird may have died from disease, then gloves should be worn.

Question 2: When accepting deceased animals, what information do you view to be the most important? Would you consider the date of decease, the cause of death, the condition it was found in etc..?

The most important information is Date found (written as unambiguously as possible), location found (including county, city/town, and address), cause of death (if known), and species (if known). Keeping note of the condition when the bird arrives is useful for internal records. For example, you don't want to pull out a bird to skin, only to find out that it has started to rot and the skin is falling apart. We usually leave notes like this in the bag with the bird.

Question 3: What is the best way to wrap an animal for the freezer?

Just a good freezer ziploc bag is enough. You'll want to make sure that there are no sharp parts (talons, beaks, etc) that can poke through the bag and break the seal. If the bird is sealed properly, it can last a few years. Be warned though, very small birds (hummingbirds, kinglets, chickadees, some warblers) will dry out much quicker than other birds.

Question 4: Do you believe your profession aids conservation efforts, if at all, if so how?

Physical collections are very important for tracking change over time in populations and can be used for things ranging from taxonomy to studies on pollution. At the most recent, AOS meeting there was a presenter who spoke about using specimens to track pollution a century ago using soot deposited on birds' feathers. They're also useful for showing people bird diversity, which is always good for inspiring people to care about them in the wild.

Question 5: Do you have any experience working with dermestid beetles for the creation of osteological specimens? If so, have you had any struggles maintaining the colony, and what suggestions do you have in order to eliminate challenges?

We have a colony here that is maintained by our Collections Manager. I've helped out with managing the skeleton cleaning a few times. The biggest challenge for the beetle colonies is maintaining the proper climate year-round. If you don't keep the temperature steady, they can die off in the winter. You'll also want to make sure that the beetles can't escape and make their way

to your skin collection, where they can destroy everything. Make sure to have a sealed room and sealed containers. We use fish tanks with screens above them, like people have for pets at home.

Question 6: Do you have any experience keeping or maintaining an online database for records? What suggestions do you have for creating a functional online record keeping system?

Large collections that are part of institutions pay for professional databases, like Specify, that they use to track their collections. For a smaller collection (especially if it's mainly made up of teach specimens) you could probably get away with using a good spreadsheet system that is backed up online (like on Google Drive)

Question 7: What do you consider the most important tools for your profession?

The only tools that are absolutely necessary are a good pair of forceps and a good pair of scissors. Realistically you'll want to have several options: bigger, straighter forceps for moving cotton up the neck, larger scissors for cutting bones on bigger birds, etc.
It's also important to have a good data book for recording data.

Question 8: What is a challenge you faced while skinning or preparing a bird or mammal, which you learned from?

One of the biggest challenges is learning to tell what the physical limits of each specimen is. Is the bird too dry? Or just dry enough that you can work around it? Has it started rotting yet? If so, is it just in a small patch you can work around and still make a specimen? How much fat is there? Will my fat cleaning tools work and do I have time to deal with it?
There are lots of little things that can pop up. Beginners don't know what to expect so they have a harder time dealing with surprises.

Question 9: Do you have a special technique intended to avoid stretching the neck of a bird you're skinning?

If you use the right amount of cotton up the neck, it should keep the neck relatively compact while still showing the plumage characteristics. You'll want to draw a "tail" of cotton up the neck and out the mouth. You can arrange the neck over this and it should smooth out nice. There are different techniques for ducks, grebes, loons, etc I can describe if you'd like to know.

Question 10: Do you have any suggestions for protecting specimen collections from insects?

Mothballs, insect traps, and sealed shelving. You'll also want to do periodic checks for insect casings and frass. Mice can also be an issue.

Joseph Bopp

Question 1: We don't do much for this, but we should probably do more. Basically wash everything with disinfectant, and use gloves.

Question 2: For us, since we will never know how a particular specimen will be used, we try to get as much information as possible, but the most important is location and date. For location be as specific as possible. Sometimes you may only be able to get to county or township, but this is still better than nothing.

Question3: For smaller animals we just put them in plastic bags, either Ziploc or garbage and don't wrap them in any specific way. We have a walk in freezer and for larger animals, like coyotes, we put them in as is. It is important when putting an animal in plastic bags to make sure any information about that animal stays with it, once info is lost the specimen is useless for a research collection. If you put a tag with the specimen, put the tag in a plastic bag then put it in the same bag as the specimen, so it isn't ruined by blood or other fluids.

Question 4: Yes. Museums are an archive of biological information. You are able to see what occurred where and can track range expansion or contraction. Additionally, we now save frozen tissue samples which through genetic analysis has numerous conservation implications.

Question 5: yes we have a colony. Never had much of an issue maintaining the colony. I always make sure I have something to put in the box. Sometimes if I know I won't be preparing stuff for a while, if I just prepared several specimens, I won't put them all in at once. I'll put some in the freezer and take them out when needed. If you prepare a large specimen, you can take some pieces of flesh and freeze them, so when you have nothing to prepare, throw a few of them in to keep the colony fed. We keep our colony inside, so we don't have to be concerned with temperature, but if yours is outside, you will want to have a heat source.

Question 6: I'm not sure what you mean by this question. Do you just want an electronic database for your own use, do you want to also post it on your web site, or do you want to be part of vert net, which is place where numerous institutions post their collections data for all to see? If you want a good collection based database, I haven't used this but SPECIFY is a free collections based database. Our fish people here use it. If you are looking for more information on this subject, I can give you the contact information of our database manager and you can talk with her.

Question 7: I don't know, I don't really have any I would say are most important. Maybe identification skills or field guides so specimens get identified correctly.

Question 8: Getting the right amount of cotton in the specimen so it ends up similar in size to what it was before it was skinned.

Question 9: Go slow, snip along the way, get forceps between tissue and skin, don't pull hard.

Question 10: Get good cabinets with good seals, but more importantly do a monthly inspection for any insect damage.

Steve Rogers

Question 1: What steps and precautions do you take to ensure a clean, safe workplace for dealing with deceased animals?

I generally don't worry much about diseases when handling birds and in fact don't even use gloves when preparing. I have found using them actually causes more cuts on your hands and much less precision during preparation. I have a designated area in the museum and at home simply use a table in my lab. Carcasses are frozen after removal and put with the garbage just before it goes out. I simply use water and soap in washing down surfaces and don't use any form of disinfectant.

Question 2: When accepting deceased animals, what information do you view to be the most important? Would you consider the date of decease, the cause of death, the condition it was found in etc..?

Most important – locality, date of collection, who collected it, condition found. Cause of death would be good to know and with the date would allow you to know the approximate temperature a bird was prior to salvage. A small bird can lose its ability to become a quality mount if it spends even a few hours in hot weather. Some of the most important info is done during prep – sex, measurements of gonads, fat score, molt on various areas, pneumatization, as well as writing the preparatory on the label.

Question 3: What is the best way to wrap an animal for the freezer?

Folded wings, tucked head if long necked, cotton in mouth if fresh and mouth can be opened, placed in heavier duty plastic bag with all air removed. Data, or better yet a tracking number assigned to the bird which records the data in a computer file or a notebook containing relevant information.

Question 4: Do you believe your profession aids conservation efforts, if at all, if so how?

Museums educate the public and create information which helps us understand the natural world. Personal experience seeing collections and taxidermy, i.e. familiarity with what lives in your area and how they live, endears the public with the organisms. If you don't know what is out there, why would you care to protect them?

Question 5: Do you have any experience working with dermestid beetles for the creation of osteological specimens? If so, have you had any struggles maintaining the colony, and what suggestions do you have in order to eliminate challenges?

I ran a dermestid beetle colony in graduate school, and started my own when arriving at the museum in 1981. I have now run it successfully for 36 years at the Carnegie and run through perhaps 11,000 bird skeletons, 3,000 reptiles, a few amphibians, a few fish, and perhaps 1000 mammals or mammal skulls. To explain how to run an efficient successful dermestid colony would need many pages of dialog. Many pieces of information can be seen on the skulls and skeleton section of the taxidermy.net web page. I have contributed some posts on skeleton prep for 17 years.

Question 6: Do you have any experience keeping or maintaining an online database for records? What suggestions do you have for creating a functional online record keeping system?

The museum databases I maintain are available on iDigBio, VertNet, and GBIF with some other web pages capitalizing on this data and using it, such as BISON. We do not have a direct feed to our data as some very large museums that have expensive database systems, but update it periodically. It is stored on site in Microsoft Access. The bird database has roughly 206,000 records representing 190,000 specimens (I post exchanged specimens), and the herp database roughly 172,000 records representing roughly 230,000 specimens with lot catalogued specimens. Place your data in the Darwin Core or Audubon core format and if it is of sufficient size you could perhaps contact iDigBio and have it uploaded.

Question 7: What do you consider the most important tools for your profession?

Define tool. In preparation it would be fingernails on the index and thumb, a freezer, quality forceps, sharp scalpel/replacement blades, linen thread, pins, Styrofoam pinning trays, Bristol paper. The computer is also a valuable tool as is a rapidiograph.

Question 8: What is a challenge you faced while skinning or preparing a bird or mammal, which you learned from?

It is all challenges on every specimen, and you either learn or re-learn the same things over the years. I have prepared roughly 5500 study skins of birds and made taxidermy mounts of primarily birds, but a number approximate to 500 or so. When preparing a taxidermy mount, it is not worth your time to start with a lower quality specimen – it is not worth the time involved.

Question 9: Do you have a special technique intended to avoid stretching the neck of a bird you're skinning?

There is no way to not stretch the neck, or other areas when properly removing flesh from a specimen, especially when using a wire wheel for fat birds. The trick is in properly putting the bird back into the position it should be when pinning it out. Poor preparators don't move the fore-chest and neck feathers into a natural position, and also don't tie the wings at the proper distance to have the coverts flow over them properly.

Question 10: Do you have any suggestions for protecting specimen collections from insects?

Proper IPM must be carried on at all times. Since arsenic has not been used for roughly 40-50 years in collections there is no way to prevent insect infestations unless vigilance to maintained. Freezing specimens routinely works for some collections, but this is only used when an outbreak happens in my collections.