The use of collections in research and teaching at the Museum of Texas Tech University

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Abstract

Texas Tech University, located in Lubbock, Texas, is a multi-disciplinary institution conducting research and offering degrees in a multitude of academic, technological, and vocational fields. The museum supports the research and teaching mission of the university by preserving in its collections unique items of artistic, scientific, historic, and technological importance and protecting them for current and future research purposes. Museum science and heritage management students translate collections management concepts learned in the classroom into collections management practices within the Quaternary collections. The genetic resources collection provides resource material for use in both traditional and emerging research methodologies. The vertebrate paleontology collections are used in research, teaching and exhibits to generate and disseminate information for both academic and public audiences. These examples clearly demonstrate the value of the museum's collections in supporting the university's mission across disciplines and into the future.

Introduction

Texas Technological College, located in Lubbock, Texas, USA, was founded in the early 20th century to provide education in the production and manufacturing techniques important for the economic development of Texas. The Museum of Texas Tech University was founded soon after, in collaboration with local and regional organizations, to bring cultural enrichment to the university and its communities and to support their development. Now Texas Tech University, it is a multi-disciplinary institution conducting research and offering degrees in a multitude of academic, technological, and vocational fields. The Graduate School strives to maintain the flexibility and diversity that were embodied in the institution from the time of its founding, through a combination of choices from the traditional degree programs to interdisciplinary, multi-disciplinary, and vocational options (TEXAS TECH UNIVERSITY 2008). To support this interdisciplinary research, some sixty specialized research centers and institutes are located at Texas Tech University, including the Museum of Texas Tech University. The museum today is a major research and collecting institution in its own right, curating approximately two million items. The museum supports the research mission of the university by preserving in its collections unique items of artistic, scientific, historic, and technological importance, protecting them for current and future research purposes.

The Museum of Texas Tech University is an American Association of Museums accredited general university museum. It is an educational scientific, cultural, and research element of Texas Tech University. The mission statement articulates that the Museum of Texas Tech University, as an education resource for a diverse audience, collects, researches, and disseminates information about the natural and cultural heritage of local and related regions. The museum's collections, exhibitions, programming, and research compliment the diverse interests of Texas Tech University and its role in public and professional education in local, state, national, and international communities (MUSEUM OF TEXAS TECH UNIVERSITY 2005).

The museum's purpose is to support the academic and intellectual mission of Texas Tech University through the collection, preservation, documentation, and research of scientific and cultural material and to disseminate information about those collections and their scientific and cultural topics through exhibition, interpretation, and publication for primary, secondary, and higher education students, the scholarly community, and the general public (MUSEUM OF TEXAS TECH UNIVERSITY 2005). Housed

within the museum, the Center for Advanced Study (CFAS) of Museum Science and Heritage Management's mission is to prepare graduate students for entry into the international community of active professionals by providing both theoretical and practical preparation and acting as a responsible academic element of Texas Tech University. The unique value, then, that the museum provides to the university is its ability to unite the academic, professional, and public communities under one roof and to provide a connection between "gown and town" that is accessible to all. It achieves this through its collections that are developed, managed, and conserved for use in research, exhibits, and education programs for public and academic audiences, and through the education and training of future academicians and professional practitioners.

Collections are curated in the six curatorial divisions of art, anthropology, ethnology and textiles, paleontology, history and natural sciences. Research and teaching are an integral activity in all the curatorial divisions. To illustrate such activity in detail, following are three specific examples from the divisions of anthropology, natural sciences, and paleontology.

Research and teaching within the larger framework of collections accountability

Research and teaching within the museum's collections is a matter of course. Research may be studying the collections but also investigating ways to preserve and manage collections better. A major advantage of having a graduate program based at and integrated into the museum is the immersion students receive in that critical interface of theory and practice. What is taught in the classroom is carried out in the daily operations of the museum, and for our purposes here, particularly so in the collections. Students are educated in the classroom and that education is enhanced and enforced through practical training, working with the collections governed by the museum's collection management policy and manual on collections management procedures.

The collections management course and the Quaternary collections are a case in point in illustrating the interface of teaching and research with collections accountability activities on a daily basis. The Quaternary collections primarily are generated through in-house research, a longstanding tradition since the museum was founded. [Collections accountability in general involves acquisition, documentation, care, exhibition, and disposal. The focus in the daily activities is on the first three aspects – acquisition, documentation, and care.] The collections management course addresses accountability, the laws and ethics of collecting, as well as the care and control of collections. These concepts are translated into the collections management practices in which the graduate students participate with the Quaternary collections.

Experiential learning is an important aspect in the education and training of museum professionals in the museum science program. Our students, however, are not limited to museum science, but come from across campus disciplines. Experiential learning also enhances their education and they are exposed to the same translation of concepts into practices. Experiential learning begins with the course labs, such as the one dealing with preservation maintenance of outdoor sculpture. The barcoding lab is reinforced through working with the barcoding system in the collections. Practicums are another avenue where students work with real collection problems and issues towards resolution. Lastly, workshops focus on a particular issue that provides students with greater exposure and can translate into applying new skills in carrying out collections activities.

Experiential learning is extended to research and its interface with collections accountability. Student research in collections management focuses on exploring ways to care for the collections better and bring greater control. As examples, a study done in the early 1980s looked at Polyvinyl acetate (PVAC) solutions of different viscosities as a basecoat in labeling pottery to determine the most appropriate solution. A more recent one examined different percentages and viscosities of PVAC

solutions and calcium carbonate to provide mechanical strength to fragile bone. Current research involves monitoring light, temperature, and humidity levels using an electronic data logger (HOBO) within our cabinets to determine: 1) if, indeed, the cabinets are light-tight; and 2) what level of protection is afforded when fluctuations occur in the collections room.

Generating collections is focused on field-generation through research. Major acquisition issues and ensuring legality are examined. Tying back to acquisitions and collections accountability, the first concerns are the laws and ethics governing the work, followed by how well the potential collection fits the museum's and division's scope of collections and collections plan. If the site or locality is on private land, do we have landowner permission to be on the land and to conduct the fieldwork? Has the landowner agreed to donate the collection to the museum? If the research is on public or tribal land, what permit is required and is that permit in order? Is the museum named as the curatorial facility to hold-in-trust that collection? A held-in-trust collection is one that has federal, tribal, or state ownership but the museum has stewardship of the collection. The accessions inventory is an important part of the legal transfer of the collection, whether it is part of a deed of gift to be signed by the landowner or an accessions agreement to be signed by a governmental agency representative for a held-in-trust collection.

Documentation and care within collections accountability come to the forefront in field-generating collections, with the mantra that good collections management begins in the field. Both documentary control and initial field preservation as warranted are stressed, including various museum forms to record not only provenience data and photo logs but also initial inventories, field treatments, and field transfer forms. Object barcodes can be assigned in the field and then are used to track the object throughout its life history in the collection. Field preservation stresses reversible treatments and approaches that do not damage the integrity of the object. Field jacketing is a good example. This is a time-honored approach to removing something fragile back to the lab where it can be exposed in more controlled conditions. However, the older use of highly acidic papers and other products or the use of foams in place of plaster have adversely impacted object integrity. While quick in the field, such methods can have disastrous results later. Following conservation principles, changing to the use of archival products and distilled water creates a neutral buffer rather than an acidic one surrounding the fragile object.

That critical interface of theory and practice, of teaching and research with collections accountability activities is brought together for students in professional presentations at museum and academic conferences and publications in museum journals. These endeavors provide opportunities whether students are in museum science or in other campus disciplines. These types of presentations and publications highlight what they have learned and incorporated into their mind-set and skill-set, contribute to their growing professionalism, and enhance the educational and research value of the museum's collections. In turn, research and teaching is intertwined with collections activities and that synergy underscores the relevance of a university museum to academic, museum, and public communities.

Collections of mammals and genetic resources as a research resource

The natural science collection at the Museum of Texas Tech University consists of mammals, birds, and invertebrates. The greatest number of loans and relevant research material is associated with the genetic resources collection. There are in excess of 220,000 vials of frozen tissue, as well as isolated DNA samples, and lysis buffer and ethanol-stored samples. The main collection is from mammals, however there are other samples of other taxa collected opportunistically. The significance and power of this collection to address natural history issues is not limited only to the production of classical species trees but it provides additional insights into what diseases a species carries, level of pollution,

as is a source of genes for recombinant DNA study and its economic development, where appropriate. The genetic resources collection, as well as similar collections, is the basis for the development of the genetic species concept that provides a better understanding of the forces that have resulted in the diversity of mammals worldwide. The focus of this presentation is on the value of the collection of mammals and the collection of genetic resources as a research resource. However, it should be noted that all collections in the Museum of Texas Tech University are available to qualified scientists, artists, or other appropriate researchers. All collections follow written collections management policy and procedures for loans, study, destructive analysis, etc.

The mammal collection at Texas Tech was started in the early 1960s. By 1967 there were 8,000 specimens. Today the collection has 110,000-catalogued specimens. The genetic resources collection was initiated in the mid 1970s and today has 250,000 vials of tissues from numerous species. These two collections have been used as a source for over 1,000 scientific papers and refereed journals and have been a major data source for over 75 doctoral dissertations and 75 master's theses. Individual researchers who used these collections as part of their graduate education include David J. Schmidly, Terry L. Yates, O. James Richmond, John W. Bickham, Kateryna Makova, Ron Van Den Bussche, Anton Nekrutenko, Cody Edwards, Darren Carroll, Heather N. Meeks, Peter V. August, Andrew DeWoody, David Webster, Paisley Kato, Serena Reeder, Brian Ammnan, Irine Tiemann-Boege, Moira Van Steadden, Michael Arnold, Ira Greenbaum, Ben Coop, Kimberlyn Nelson, Cole Matson, William J. Blier, Rodney Honeycutt, Mazin Qumsiyeh, Meredith Hamilton, Joaquin Arroyo-Cabrales, Brenda Rodgers, Jeff Wickliffe, and Sergio Solari. These individuals have not only been faculty members at significant educational institutions but they also include individuals who have been presidents of universities, leaders of government initiatives, and directors of NSF divisions. Using museum collections to study biodiversity and to describe life thus appears to be an excellent experience to gain an intellectual and educational perspective relative to academic and other areas of success.

Successful research efforts have been accomplished through several types of studies. In some cases specimens that originally have been collected for chromosomal data have been studied again in a new light when new methods such as mitochondrial DNA, Amplified Fragment Length Polymorphism, chromosomal painting and banding, etc. have been developed. In these cases new experimental designs draw heavily from the results and conclusions of the earlier studies.

There are museum issues that need to be addressed using voucher specimens with genetic resources curated in the form of tissues. Tissue loans are destructive, and, for any given specimen, there is a finite amount of material available to be studied. Tissues are expensive to collect, archive, and include in databases that must be searched by mammalogists, molecular geneticists or conservation biologists, in comparison to loans of voucher specimens that have classically been made between two museums. Very few of the loan requests for tissues for molecular and genetic analysis are from individuals associated with a museum. This makes enforcing conditions of a loan difficult since non-museum institutions are not always understanding or appreciative of tradition loan agreements and conditions. Research into biodiversity requires new types of museum collections that interface with national security issue such as human disease, ecotoxicology, etc., and involve scientists who do not typically operate within a museum environment. Sometimes this taxes the application of the traditional museological concepts and requires changes in curation methods, database structure, loan procedures, and safety of staff. For example, our team has been studying the biological consequences of chronic exposure to radiation since 1994. All of the specimens used by us are curated in the Museum of Texas Tech University. This arrangement provides two benefits for an ecotoxicological study. First, these specimens can be used for traditional study and will still be available as new methods are developed. Second, if there is reason to question our results this will be possible by having independent researchers in other labs where our experiments can be replicated.

Weaving the significance of museum collections into issues such as public health, disease, and bioterrorism (PHILLIPS ET AL. 2009) greatly helps justify the need for such collections. Three examples are: *The ecology and evolutionary history of an emergent disease: Hantavirus Pulmonary Syndrome*. Bioscience (YATES ET AL. 2002); *Predicted Hantavirus Risk in 2006 for the Southwestern U.S.* Occasional Papers, Museum of Texas Tech (GLASS ET AL. 2006); and *Global disease surveillance, Emergent disease preparedness, and National security*. Publication of Museum of Texas Tech University (PHILLIPS ET AL. 2009). The Bioscience article establishes how ocean currents in the Pacific affect the probability of contacting Hantavirus in the South Western United States. The Occasional Paper publication predicted specific Hantavirus risk areas in New Mexico and Arizona, as well as the time of risk before actual risk occurred. Some areas in New Mexico and Arizona had a high risk whereas others had a low risk. The data on which these risks were established was based on tissues and voucher specimens archived in museums.[1]

The vertebrate paleontology collection at the Museum of Texas Tech University: Its role in teaching, exhibit, and research

The collection of fossil vertebrates at the museum is an important resource for teaching paleontology and evolution to undergraduate and graduate students from the geology, biology, and museum science and heritage management departments. Museum science and heritage management students use the collection actively for learning barcoding, housing, and cataloging of specimens. They also utilize the paleontology lab for learning the preparation of fossil specimens and basic molding and casting technique. The holdings of fossil vertebrates from the Triassic of Texas and Cretaceous of Antarctica have been utilized by researchers from all over the world. The permanent *Changing World* (Dinosaur Hall) exhibition has become a window through which local school children and adults are introduced informally to science, natural history, evolution, changing environments, plate tectonics, volcanisms, and mass extinction. The Triassic fossil sites near Post have become a proximate field laboratory for teaching various collecting techniques. Active field programs in different parts of the world including Antarctica, China, Brazil, South America, and India have amassed a large collection of fossil material or their replicas and fostered international collaboration. Exquisite three-dimensional replicas of pterosaurs from Brazil, now housed at the museum, have been used to study their flight dynamics. The collaboration on pterosaur flight with an aeronautical engineer has led to a novel design of a robotic spy plane that not only flies but also walks and sails just like the original.

The story of vertebrate evolution during the past 500 million years is based on fossils, the remains or traces of ancient backboned animals, which have been preserved in the sedimentary rocks of the earth's crust. Vertebrate paleontology, in a certain sense, is the study of fossils, for all of its reconstructions and theories are based on these objects. The purpose of the vertebrate paleontology (VP) collection at the Museum of Texas Tech University is to obtain and preserve the record of fossil vertebrates for research and education, to curate them in an orderly and accessible fashion, and to maintain the records of their source and origin. Fossil specimens are used in teaching paleontology and in advancing knowledge of various aspects of this science through research. An active research program is essential if a collection is to be properly maintained and utilized.

A university-held collection is an intellectual resource, intellectual property, and an integral part of the institution of higher education. Vertebrate fossils are a non-renewable natural resource relating to the evolutionary history of animals. These collections are truly irreplaceable and they are held as a public trust. They are living testimony to the past of our world and must be passed to the generations who

[1] All three of the articles are available on our website at www.nsrl.ttu.edu (accessed December 20, 2010).

are to come. The VP collection at the museum contains both fossil specimens and casts along with their associated documentation from the Pennsylvanian to the Pleistocene periods. They comprise the tangible base for taxonomic, biostratigraphic, and morphologic interpretations in the history of vertebrate life. They provide the data needed to understand the nature and extent of interconnections between biological and environmental processes over geologic time. The collections contain a number of holotype specimens, which were used by the original authors in erection of new species. Casts are especially useful for comparative studies and biomechanical analysis, which can be applied to research and teaching. The VP division accepts the responsibility of collecting, conserving, housing, and maintaining records and collections of vertebrate fossils.

The VP collection, though of modest size, is one of the important research collections, numbering over 20,000-catalogued specimens assembled over a period of more than 70 years. The holdings of fossil vertebrates from the Triassic of Texas, the Cretaceous of Antarctica, and the Mio-Pliocene of the High Plains of Texas have come into prominence as one of the best in the nation. The collections contain representatives of major groups of vertebrates including fish, amphibians, reptiles, birds, and mammals.

Research almost always entails acquisition of additional material and growth of the research collection. Specimens for the VP collections are acquired chiefly by active field expeditions by faculty, staff, and graduate students. The most prolific fossils sites of Late Triassic vertebrates and Neogene Blanco faunas lie within 50-miles-radius of the museum campus on private lands. Landowners are very generous in granting permission to the museum to explore their property for fossils and in their support for research. Some of the Triassic fossil sites in the Crosby and Garza counties of Texas are used for teaching field methods for museum, heritage, and geology students, who learn how to find and excavate fossils, record field data, collect bones, and jacket them with casts of polypropylene matting and plaster of Paris before they are removed from the matrix.

The paleontology division has a state-of-the-art lab and a casting lab with all modern equipment. Field specimens are brought to the lab and stored with their field labels until each specimen is prepared. In the laboratory, the field collection process is reversed: the plaster jackets are removed, and the fossil bones are extracted from the matrix and reinforced by consolidants such as Butvar and paper pulp. During the course of the in-lab collection process, all the documentation including locality data, latitudes and longitudes, stratigraphic levels, field sketches and photographs of excavations are carefully recorded.

The Late Triassic vertebrates at the museum during the dawn age of dinosaurs represent one of the finest and most comprehensive collections in the world in terms of the variety of species and quality of preservation. Several expeditions to Antarctica have yielded one of the largest collections of Permo-Triassic plant fossils and Late Cretaceous marine vertebrates. Particularly significant is the presence of several types of sharks, bony fish, plesiosaurs, mosasaurs, and the oldest loon. Fieldwork in India, China, and Brazil produced important collaborative research, although the fossils were kept in host institutions. Portions of the VP collection were through fieldwork supported by funding agencies such as the National Science Foundation and the National Geographic Society.

The collections of fossil vertebrates and other geological specimens in the museum are important resources for research and teaching in paleontology. We have excellent steel cabinet furniture for housing specimens, and climate-controlled collections housing areas, which are locked for safety and security. Both the specimens and their associated information are organized and easily accessible. Each catalog number is cross-referenced to geological horizon, taxonomic name, and/or locality in the catalog database for easy retrieval. Barcoding is used to capture and retrieve data for each specimen. A laser surface scanning lab is used to capture specimens in three dimensions, and resulting images

are used in research, animation, and teaching. As collections information is computerized, data can be more widely shared.

The primary uses of the VP collections are in teaching, scientific research, and exhibits. Dissemination of scientific research in VP division is carried out through peer-reviewed publications, lectures at national and international conferences, display for general public, popular lectures, and formal and informal educational programs and activities.

The museum is internationally acclaimed for its graduate programs in museum science and heritage management and has acquired a reputation for excellence. Through classroom lectures and hands-on experiential learning, the museum provides invaluable experience for graduate students wishing to enter the museum and heritage profession. Students utilize the collections in practicum projects, experience in collection management techniques, and for research projects, including topics for theses and dissertations.

The VP collections serve a variety of research purposes: (1) They are the basis for original scientific research on the age, affinity, anatomy, and evolution of the animals; (2) They provide a scientific record of the extinct biotic assemblages, their anatomy, adaptation, and mode of life. (3) They are used to train present-day graduate students and will be used to train coming generations of scientists. (4) They are used in exhibits, lectures, and other educational programs to disseminate knowledge. (5) They are open to qualified investigators from other institutions, for comparative studies. Researchers from all over the world come to the museum to study the collection.

Its curator has published many monographs, books, and peer-reviewed papers on the basis of the museum's collection that received national and international attention.

The VP collection also contains many examples of high-fidelity cast skeletons of dinosaurs, pterosaurs, and mammalian teeth, which are important components for teaching, research, and exhibit. The assemblage of cast skeletons of pterosaurs is one the best in the nation and has been used for animal flight research by the curator and the inspiration for designing the pterodrone, a robotic spy plane, to be used for defense purposes. The pterodrone, which can walk, fly, and sail now is in development in collaboration with an aeronautical engineer.

The museum is considered one of the world's best repositories of Antarctic material because of long and active fieldwork beginning in 1933 when the late Alton Wade made his first of seven trips to Antarctica as a member of the Second Byrd Expedition. During 1980s, several expeditions from the paleontology division brought back valuable vertebrate fossils and plant material from Antarctica.

Museums are centers for public learning available to all without regard to age, background, or knowledge. Exhibits are the principal means by which museums engage the public. A dinosaur gallery is often the window through which many children and adults are first introduced to science and natural history. In 2004 *Changing Worlds,* a permanent exhibition of dinosaurs, in a 9,000-square-foot exhibition space opened at the museum. There are only ten university museums in the nation that have permanent dinosaur exhibits; the museum is now one of these elite groups. Thousands of visitors every year pass through three galleries of Mesozoic life that feature critical events in the rise and fall of dinosaurs in relation to the drifting continents: from the beginning in the Triassic Pangean world along with other archosaurs, radiation and gigantism in the Jurassic, to their diversification and disappearance in the Cretaceous. Visitors range from the general public to classes from the local schools coming to study the exhibits as part of their science education.

Conclusion

What is the value to a university in having a museum? Why is an institution that aims to preserve both tangible objects and intangible information and expression considered important, or even necessary, especially in this age of digital information and virtual experience? The answer lies in what collections can reveal, not only under current investigative techniques, methodologies, and philosophies, but also for what they may reveal in the future. They provide examples of items and adaptations produced in relation to the ways in which species, cultures, and places have responded to the environment from their origin to the present day. They reveal stories in ways that other records often do not.

Collections are non-renewable resources, once gone, never again available for the future. Through the preservation of collections, museums provide universities with possibilities for future research and teaching that are unparalleled by any other kind of institution. The unique mission and purpose of a museum supports the university in its endeavors by providing a place for the in-perpetuity preservation of works, artifacts, objects, and specimens on which research and teaching is based. Additionally, the museum characteristically is an interdisciplinary institution that provides opportunities for research and teaching across disciplines that may not so easily be achieved in traditional university academic departments.

The International Council of Museums (ICOM) *Code of Ethics for Museums* states that museums that maintain collections hold them in trust for the benefit of society and its development (INTERNATIONAL COUNCIL OF MUSEUMS 2006). Museums must acquire, conserve, and exhibit collections, and educate the public about these collections. Developing an understanding of the cultural and environmental past based on collections is important not only in and of itself, but is critical for understanding the present and creating a viable future. A university museum is a unique interface between the academic and research community and the wider public and because of this is critically placed to disseminate new knowledge and information to a broader community.

The Museum of Texas Tech University supports an educational institution that was established to provide both traditional academic and vocational education to contribute to the economic development of the State of Texas at a time when this was of great importance. The museum continues to support the university through the acquisition and preservation and use of collections that provide faculty, staff, students, and the wider public with access to a wealth of diverse natural and cultural material for research, teaching, and interpretation purposes. The museum's special multi and interdisciplinary collections-based research and teaching approach provides a place for collections to be protected in-perpetuity so that current and future research potential is developed, accounted for, and safeguarded.

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