The Journey of a Specimen: a Blogging Campaign for the KU Natural History Museum

by

Thomas C. Hardy

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Michael Williams, Chairperson

Committee Members

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Thomas Lorenz

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Douglas Ward

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Acceptance Page

The Project Committee for Thomas C. Hardy certifies that this is the approved version of the following project:

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Abstract

The KU Natural History Museum has a staggering collection of over 8 million biological specimens. This project attempts to demonstrate how to bring this collection closer to the public via photos and text presented on the museum's blog.

To produce a prototype for future publications, existing museum websites and blogs were reviewed and literature on web audiences was evaluated. The investigator built content for the prototype by collecting images and text through a trip to Peru, conducting interviews with significant researchers, and taking photographs of a sample of the museum's collection.

The final prototype for the project included eight posts which demonstrate an organization scheme in which content was divided into two subsections – the journey of a specimen from the field to the lab, and the usefulness of a group of specimens once put into the collection.

An Opportunity

The KU Natural History Museum possesses a staggering collection of over 8 million biological specimens, representing the 4th largest biological collection in the United States. These specimens are made up from a variety of organisms, from plants to insects to fossils and all types of vertebrate animals. Taken together, the collection composes one of the world's largest repositories for biodiversity research (KU Natural History Museum [NHM], 2011).

A museum's status among the research community is often determined by the scope and care of its collections. Museum collections are used in many ways. They are extremely important for taxonomic work and for cataloguing species. They help determine if species territories are dwindling or expanding. They give information about migration, ecosystem health, and the spread of disease (Smithsonian Museum of Natural History, 2012).

Collections are not only valuable for research, however, and also form the basis of educating the public on the natural world. Less than .1% of the specimens in collections are on exhibit in the KU Natural History Museum at any given time. Walk into the collection to see the depth and breadth of specimens and it immediately evokes the feeling of an untapped resource. Via the skills of a journalist, this project aims to make the remaining 99.9% of the natural history collection more interesting, accessible, and relevant to the general public.

The display and explanation of museum collections online has transformed the role of museums. Research and outreach can be facilitated for those who do not have the time or the funds to travel to a museum to explore its collections. By putting collections online, museums expand their usefulness and relevance. (Kalfatovic, 2002). Many of the KU Natural History Museum's collections are already available online. They are not, however, comprehensively explained for a general audience. Most of the museum's specimens are in an online database which is primarily directed toward researchers (NHM, 2011).

According to J. Humphrey, communications officer for the KU Natural History Museum, the museum has "a desire to bring the collections more into the public view, especially electronically" (J. Humphrey, interview, January 26, 2012). Humphrey views the communication of the museum's collection as a way to both communicate the museum's mission and to effectively teach the general public about collections (Humphrey 2012).

Humphrey goes on to stress the advantages of an online presence: "I think that online exhibits for museums are a way for peple to experience the museum without entering the brick and mortar. You have the potential to reach more people than you would. We only see about 50,000 per year" (Humphrey 2012).

Perhaps most importantly, specimens lend themselves to presentation in a digital format. Humphrey continues, "With specimens, you have the object itself, which is just interesting to look at. And then you have all the information about

that specimen. And then you have all the information related to it. Like why is this significant to the herpetology collections?" (Humphrey 2012).

From what Humphrey indicates, online content featuring the museum's specimens and their function would both help communicate the museum's mission and serve as content that is relevant to the museum's research. With limited staff, the museum currently has no feasible way to achieve this goal.

The desire to make its collections more accessible to the public, combined with the depth and breadth of the museum's collections and the wish to make them more available to the public have created a scenario that could be feasibly rectified, given the right assistance.

But what about the user-side? Does the general public wish to obtain information via a website, or would a magazine, newsletter, or book be more effective?

Literature Review

The Internet is "perhaps the most rapidly developing new medium in history" (Eighmey and McCord, 1998, p. 1). Not only have corporate websites taken off, but also information-providing websites, such as news media, outreach, NGO and encyclopedia websites. Wikipedia, an online encyclopedia of information, contains 21 million articles that receive 2.7 billion pageviews each

month (Wikipedia.org). It seems that information, even user-generated content, is in high demand.

This study is one of many that examine adoption of new technologies in order for the user to obtain information. Another example comes from a study done by Mitchell Weisberg that examined child learning from a suite of e-readers and tablet devices. Children's textbooks were put on the devices and learning was compared to that of children with paper textbooks. Amount learned was the same, and many preferred the ease of use and flexibility that came with the electronic versions (Weisberg 2011).

In their paper, Eighmey and McCord state "This study indicates members of the WWW audience are attracted to information that adds value in both form and substance…" (p. 7). The scholars have identified that consumers of online content care both about the information provided and how that information is presented. This should be kept in mind when we return to exploring how such content should be structured and executed.

To fully understand a Web audience, it is important to examine audience demographics. According to a presentation on the Pew Research Center's American Life Project, the majority of people who obtain information online are under 50. A third of those are under 30, and compared to other adults, they are more educated, more affluent, and often tend to be white or Hispanic (Purcell, 2011).

According to Purcell, museums must take on the role of filters of information – there is plenty of information out there, but museums should be depended upon for accuracy and quality. It states that museum web content should link to other relevant sources, and should also try to get a conversation going, should try to get the ball rolling in helping a community see, understand, and discuss a topic.

Purcell goes on to stress how museums must make their exhibits relevant to readers. They must keep visitor demographics in mind. Their web content must attempt to connect to the viewer's life in some way – perhaps through explaining how the topic relates to something in everyday life or a physical exhibit within the museum.

Purcell also discusses the rising importance of multi-platform access. Increasingly, phones and tablet computers are being used to access information online. Websites that hope to disseminate information should make it accessible by these devices – both images and text need to be easily consumable.

Perhaps most importantly, Purcell says that museums should be *interactive* – they should, when at all possible, respond to the questions or points raised by those that visit museum websites. If enough interest is generated by an online article, the museum should host an event that deals with the topic, or explore it further with another, more focused article.

A survey done by Purcell, Rainie, Mitchell, Rosenstiel, and Olmstead states that most adults use their social networks and social networking sites to find

and filter information that they seek. This suggests that online museum presences likely benefit from a social media presence. An institution's information can be effectively disseminated via a social networking presence. The survey found that, among those that get their news online, 75% are forwarded information via social networking sites or email (Purcell, 2010).

Other natural history museums have, to different degrees, attempted to describe what their collections encompass and what they are used for. These can be looked to for guidance and inspiration, and should be thoroughly considered before beginning a project to do such a task.

Many of the largest natural history museums dedicate portions of their websites to explaining the significance and use of natural history collections. These shall be examined to assess the breadth and depth of information that they provide.

Literature Review: Other Websites

American Museum of Natural History - http://www.amnh.org/

The website for the American Museum of Natural History is widely known to have an enormous collection, in many ways the most sprawling of all collections in the United States. On its website, however, the museum does little to explain to an average visitor about its collections – what it does with them, how they elevate the institution, and how they serve researchers. The only way to learn

about the collection is by research division (ichthyology, ornithology, etc.) and does very little to give a general audience an idea about the nature of their collections or about how specimens are processed. Their content is focused on guiding researchers to where they need to go.

When taking the website as a whole, it seems unusual that its creators would leave this portion relatively unexplained. The website features content about its exhibitions, the expeditions of its scientists, and even about imaging of specimens, but does not explain how those collections are useful to their scientists. This lack of information detracts from the museum's mission to "discover, interpret and disseminate information about human cultures, the natural world and the universe". It gives the website a closed-door feel, as if the sitegoer does not care or does not need to know.

National (Smithsonian) Museum of Natural History - http://www.mnh.si.edu/

The Smithsonian Museum of Natural History goes a step further in explaining collections. It briefly explains the role of collections at http://www.mnh.si.edu/rc/

It goes into the purpose of a collection: "Such collections-based research then provides the essential building blocks for answering broader questions about our future. NMNH scientists and their colleagues worldwide seek the puzzle

pieces that will form detailed pictures of vital topics such as evolutionary relationships of organisms, biodiversity loss and global climate change."

The description that the NMNH gives certainly explains the overarching purpose of collections. But it still leaves many questions to be answered. For a general audience to understand what a collection really *is*, more particular information must be provided. It is difficult to figure out just *how* specimens contribute useful information. Perhaps the public needs to know what kinds of data are obtained from specimens and how such data is obtained. To understand a collection, one may need to know specifically what they consist of: living things that have been preserved in a variety of ways. They are jars of alcohol-soaked snakes. They are skulls and skins of mammals. They are dried and mounted plants. If the public is not shown this, collections seem vague and mysterious.

As a journalist, my approach focuses on what the reader seeks when they read about specimens. A website about the dissemination of knowledge must be precise, readable, and understandable for it to achieve its goals.

The British Museum of Natural History - http://www.nhm.ac.uk/

The British Museum of Natural History, which contains the largest natural history collection in the world, treats collections in a similar way to the Smithsonian, but with less information. The extent of the layman's information given is shown below:

> The Museum is home to the largest and most important natural history collection in the world, with over 70 million specimens ranging from microscopic slides to mammoth skeletons. It also offers an array of educational, electronic and exhibition resources. All these items are organised into 'collections', which can be defined as groups of items that have something in common.
>
> Our scientific activities revolve around the remarkable collections we look after, which represent the diversity of the natural world, past and present, and have been gathered over the last 400 years. Through them we gain knowledge of the animals and plants with which we share the planet and also of the processes that have shaped the world around us and our solar system.
>
> Use of the collections is promoted to further knowledge of the natural world through loans, visits and collaborative projects, as well as supporting the Museum's own research programme. (http://www.nhm.ac.uk/research-curation/collections/index.html)

Information given does very little to explain how the museum's natural history collections are processed, catalogued, or used to provide researchers with information. Just *how* does a collection help them understand "…the processes that have shaped the world around us"? Just like the previous two museum

websites examined, the British Museum of Natural History does not present its information in a consumable way. It is didactic. It is not story-driven or playful or apt. The information is too compacted, too brief, to be of use to those who wish to understand how scientists do their work or why we need museums and their collections.

From the perspective of a journalist, this approach seems not only unhelpful, but could even be harmful. When explaining how an institution is relevant, concise and yet thorough information is vital. This information must be understandable to the website's audience, which is made up of a small percentage of scientists as opposed to those with little knowledge of the field.

It has always been vital for museums to make their purpose and mission understood, and without explaining how natural history museum collections function, these museums shall make only part of their mission understood. A more holistic, engaging, thorough treatment of specimens and collections would bring their efforts and their mission to light.

Other University Museums

The websites of many leading university natural history museums sometimes have online exhibits related to their collections, but in no case do they thoroughly explain them (Yale 2011; Oklahoma 2012; Drexel 2012). It may be the case that not all natural history museums have an interest in communicating

the purpose of their collections to the general public, or perhaps do not have the time or resources to do so.

Literature Review: Online Exhibits as Examples

To lay out the details of a project plan, the strengths and weaknesses of such a project must be explored, as well as guidelines for how to conceive and execute it. Many guidelines take the form of online articles, etc. and will be supplemented by interviews with KU Natural History Museum web developer, Brett Stoppel.

An Overview of Online Exhibitions cites the cost-effectiveness, the removal of the limitations of time and space, 24-hour availability, the ease with which visitors can view all of the information that they want, and the interactive possibilities of online exhibits. The article also cites the speed with which users can access information, the variety of ways that users can learn (from text, images, and video), and increased collaboration opportunities. It lists potential pitfalls of online exhibits as being able to poorly represent fine detail, the inferiority of images to actual objects, and the requirement for users to be connected to the Internet (Khoon & Ramaiah, 2008).

The website for the Conference on Museums and the Web has a list of categories for the "Best of the Web" awards, given out yearly. These awards require more facets than the scope of this project will delve into, but certain awards can be helpful as guides for formulating how to build an online exhibit.

The most relevant awards include: Education (presence of identifiable target audience), Exhibition (effective use of media, presenting exhibits in new ways), and Research (accuracy and depth, ease of use).

Exploiting Synergies, by Terence Huwe, discusses experience gained from the creation of an online repository for labor history in California. The scope of the project is much larger than this, but the article offers some pieces of information that would be useful to this endeavor. Most useful was the advice that it offered on selecting certain items in the collection as representatives or flagships of the collection. Not everything in the collection can be made available immediately, and they decided to pick and choose: "The challenge is to identify the hidden gems within our special collections" (Huwe 15).

The article discusses how the content can be most effective. The author makes a point of information *synthesis* – of bringing the items together in a curatorial way: "As an online repository, this collection would enable scholars to trace issues, legislative mandates, social movements, and speeches over the full span of a century. An easily searchable chronological span of digital files would allow crucial new insights to come into focus" (Huwe 15). Integration is just as important as content.

It is also important to look at websites that successfully execute online exhibits. An exemplary exhibition on the web can be found on the Colonial Williamsburg website. The "Historic Threads" exhibit brings lavish colonial-era clothing to life through the use of images and text. It is simple to use, and yet

guides the viewer through exhibit as a museum hallway might. For the user who wishes to explore on his or her own, it also has a large bank of images that can be browsed and read about at will (Williamsburg 2012). This at-will format, as well as dazzling images and relevant text come together in powerful ways.

Not only is the website easy to navigate, it ties text and images together in an effort to make the exhibit a type of immersion into the time. Form of clothing is connected to function and to social status. The clothing becomes a part of the workday, an integral part of the wedding, part of family history. The exhibit views the objects with wide perspective, connecting them in as many ways as possible to related information (Williamsburg 2012).

Methodology

It is perhaps most important to look at what the KU Natural History Museum wants, and the extent to which this project would branch from the museum's typical piece of content about its exhibits, collections, etc.

In an interview with Brett Stoppel, web developer at the KU Natural History Museum, he built on the former interview with Jen Humphrey. Stoppel commented mostly on length, delivery method, and accessibility (B. Stoppel interview, January 31, 2012).

Stoppel identified a need for short, roughly 300-word content pieces that could be published on their own in a series, but which could also be combined to create a holistic view of the topic. Stoppel said that releasing the series on the museum's blog would create the most initial impact, grabbing the most possible user traffic, and then potentially be put in a more permanent, accessible state, such as its "Explore a Topic" section or something similar (Stoppel 2012).

Stoppel also stressed a user-friendly, informal tone and simple, straightforward presentation. He emphasized the serial nature he preferred, with short content pieces interspersed with photographs. (Stoppel 2012).

In summation of conclusions drawn from literature, existing websites, and interviews with museum staff, an effective solution to this problem has many needs:

1) It must describe the museum's collection in a circumspect way without losing sight of the value of each individual specimen.
2) It must teach the viewer about how a museum's collection (and in particular, the KU Natural History Museum's collection) is used to conduct research, to which the museum's mission is closely tied.
3) The solution is best executed via many forms of media.
4) Content pieces must be charismatic, interesting, presented in an engaging way, and easy to navigate.
5) It must cater to its target audience.
6) It should make references and connections to other relevant procedures, data, or institutions.
7) The solution should be published in serial, but be easily integrated into a cohesive whole.

There are many ways that this information could be communicated to a potential audience. It could be primarily visual, via graphs and photos on the museum's website. The salient facts of the collections could also be listed. But item #4, listed above: "Content pieces must be charismatic, interesting, presented in an engaging way, and easy to navigate," is hard to fulfill by using this approach.

The powers of storytelling – both its ability to communicate ideas and concepts, as well as its consumability and power to remain in one's memory – need not be justified here. When journalists tell stories, they aim to present information in a way that engages readers, connects them to the topic of discussion, and leaves them, hopefully, informed and interested. Telling the story of collections may explain them more thoroughly while also increasing their relevance to the reader.

From time spent with Humphrey, Stoppel, and scientists in their collections, two "stories," or ways of seeing into the collections come to the surface: The first is the journey of a specimen, the second is the importance of these specimens when put into a collection. I will use these two approaches to tell the story of collections.

Journey of a Specimen: There is the story of the specimen itself – the insect, the parasite, the bird. The specimen had a story before it became a specimen. And this story is what appeals to scientists – where was it found? Is it male or female? Was it healthy? What was in its stomach? The story of the specimen's life up to the catching of it becomes of paramount importance to the scientist. This is the journey of the creature – from birth to capture, through the process of being turned into a specimen, and then being mined for data. Who has borrowed the specimen since it was first caught? Was it of great importance to a paper, a presentation? I plan to pick a specimen and follow it through the entire process. Not only will this segment explain what data the specimen provides, but

also how scientists go about obtaining that data. It will follow the *Journey of a Specimen*, and have three main components. Each of these components will be explained in its own blog post, with the last component possibly requiring two serial posts:

Journey of a Specimen

1: The specimen's life up through the moment of being trapped – its classification, habitat, behavior, diet. The instruments used to trap the insect.

2: Discovery by a scientist, travel back to the museum – cleaning the traps out, collecting the specimens, labeling. Going through customs (which can be exciting).

3-4: Tissue processing, DNA sampling, taxidermy, etc. – how the processes work, what DNA sampling tells us, how long a collected specimen will last.

Execution of this first section, *Journey of a Specimen*, may also involve interviews with Andrew Short, Collection Manager and Caroline Chaboo, Curator. The entire journey of a specimen from its home in the Amazon, through preservation processes and transportation, back to Kansas, will be recorded with photos and text.

For the last piece of content within this section, I may branch out to another division, likely Ornithology, to hit upon taxidermy, and I may also take

photos of a group of very charismatic herpetology specimens that have been "cleared" (made transluscent) and "stained" (dyed).

Collections. The second section will concern itself with the banks of specimens as a whole – the body of knowledge that they create, the "collection." It will ask and answer the question: how are collections useful? When a scientist turns to a collection for information, what are they searching for and how does the collection help them find it? What is it about having a large library of specimens that is particularly useful? The anticipated pieces of content will answer these questions:

Why We Need Collections:

1: How did collections start? What are in collections? How are collections organized and what does it take to maintain them?

2: How do collections help scientists answer their research questions? What does X need when he goes to a collection? What does Y need?

3: What can collections tell us about climate change and its effects on biodiversity?

4: What benefits are had by putting collections on the Internet, as large data sets?

The series will start with a very brief explanation of the history of collections, followed by their organization and maintenance. For the first section

in this series, I will interview Andrew Campbell, Collections Manager for the Herpetology Collection about the upkeep of the museum's "wet lab" collection. It will delve into the first natural history collection, their system of organization, and the job of collection managers.

The second piece of content may approach the topic from one or two angles. I will interview David McLeod, a Herpetology research associate and professor about what he's looking for when he goes to a collection and how his hunt will aid him in answering his research questions. Given space in the piece of content, I may also interview graduate students in Vertebrate Paleontology and Botany. I will take on the perspective of the researcher who has a question, follow him/her into the collection, and go through how they use specific specimens to answer their research questions.

To answer the third question, the corresponding piece of content will use two perspectives: that of Paleontologists (some of which study the long-term effects of climate change and its role in extinction) and Ornithologists, which use recently collected specimens to track how climate affects migration patterns. David Burnham of Vertebrate Paleontology and Mark Robbins of Ornithology will be interviewed. It will attempt to give an idea of how collections are useful in tracking the effects of climate change upon plants and animals. This section ties the series of posts into issues of climate change, making collections more relevant to the environmental issues to which the reader may have familiarity.

The last section will describe how collections are being digitized and how they interface with technology. Jim Beach, Assistant Director for Informatics, will be interviewed about Specify, a software program used by many museums to organize their collections and make them more accessible to researchers. Town Peterson, Curator of Ornithology, may also be interviewed for his use of biodiversity mapping and his work on predicting the spread of diseases like Avian Flu.

Photographs will be taken for all pieces of content, and slide shows will be used when necessary. A few maps will be included, mainly to illustrate where people do their work and the ranges of the specimens that they collect.

I hope to create pieces of content that are as varied as the organisms being studied, yet unify how collections work. I hope to illustrate implicitly that researchers from all fields use collections in a similar way, and in fact many researchers have similar pursuits while studying any kind of organism.

The target audience includes all those who visit the Natural History Museum's website. Many visit for museum hours and directions, and much of the content on the website is designed to "hook" those already interested in the museum into learning more about it. This piece will serve that function.

Photographs of the collections will also be required, most likely Herpetology, Entomology, and Ornithology.

Methodology: Peruvian Amazon

In June 2011, Biodiversity Institute entomologist Caroline Chaboo went to the Peruvian Amazon to continue her research on Chrysomelid beetles and to gather specimens for study. I was sent on the trip as well to be the group's journalist – to take photos and blog from the field.

More importantly to this project, my work in Peru formed the basis for my methodological approach. Many of my photos and posts tried to capture and communicate what it was like to do research abroad. But to really know what the experience was like (and to totally understand the significance of specimens), I participated in the research.

I assert that, for a blogger's posts to be well informed and relevant, he or she *must make as few non-experiential assertions in his/her content as possible*. Going on the trip allowed me to not only see the researchers do the work, but also participate in the work to be done. I will be listed as a contributor to the paper generated by this expedition. The trip allows me special insight into the subject. I experienced (did not just ask someone about) collecting in the field.

Conclusions

The approach of this project brings a journalist's skillset to explain a large, unwieldy subject such as a museum collection. The project communicates the value of collections, tells the story of how they are created and maintained, and

achieves the outreach goals of the KU Natural History Museum via coherent, engaging writing and ample photographs.

The wide utility of this approach should be considered. The method could easily be adapted to assist a great number of other institutions communicate their goals, research, or holdings. University departments, research institutes, nonprofit organizations, conservation groups, state parks, libraries, historical sites, etc. could potentially make use of a journalist's approach to tell a story that the organization deems vital. The approach could be used for public education, outreach, exhibit enhancement, or publicity. It could be helpful to a museum or research institute that wishes to communicate its current research or a study that it deems particularly important. It could help a historical or literary museum attempt to explain the significance of a particular item to the general public. It may be of use to an NGO that wishes to communicate its mission. The activities of any interesting organization are ripe for this storytelling approach.

Conclusions: Vital Components

The approach outlined in this paper was executed and will be published in serial on the KU Natural History Museum's website starting on May 14, 2012. Many components of the outlined approach were vital to the completion of the project; some were not.

The items judged to be **most vital** to the completion of this project include:

- In-the-field experience with specimen collection and processing. Learning to perform these processes gave not only real-world experience, but also provided a glimpse into just how time-consuming and specialized the work can be.
- An intimate, working knowledge of the KU Natural History Museum, its goals, its research, and its people.
- Well-prepared interviews with selected researchers. Each scientist has a different interest and background; it proved important to match these interests with topics covered in the blog posts.
- Photographic competence that allowed for the story to be told not only via text but also images.
- The ability to write in a playful yet informative way to a general audience.

Conclusions: Improvement

Perhaps the most limiting factor of the project was a lack of expertise in web development and design. A web developer, if involved from the beginning, could have been instrumental in designing a more complete web experience for the project.

Some other items prevented this project from achieving its full potential:

- Lack of web design knowledge and no access to outside help limited the content of the project to strictly photos and text. A more comprehensive experience could have been provided with an interface or online exhibit created for the purpose of the project.
- Photos for the project could have been better. Limited photography experience inhibited the telling of the story via images. In addition, more video could have been taken.
- The topic selected was more complicated than the scope of the project allowed; some facets of collections (such as the morality of collecting) could not be covered.
- Interviews and connections should have been made with more collaborating institutions and scientists. Quotations or comments from Peruvian scientists would have added to the content.

Conclusions: Recommendations

Perhaps the most important aspect to recreate in such a project is to engage, first-person, with as many facets of the subject as possible. For example, if research is done, help with the research. If special tools or processes are involved, learn them. If professionals are involved, interview them. Spend time with them and their space to get an idea of how their work gets done. When making the project relevant, draw on personal narratives or the passion of those involved.

When pursuing a project like this, the author also suggests:

- A web developer/designer be involved from the start, or that the method for displaying content can be flexible enough to accommodate the easy creation of an online exhibit or experience that provides a more holistic framework for the viewer.
- Those undertaking the project are thoroughly familiar with writing, photography, and video, and have working knowledge of how to best produce those items for the web.
- Efforts be made to establish contacts in foreign countries or collaborating institutions.
- Method of presentation is decided early in the process, which helps pinpoint what kind of content one is searching for.

Appendix 1: Posts with a few photos to be used. These comprise the finished text of the project and intend to simulate what the blog posts will contain when published

Introduction. Post Date: May 14, 2012.

When we go to a natural history museum, we browse exhibits on evolution. We warp through time by imagining ourselves in dioramas. We gawk at intimidating dinosaur bones. The impressive bones, lifelike recreations and salient facts are presented simply and clearly. The exhibits tell us the story of, for example, a T-rex fossil, from birth to death.

We know it's not that simple. We know that paleontologists had to dig up the fossil, had to piece it together, had to figure out what it ate, how it moved, how it evolved. To tell us the story of a fossil, there is a lot of information that must be gathered.

What we don't know is how the paleontologists do it.

The process is long and complicated. Just like any other science, biology is an aggregation of knowledge that can boggle the mind. But there is one thing, when understood, that is the backbone to it all. And if you understand it, you will understand biology's most valuable tool.

This tool is there every time that we visit a museum. It's right in front of us, though few actually know it. It's the best kept secret in science, and perhaps the most fascinating. This thing, visible and yet hidden, is the natural history collection.

The fossil T-rex in front of you is part of the collection. So are the whale bones, the shark teeth, the taxidermied lions. Nearly every bone, skin, and fossil on display in a natural history museum has a number attached to it, a clue that it is actually part of something larger.

Natural history museums are icebergs: most of their contents are hidden from view. Some institutions, like the KU Natural History Museum, contain more than 1,000 items in the collection for each item on display. There are more bones from where that T-rex came from. There are more lion skins. In fact, there are specimens of every kind, from fossilized moss to a finch collected by Darwin to a mite collected yesterday. These specimens, when gathered and organized, are the tools that biologists use to figure out everything from how a T-rex evolved to how we can prevent the extinction of an endangered bird in Mongolia.

This series of blog posts will attempt to describe what natural history collections are and how biologists use them. It will tell the story of collections from two perspectives: the journey of a single specimen, and that of the

scientist who uses a collection of specimens. Our story starts when a peculiar beetle from the hot rain forest of Peru fell into the hands of one of KU's most tenacious, energetic, prolific biologists.

Journey of a Specimen Post 1. Post date: May 21, 2012.

It was a typical June morning in Kansas: cloudless sky, wet grass, a cool breeze. And like any summer morning in Kansas, there was also the sense that things were going to get a lot hotter.

We stood outside the KU Entomology building with our gear: waterproof boots, pocket knives, water bottles, bug spray, and dozens of pairs of socks. Camping gear. But there were other strange items – plastic vials and trays, PVC pipes, a portable microscope, a black light, foreceps, and tiny printed labels. It looked like we were headed into the wild to set up some illicit lab.

Caroline Chaboo, an insect scientist working for the KU Biodiversity Institute, had pressing questions and she needed data from the field. She needed insects. We were going on a bug hunt.

On the same day in the Peruvian Amazon, a small beetle, about the width of a dime, munched its way across the leaf of a plant. It had survived many perils to reach adulthood: wasps, assassin bugs, giant ants, spiders, etc. One factor that had helped this female *Acromis sparsa* live to adulthood was that its mother, strangely enough, had taken care of it. And in the hot, wet, dark, predator-stocked Peruvian Amazon, it helps quite a bit to have something watch over your soft, grub-like body.

Unfortunately for that beetle, it dwelt in the hunting grounds of another insatiable predator, Dr. Chaboo, whom I accompanied in June 2011 on a 10-day collection trip into the rain forest. Dr. Chaboo has the work ethic of an ant and the eye of a hawk. She picked it up off its leafy host plant and

dropped it into a plastic vial. *Acromis sparsa* was one of many types of insects that she regularly travels to the rain forest to collect. The collection trip of June 2011 was one of many trips. She often goes to the same spot, even the same plant. "It's my living library," she says. "I go there one year and get a chapter's worth of information, I go another year and get another chapter's worth of information."

But Dr. Chaboo doesn't just browse the forest, collecting beetles and gathering information. She has specific questions about the anatomy and behaviors of *Acromis sparsa.* The behavior that likely allowed that beetle to live long enough to reach adulthood and run into Dr. Chaboo – maternal care – was the very thing that she wished to learn about. Adding the beetle to the collection gives her the tools and the time to examine it. Just what she is looking for will be covered in our next post.

Post 2. Post Date: May 28, 2012.

There are many ways to catch an insect. There are net-like flight-intercept traps that are hoisted high into a rain forest canopy, light traps which are turned on after dark, malaise traps, scent traps, bait traps, the list goes on. But some insects are predictable enough to catch by hand. Dr. Chaboo treks through the rain forests of Peru, pulling down leaves, checking under them, turning over fronds. She has a few research projects cooking, and she's looking for different beetles on different plants.

She sees one of her insects, *Acromis sparsa*, on a leaf. At first glance, it looks like a typical beetle. It's about the size of a small button. It is yellow and brown. It eats the leaves of a plant related to snapdragons. But if you look closer (and if you know your bugs) and you will notice something peculiar. Its wing covers, known to entomologists as elytra, are huge. They are much larger than necessary to cover the wings and likely very cumbersome. Not

the kind of thing that a beetle should drag around the rainforest.

The beetle's extended elytra aren't for her protection, they don't help her catch food and they don't attract mates. They assist her with a behavior that's much more common in mammals than in insects. They help her take care of her young.

Her wide-flared elytra form a protective roof over her larvae. She ushers them around, from fungus to fungus, which they eat. She even chases off predators.

Maternal care is a rarity among insects. To learn about it, Chaboo and her colleagues observe their behavior. But she also needs to examine their anatomy and take DNA samples. For these, she needs specimens. She picks up the insect and drops it into a plastic vial.

With help from her colleagues, Chaboo gathered data that helped her look for maternal care in other beetles. They looked through the collections for other specimens that had similar DNA and extended elytra. They were not known to exhibit maternal care, but Chaboo and her colleagues had a hunch. Back to the rain forest. Sure enough, Chaboo and her colleagues found more

insects that practice maternal care. They plan to publish a paper that outlines the discoveries.

So natural history collections not only provide scientists with storage facilities for their data, but also resources for research. In this case, the collections served to give them clues about which beetles potentially practiced maternal care. Because earlier scientists had collected beetles with extended elytra in the past (and noted where they found them), Chaboo and her colleagues could track them down to find out if they actually did practice maternal care.

Post 3. Post Date: June 4, 2012.

Specimen collection can be straightforward. Collection can be done just outside the front door. A Biodiversity Institute scientist once found a new species of insect in his own home. Many collection trips happen within 200 miles. It is not extremely difficult to gather milkweed in eastern Kansas or sedge wrens in western Missouri. Some collecting, however, is not quite so simple.

For a collection trip to Peru, grants must usually be requested and given. Permits must be received. Gear, supplies, and tools must be gathered and weighed to make sure that they aren't too heavy. The flight, the truck ride and the boat ride must be arranged. DNA-grade ethanol has to be trucked (it cannot be transported by plane – too flammable) from Lima, Peru over the Andes mountains and then put on a four-hour boat ride to the research station in southeastern Peru. The return trip is easier in many respects, though U.S. customs agents don't usually expect to find plastic

baggies of dead insects floating in alcohol.

When the insects return to the lab, they are sorted by classification (bees, wasps, beetles) and some are identified by the researcher who collected them. Others are sent to specialists who are better at identifying insects in their field of study. There are a million insect species, and no one knows them all. In Dr. Chaboo's insect family, *Chrysomelidae*, there are 40,000 species. She can identify a few hundred. There are a measley 5,500 species of mammals.

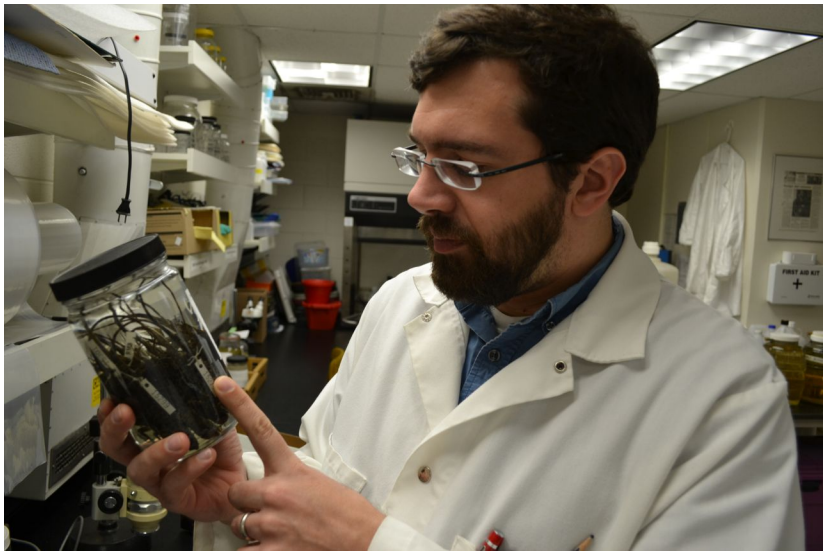
DNA is extracted from some specimens. This can help scientists (and helps Dr. Chaboo) make a phylogenetic tree – a map of how closely related certain species are. The specimens are then dried, given specimen numbers and barcodes, and pinned to foam. Some of the specimens collected will go back to Peruvian museums and some will remain at the KU collection indefinitely. The KU Entomology (insect) Collection currently contains about 4.7 million specimens. Once a specimen is put in, it will last for hundreds or perhaps thousands of years. No one really knows how long specimens will keep; we've only been collecting them for a few hundred years.

Collections Post 1. Post Date: June 11, 2012.

Collections of items fascinate us. It may be the exhaustive dedication required to compile the items. It may be the strange nature of what has been collected. And it could also be because so much time was put toward gathering items that may have value, but rarely have any use.

Not so with natural history collections. Natural history collections are *active*, they are to be *used*. Some collections, like those at the KU Biodiversity Institute, are used so frequently that they require a full-time collection manager.

"I like to think that I fight entropy," says Andrew Campbell, the collection manager for herpetology. "Inevitably, things become disorganized in any well-used system. It is my job to keep it in order." His collection consists of 330,000 reptiles and amphibians in jars of alcohol. They are lined up on immense racks and organized by taxonomy and geography. "The primary goal of a collection is to serve as a resource for current and future research," says Campbell. He grins, raises a pointed finger. "But we can't do that without organization."



Andy Bentley, the collection manager for fishes, keeps a no-nonsense, high-efficiency system. He talks straight, walks straight, even his hand gestures imply exactness. And he knows it. “Collection managers tend to be meticulous,” he says as he introduces collections and the role of the collection manager, from the broad points to the fine. The fish collection is massive. “If you mis-shelf something in the collection, you will never find it.”

These collection managers live collections, and their pride is palpable. Get them talking about collections and they will not stop. Their offices are away from the collections, but they’re ready at any moment to spring up and jet to their quarry. Once in, they linger and hesitate to leave.

It’s good that they have this kind of dedication – there’s an immense amount of work to do. Every specimen that comes in must be classified and

examined. Species is determined. Location is noted, songs or calls are recorded, photos are often taken. Depending on how the specimen is to be used, hundreds of measurements, photographs and habitat notes could be taken. Stomach contents could be examined, DNA could be extracted, scales could be counted, leaves could be counted, bones could be measured, roots could be measured, wings could be measured… the list goes on and on. Collections from donors or other museums are sometimes added to existing holdings. These must be re-sorted and given labels. Specimens are often requested by researchers at other universities. These must be found, taken out, and shipped.

Each of these responsibilities and duties pertains to every collection. One research institution may have a dozen collections or more. The Biodiversity Institute has collections for plants, insects, parasites, invertebrates, mammals, fish, reptiles, amphibians, birds, fossils, and archaeological artifacts. Depending on what type of organism a collection holds, the method of storage may vary. Reptiles, amphibians, and fish are often kept in jars of alcohol, which helps preserve them. Mammals and birds are usually put through a process similar to taxidermy and then stored on drawers in large metal cabinets. Insects and plants are dried and mounted;

insects pinned in neat rows, plants often glued to paper. Fossils are cleaned and pieced together. These responsibilities fall to collection managers. “And I’ve found someone to pay me to do it,” says Campbell, flashing another furtive smile.

This is data. A lot of data. And this data helps biologists determine everything from whether a frog species in the Philippines is endangered to how *homo sapiens* evolved. The next post in this series will tell how scientists use this data to make their discoveries.

Post 2. Post Date: June 18, 2012.

“WELCOME TO ORNITHOLOGY,” reads an old sign above the entrance to the collection. On the other side stand 120 cabinets full of 107,000 specimens.

Mark Robbins, a collection manager at the Biodiversity Institute, watches over bird specimens. He has a palpable affection for the collection, a delicate and quiet reverence. He walks the maze of steel storage containers with presence, as if they were the walls of his home. He pulls out bird specimens, handles them with bated breath. He started birdwatching 42 years ago. He moves with the quickness of an 18-year-old.

I told Robbins that I was going to ask him some questions about the use of natural history collections. He immediately interjected, saying, “First, you should know this: you can never predict how collections can be used.”

His statement implied two key points about collections. First, the bodies of organisms (specimens in a collection) have so many possible uses, provide so much potential data, that one should not put a limit to the ways in which a specimen could be of use. The uses are innumerable. And second, the usefulness of collections is hard to limit because technology will continue to innovate new ways to extract data from specimens. They are all artifacts, and their value is going up.

They are perhaps most useful in figuring out if what a scientist has caught is a species known to science (and if it is, what exactly it is) or if it is something new. The scientist compares it to what is in the collection and if there is no match, he or she gives it a name and adds it to the community's body of knowledge. In this way, collections help scientists make a list of what's out there.

But the uses also extend much further into research. Scientists do their research by asking questions, and they use collections to answer these questions, whatever they may be. In previous posts Caroline Chaboo used collections to make predictions about maternal care behaviors not yet known about in certain insects. Collections interface with the work of nearly every biologist, and helps them answer a variety of questions ranging from whether dinosaurs evolved from birds to asking if climate change will endanger the habitat of prairie chickens.

To serve as an example, Mark Robbins uses the collections to track the migration patterns of sedge wrens – small insect-eating birds whose weight can be measured in a few paperclips. He collects them, takes notes on location, habitat, etc., and takes them back to the collection to be prepared. By testing and processing the birds' tissues, he can sometimes tell where

they have migrated from. He adds this data to the collection. As the data builds, he can make a map of where the birds mate, which habitats they prefer, and which climates they like.

The earth is heating up, and habitats aren't what they used to be. Many birds are moving further and further north. Armed with this data, Robbins can track the outlook for sedge wrens. Will a warmer earth make them go extinct?

With this knowledge, he can help inform policy makers about important sedge wren habitats. He can argue for the conservation of a particular habitat. And if anyone doubts him, he's got the collections data to back it all up.

Imagine this kind of data on a grand scale. The benefits of putting the world's natural history data together seems to fit Robbins' prophetic assertion that technology will increase the usefulness of specimens. It already has, to some extent. In our next posts, we will talk about the digitization of specimens and their use on a grand scale in computer models.

Post 3. Post date: June 25, 2012.

Natural history collections represent staggering amounts of time and money, and some museum collection statistics can be intimidating. The Field Museum in Chicago has 19.5 million zoological specimens. The American Museum of Natural History has over 32 million specimens. The British Museum of Natural History has 70 million. The KU Biodiversity Institute has a respectable 10 million, quite a few for a university collection.

As said in previous posts, collections are to be *used*. For that to occur, they must be both organized and accessible. And they are, to a large degree. But scientists face an enormous challenge to maximize the potential of their

collections. The problem is this: most of the world's natural history collections are not digitized.

If you have a collection of about 10 million specimens (like KU's collection), and each specimen takes, say, 10 minutes to digitize, you are looking at 1,600,000 man-hours of work. No museum has the manpower or the money to digitize their collections quickly. Into this fray wades Jim Beach, Assistant Director for Informatics at the KU Biodiversity Institute.

One cannot but help notice his pragmatism. Previously a tree biologist, Beach knows what scientists and collection managers need to make their collections organized and accessible. "Our job," he says, laying his hands flat on the table and giving emphasis to each word, "is to get the data online so that it can be used."

One of the products that Beach and the staff in Informatics created is called Specify, a software that helps collection managers and scientists digitize and organize their collections. Specify is a database. It is a complex, specialized Excel spreadsheet for scientists. It lets them put in data about the specimens that they collect and then organize that data. For example, when a scientist collects a bird specimen, she could put information into the database about what species it is, where it was found, its sex, its size, its

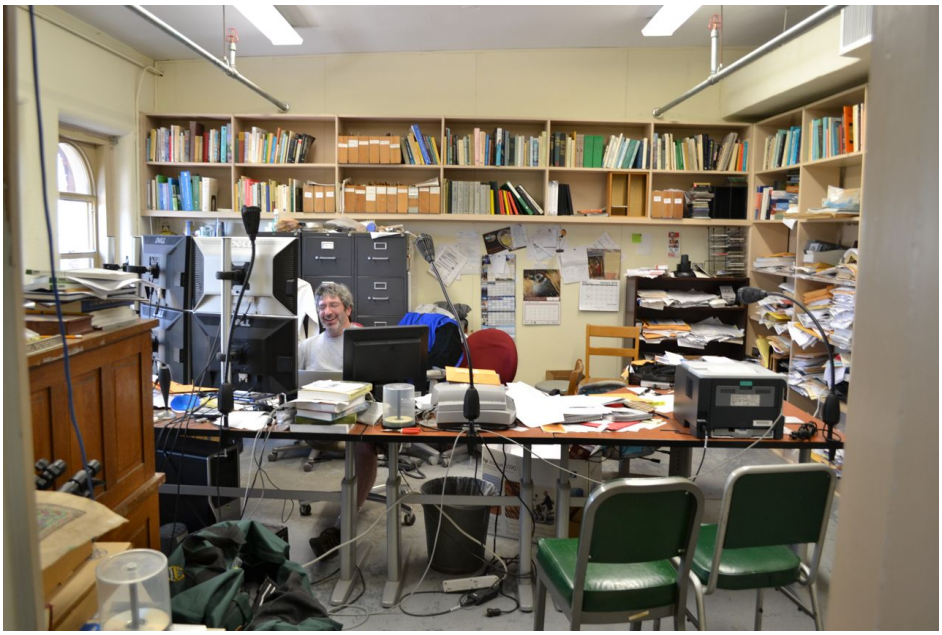
color, etc. The software works for everything from fish to pelicans and is useable for any type of collection. Over 400 collections in 24 countries use Specify to organize their data.

This helps collection managers keep their collections under control. It helps scientists sort through a collection's data for the information they need. Curious about the spread of an invasive species? Search the database for the time and location of specimens from that species. Want to know where the largest concentration of cottonwood trees is? As long as your institution has collected specimens, Specify will help you find and use that data.

More and more, you won't even need to have gathered the specimens, as long as someone else has. In our next post, we'll talk about how Specify and other programs have merged collections into one large database, accessible from anywhere.

Post 4. Post date: July 2, 2012.

Town Peterson's office gives the impression that he must do something important. He's the Curator of Ornithology. He has ready access to scholarly articles and books; his shelves are lined with them. There are photos of exotic birds. There are enough scattered papers on his desk to imply that he doesn't have much spare time. But most notably, he has eight computer monitors arranged to make one large, intimidating screen.

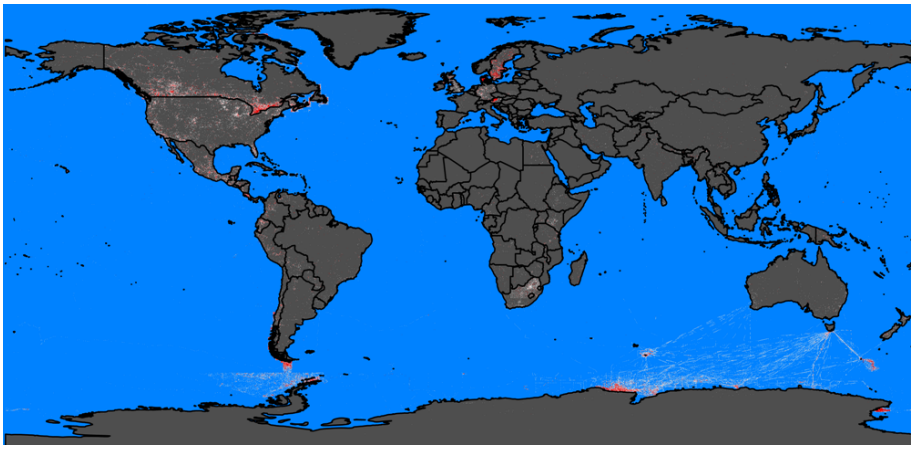


Peterson needs to visualize data. He concerns himself with the entire process of specimen collection and use, from the data collected in the field to how that specimen functions once it has been put into the collection. “But there’s more beyond that,” he says. “The data needs to be made available globally.”

There are many online databases that synthesize collection data. As discussed in our last post, Specify software helps with this process. It organizes collection data and exports it so that it can be put online. The biggest online database is called GBIF – the Global Biodiversity Information Facility, which has put together the records from about 9,000 sets of data. All told, it has 321 million records.

Peterson, Jorge Soberon, also of the Biodiversity Institute, and some of their colleagues at GBIF set out to use some of this data. “We harvested all of the bird data from GBIF, and that comes out to about 85 million records, and we developed ways to tell what a well-known area would be. Then we needed to figure that out for every 100 x 100 meter block on the surface of the earth. We wanted to make a map of what the world knows about birds. We wanted to use that information to challenge the ornithologists and birders of the world to fill those gaps.”

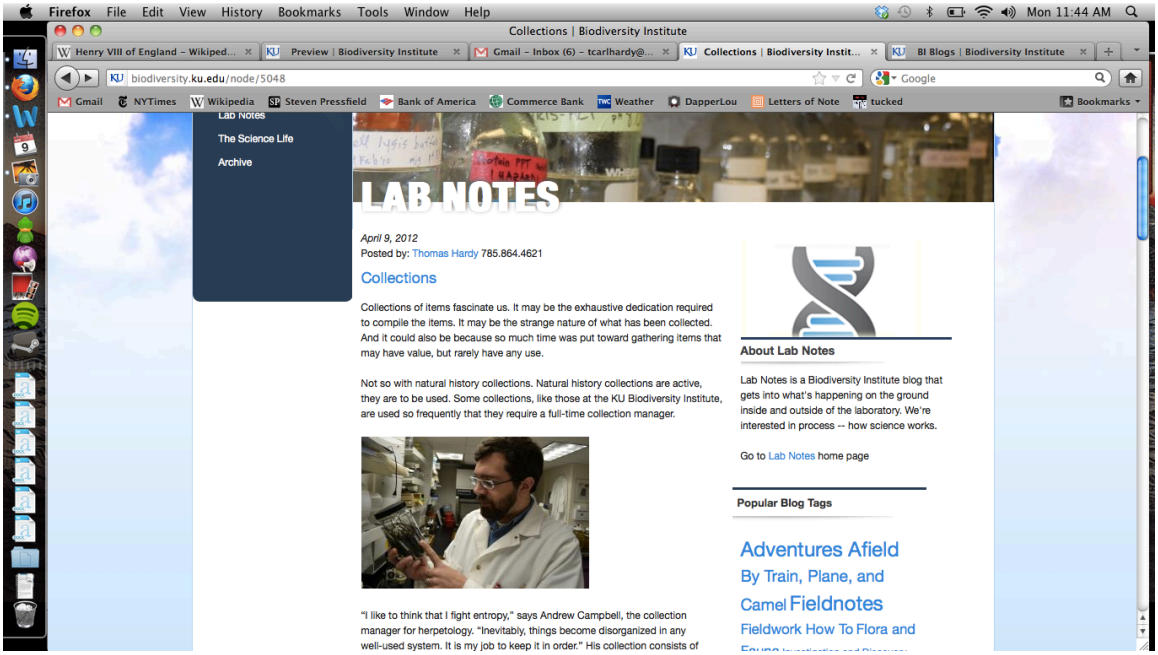
Though the project isn’t completely finished, they have made a map of their data:

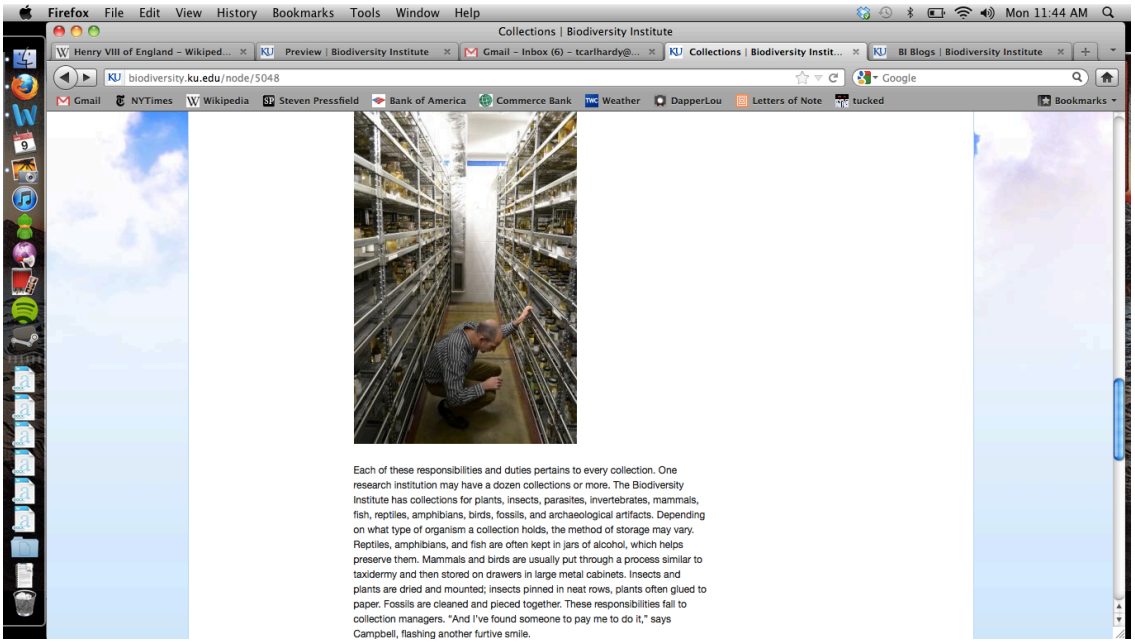


Large amounts of collection data like this can also be used for predictive purposes. Predicting the future habitats of species has become more important, especially because of climate change. Change in climate means change in habitat, and that forces species to move. Peterson uses these models to predict where they might go, or if they have any place to go at all. “For any species,” says Peterson, “if you have a decent list of where it has occurred, you can pretty easily determine the conditions under which your species can exist. Where the species currently lives is evidence that the species can maintain populations under those conditions.”

To assist with an art exhibit on campus, Town generated a model for the movement of cottonwood trees in Kansas. The result was surprising: their livable range decreased significantly. It could be that there are no cottonwood trees in Kansas some day. Why? Cottonwoods are especially thirsty, and they stay near water. “Think about what climate change is going to do,” says Peterson. “Climate change is going to push everything northward. But all of the rivers in Kansas go east-west. There aren’t any rivers for cottonwoods to follow. You could lose all of those trees. Wholesale.”

Appendix 2: Screenshots of the Biodiversity Institute blog. These show the format that the blog posts will take.





Publishing Timetable for project on www.naturalhistory.ku.edu

May 14, 2012: *Introduction*

May 21, 2012: *Journey of a Specimen: Setting Out*

May 28, 2012: *Journey of a Specimen: Maternal Care*

June 4, 2012: *Journey of a Specimen: Catching the Quarry*

June 11, 2012: *Collections: Collection Managers*

June 18, 2012: *Collections: Robbins' Wrens*

June 25, 2012: *Collections: Informatics*

July 2, 2012: *Collections: Harvesting Data*

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