DENVER MUSEUM OF NATURE & SCIENCE REPORTS

NUMBER 6, JUNE 15, 2017

SPNHC

DENVER COLORADO | 2017

The Next Generation in Best Practices

32nd Annual Meeting of the Society for the Preservation of Natural History Collections

June 18–24, 2017
Denver, Colorado

Kelly Tomajko and
Brent Wagner (Eds)

SPNHC
ADVANCING COLLECTIONS CARE

DENVER BOTANIC GARDENS

DENVER MUSEUM OF NATURE&SCIENCE
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Edited by

Kelly Tomajko[1] and

Brent Wagner[2]

Welcome

Welcome to Denver, the Mile High City, located 5,280 feet above sea level.

The Denver Museum of Nature & Science and Denver Botanic Gardens are honored to be your hosts for the 32nd annual meeting of the Society for the Preservation of Natural History Collections.

Since its founding in 1900, Denver Museum of Nature & Science has grown into one of the largest natural history museums in the western United States. The Museum preserves and provides access to its collections in its new state-of-the-art Avenir Collections Center. The new wing housing the Center has received LEED Platinum certification and is designed to use 50 percent less energy than a standard building of its type. Last year, the Museum attracted over 1.72 million visitors, making it one of the top ten visited museums in the country. Visit at www.dmns.org.

Denver Botanic Gardens is considered one of the top botanical gardens in the United States. Accredited by the American Alliance of Museums, the Gardens' collections include living plants, two herbaria, archives and special collections, and an art collection. The Gardens is a dynamic, 24-acre urban oasis in the heart of the city. Additional sites extend this experience throughout the Front Range - Denver Botanic Gardens Chatfield Farms in Jefferson County and Mount Goliath, a high-altitude trail and interpretive site. Visit at www.botanicgardens.org.

The theme of the meeting is "The Next Generation in Best Practices." This broad theme is intended to reflect the core aim of SPNHC to codify and disseminate best practices for the development, management, and

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brent.wagner@dmns.org

care of natural history collections and their associated data. We hope you enjoy the diverse menu of workshops, plenary speakers, presentations and posters, and field trips. We hope you are able to join us for tours of the Avenir Collections Center along with several engaging social events. And we hope you find ample opportunity to network and collaborate with your colleagues.

I want to extend sincere thanks to our sponsoring partners whose financial support makes this meeting possible, and to all members of the Local Organizing Committee who contributed many focused hours to ensure a great experience for all attendees.

Kelly Tomajko
Chair, SPNHC 2017 Local Organizing Committee

SPNHC
ADVANCING COLLECTIONS CARE

On behalf of SPNHC Council, it gives me great pleasure to welcome all participants to our 32nd Annual Meeting in Denver, Colorado. This meeting is being hosted as a joint venture by Denver Museum of Nature & Science and the Denver Botanic Gardens.

The conference theme is "The Next Generation in Best Practices." This broad theme reflects the core aim of SPNHC, which is to codify and disseminate best practices for the development, management, and care of natural history collections and their associated data. The Local Organizing Committee from Denver has done a tremendous job of providing an engaging and thoughtful program of events around this theme, including oral and poster sessions, informative workshops, and some exciting social events. We thank them for the huge amount of work they have done in making this meeting bound for success.

It is rewarding to announce that our SPNHC Annual Meeting Travel Grant programs have assisted in funding the attendance of five members, who will be mentored by established collections professionals. We thank our mentors for their valuable contributions.

Meetings such as these would not be possible without the valued financial backing of our sponsoring partners. We thank them for their continued support and encourage you to do the same by visiting their booths at the tradeshow.

If you need any assistance during the meeting please look for one of the members of the Local Organizing Committee or a Council member, who can be identified by ribbons on their name tags.

The core of SPNHC's accomplishments is the result of the valuable work done by the society's committees. In these changing times, it's important for museum professionals to stand together and advocate for what we feel is important. If not already, I encourage everyone to become involved in the work of the society by becoming engaged with one of our many committees, which all work towards our unwavering fundamental goal of caring, conserving, and promoting our natural history collections.

Our annual meeting provides us the opportunity to network with professionals, learn about evolving technologies in collection/data management, highlight and celebrate our accomplishments, and socialize with our colleagues. This meeting is bound to be a success in all of these areas, and I'm excited to wish all of you a productive and fun-filled meeting.

Linda S. Ford
President
Society for the Preservation of Natural History Collections (SPNHC)

CONTENTS

SPNHC
ADVANCING COLLECTIONS CARE

SPNHC Annual Meeting Travel Grants

The Society for the Preservation of Natural History Collections (SPNHC) has a Travel Grant program designed to assist members with the costs of attending the Society's annual meetings.

The SPNHC Annual Meeting Travel Grant program consists of two different grants:

The **Fitzgerald Travel Grant** is given to SPNHC members in fields related to the management and preservation/conservation of natural history collections. Preference is given to graduate students or emerging professionals. Each year, multiple Fitzgerald travel grants are awarded; however, the number varies, as determined by the members of the SPNHC Annual Meeting Travel Grant Program Committee, depending on the number and quality of the applicants.

The **Christine Allen Travel Grant** is a single grant of $750. This grant is dedicated to the memory of Christine Allen, who worked for University Products, Gaylord Brothers, and Hollinger Metal Edge during her long career in museum support. She was a long time member and supporter of the Society and worked tirelessly with many of us to ensure that the products marketed by her companies reflected the needs articulated by the SPNHC membership. The grant is funded by her three former employers. Preference is given to graduate students or emerging professionals who focus on physical care and preservation/conservation of natural history collections.

2017 SPNHC Annual Meeting Travel Grant Recipients

Fitzgerald Travel Grant Recipients

James Erdmann
Graduate Student in Biological Sciences
Head Collections Manager
Department of Biological Sciences
Southeastern Louisiana University

Kathryn Estes-Smargiassi
Asst. Collections Manager
Invertebrate Paleontology Department
Natural History Museum of Los Angeles County

Stephanie Leon
Assistant Collections Curator
Archbold Biological Station (FL)

Rachel Poutasse
Curatorial Assistant
RSA-POM Herbarium
Rancho Santa Ana Botanic Garden (CA)

Kelly Martin
Collections Assistant
University of Wisconsin Geology Museum
*Sponsored by Edinburg University Press

Christine Allen Travel Grant Recipient

Christine Haynes
Graduate Student in Conservation
Conservation Center of the Institute of Fine Arts
New York University

CONFERENCE PARTNERS

DIAMOND PARTNERS

PLATINUM PARTNERS

GOLD PARTNERS

SECURALL Safety Storage Equipment

UNIVERSITY PRODUCTS
THINKING IN & OUT OF THE BOX SINCE 1968

SILVER PARTNERS

WAIT CRIMM ASSOCIATES

T AND D

PROTECT HERITAGE
Bridging Past and Future

improve group
THERE IS A BETTER WAY

EON
Today's office

BRONZE PARTNERS

Society of Herbarium Curators
AFFIRMING HERBARIA'S VITAL ROLE

O.Berk
KOLS CONTAINERS

AURORA

HOLLINGER METAL EDGE
Archival Storage Materials

gkkworks

Alcmon

TRU VUE

LYRASIS

SUPPORTING PARTNERS

WeatherstonBruer

Archives of Natural History
EDINBURGH University Press

GENERAL INFORMATION

Conference Venue and Accommodation
The Curtis Hotel
1405 Curtis Street
Denver, CO 80202
303-571-0300
www.thecurtis.com

Additional Accommodation
Campus Village Apartments
318 Walnut Street
Denver, CO 80204
303-573-5272
www.campusvillagedenver.com

SPNHC Registration Desk
Feel free to visit the Registration Desk any time during the hours below to check in, pick up your registration materials, and ask questions. Conference badges should be worn at all times while attending the conference. Conference participants will have free admission to the Denver Museum of Nature & Science and Denver Botanic Gardens by presenting their conference badge.

Saturday, June 17: 6:00am–8:00pm
Sunday, June 18: 7:00am–6:00pm
Monday, June 19: 7:00am–6:00pm
Tuesday, June 20: 7:30am–8:00pm
Wednesday, June 21: 6:30am–6:00pm
Thursday, June 22: 6:30am–5:30pm
Friday, June 23: 7:30am–1:00pm
Saturday, June 24: 6:00am–noon

Oral Presentations
Talks are scheduled in 20 minutes time slots including any time for questions. This schedule will be enforced to accommodate concurrent session needs, courtesy for presenters and attendees who may need to move between meeting rooms. Presenters should plan to use their time slots for both their presentation and time for audience questions. Presentation slides should be prepared and saved as either PowerPoint in standard 4:3 or pdf. Please test and upload your presentation in the Speaker Ready Room 24 hours prior to your scheduled session.

Speaker Ready Room Hours
Sunday, June 18: noon–6:00pm
Monday, June 19: noon–6:00pm
Tuesday, June 20: noon–6:00pm
Wednesday, June 21: noon–6:00pm

Poster Sessions
Two poster sessions have been scheduled without any concurrent offerings so that presenters are able to have quality time with viewers. Poster presenters are expected to set up and take down their posters during designated times and to be present during their assigned session.

Poster Session 1, June 21
Set Up 7:00am–8:00am
Poster Session 3:50pm–5:00pm
Take Down 5:00pm–5:30pm

Poster Session 2, June 22
Set Up 7:00am–8:00am
Poster Session 8:00am–9:20am
Take Down 4:10pm–5:00pm

Social Media
Find us on Facebook:
www.facebook.com/spnhc2017

Find us on Twitter:
@SPNHCDen2017

Instagram:
spnhcden2017

WIFI
Wireless internet access will be available throughout The Curtis via current access instructions posted in the 3rd floor meeting rooms.

Parking
Overnight self or valet parking is available at The Curtis for the discounted rate of $25.

Getting Around

RTD (Regional Transportation District) is Denver's public transportation system of light rails and buses. You can purchase regular one-way tickets at rail stations with cash or card, or on buses with exact change. Passes and books can be purchased at the Level 1 Transit Center at the Airport 8am–5:30pm weekdays and 8am–4pm weekends, and at the Union Station underground bus concourse 7am–6:30pm weekdays. You can also get more information on routes and purchase passes at the Visit Denver Tourist Information Center at 1575 California St., just a few blocks away from The Curtis Denver. They are open M–F 9am–6pm, Sat 9am–5pm and Sun 10am–2pm.

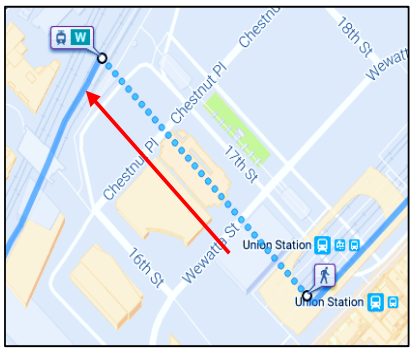
One-way fare (excluding airport)	$2.60
One-way fare (airport only)	$9.00
Day Pass	$5.20
Book of 5 Day Passes	$26.00
10-ride ticket book	$23.50

Other transportation options include rideshare apps Lyft, Uber, and Metro Taxi—all are available on Android and Apple App stores. You can also reach Metro Taxi by calling 303-333-3333.

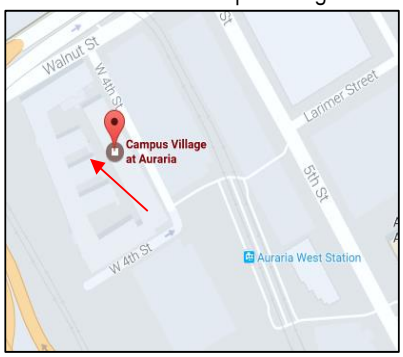
Denver International Airport —> Campus Village (70 minutes on average)

- Follow signs to Transit Center to board the A Line train to Union Station.
- At Union Station head north past Wewatta and Chestnut Streets to the W light rail (W-Line Jeffco train).

Union Station to W-Line



Auraria West to Campus Village



- Depart at the Auraria West Station.
- Walk through the parking lot to the north and you should see Campus Village to your left.

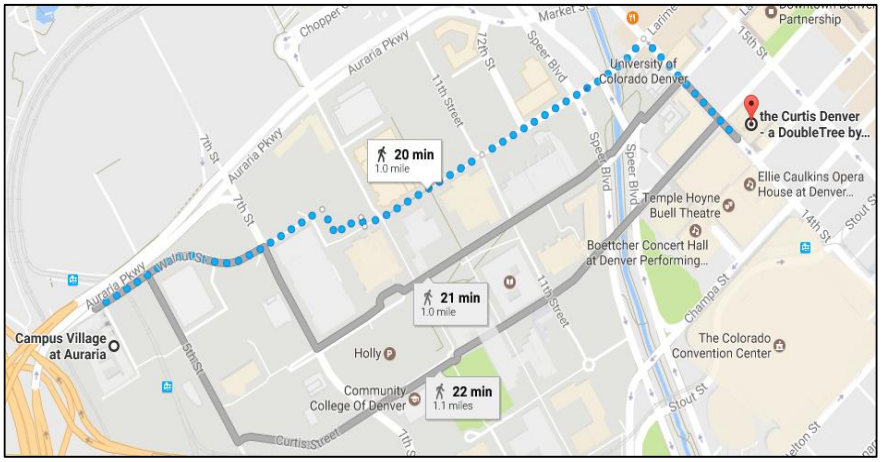
Denver International Airport —> The Curtis Denver (70 minutes on average)

- Follow signs to Transit Center to board the A Line train to Union Station.
- At Union Station walk north to the corner of 17th Street and Wewatta to catch the Free Mall Ride bus toward 16th Street.
- Ride to Curtis Street. Turn right on Curtis—the Curtis Hotel is a block and a half down on the right.

Campus Village —> Denver Museum of Nature & Science (45 minutes on average)

- Walk to the Auraria Pkwy and 9th St. Station (Walnut -> left on 7th -> right on Auraria Pkwy).
- Take the 20 Bus toward the Anschutz Medical Campus for 23 stops.
- Depart at Montview Blvd. DMNS is across Colorado Blvd and main entrance is located on the north side of the building.

Campus Village —> The Curtis Denver (20-minute walk)



Campus Village —> Denver Botanic Gardens (45 minutes on average)

- Walk to the Auraria Pkwy and 9th Street Station (Walnut -> left on 7th -> right on Auraria Pkwy)
- Take the 15L bus toward Aurora Metro Center Station for 10 stops
- Depart at Colfax and Josephine Street (You will have just crossed York St.)
- Walk south on York Street for 5 blocks and the entrance to the Botanic Gardens will be on your right.

The Curtis Denver -> Denver Museum of Nature & Science (30 minutes on average)

- Walk north on Curtis St to 17th Street. On the left will be the 17th and Arapahoe Street stop.
- Take the 32 Bus toward Colorado Blvd for 22 stops
- Depart at 22nd Ave. and Colorado Blvd. The entrance to DMNS is across the parking lot on the north side.

The Curtis Denver —> Denver Botanic Gardens (30 minutes on average)

- Walk north on Curtis St to 17th St. On the left will be the 17th and Arapahoe St. stop.
- Take the 10 bus toward 9th & Clermont for 15 stops.
- Depart at 12th Ave. & York Street and walk south down York Street for a block and a half. The entrance to the Denver Botanic Gardens will be on your right.

The Curtis


3RD FLOOR
HOPSCOTCH
STAIRS
SPEAKER READY ROOM
BOYS
GIRLS
FAMILY RESTROOM
DUCK, DUCK, GOOSE
RED ROVER
STAIRS
ELEVATORS
MARCO POLO FOYER
MARCO PATIO
KEN
BARBIE
MARCO POLO BALLROOM
REGISTRATION
FOUR SQUARE BALLROOM
FOUR SQUARE PATIO

PROGRAM

SCHEDULE AT A GLANCE

all activities are scheduled at The Curtis 3rd floor unless otherwise indicated

Saturday, June 17, 2017

Registration—SPNHC Registration Desk
6:00am–8:00pm

Sunday, June 18, 2017

Registration—SPNHC Registration Desk
7:00am–6:00pm

Speaker Ready Room Open
Noon–6:00pm

Workshops
8:00am–1:00pm
Natural History Collections Club Network: Strategies for Building Undergraduate Interest and Participation in Natural History Collections—Hopscotch

Workshops
8:00am–5:00pm
TDWG Working Session—Duck Duck Goose
Natural History Biodiversity Informatics 101—Red Rover

Coffee Break—Marco Polo
9:30am–10:00am

Lunch—Marco Polo
Noon–1:00pm

Workshops
Noon–5:00pm
Standards and Best Practices for Fluid Preservation—Hopscotch

Coffee Break—Marco Polo
3:00pm–3:30pm

Monday, June 19, 2017

Registration—SPNHC Registration Desk
7:00am–6:00 pm

Speaker Ready Room Open
Noon–6:00pm

Workshops
8:00am–1:00pm
Getting It Paid For: Best Practices in Preparing Successful IMLS Grant Applications—Hopscotch
A Dentist's Nightmare: Volunteering for Cavities—DMNS

Workshops
8:00am–5:00pm
Directors' Summit on Digital Data—Duck Duck Goose
Are You Ready? Scenario Planning and Collaboration to Improve Disaster Preparedness—Red Rover
Care of Historic Mammalian Taxidermy—DMNS
Legal Aspects of Shipping Preserved Animals and Tissues—DMNS

Coffee Break—Marco Polo
9:30am–10:00am

Lunch—Marco Polo
Noon–1:00pm

Workshops
Noon–5:00pm
Writing for Successful Journal Publication to Promote Effective Change in Natural History Collections—Hopscotch

Coffee Break—Marco Polo
3:00pm–3:30pm

Tuesday, June 20, 2017

Registration—SPNHC Registration Desk
7:30am–8:00pm

Speaker Ready Room Open
Noon–6:00pm

Plenary Session—Four Square
9:00am–noon

Coffee Break—Marco Polo
10:30am–11:00am

Lunch—on your own
Noon–1:30pm

Sponsoring Partner Set Up—Marco Polo
1:30pm–5:00pm

SPNHC Committee Meetings
1:30pm–2:30pm
Legislation & Regulations—Hopscotch
Long Range Planning—Duck Duck Goose
Membership—Red Rover

2:30pm–3:30pm
Conservation—Hopscotch
Professional Development—Duck Duck Goose
Best Practices—Red Rover

3:30pm–4:30pm
Conference—Hopscotch
Web—Duck Duck Goose
Emerging Professionals—Red Rover

4:30pm–5:30pm
Publications—Hopscotch
International Relations—Duck Duck Goose
U.S. Federal Collections—Red Rover

Ice Breaker Reception—Four Square
6:00pm–8:00pm

Wednesday, June 21, 2017

Registration—SPNHC Registration Desk
6:30am–6:00pm

Speaker Ready Room Open
Noon–6:00pm

Poster Set Up
7:00am–8:00am

Technical Sessions—Four Square, Hopscotch, Duck Duck Goose, Red Rover
8:00am–3:50pm

Sponsoring Partners Tradeshow—Marco Polo
9:00am–5:00pm

Coffee Break—Marco Polo
9:40am–10:00am

Emerging Professionals Luncheon—Four Square
Noon–1:30pm

Lunch—Marco Polo
Noon–1:30pm

Coffee Break—Marco Polo
2:50pm–3:10pm

Poster Session—Four Square Hallway
3:50pm–5:00pm

Poster Take Down—Four Square Hallway
5:00pm–5:30pm

Sponsoring Partners Reception—Marco Polo
5:00pm–7:30pm

SPNHC Council Meeting—Hopscotch
6:00pm–8:00pm

Thursday, June 22, 2017

Registration—SPNHC Registration Desk
6:30am–5:30pm

Poster Set Up—Four Square Hallway
7:00am–8:00am

Poster Session—Four Square Hallway
8:00am–9:20am

Technical Sessions—Four Square, Hopscotch, Duck Duck Goose, Red Rover
9:20am–4:10pm

Sponsoring Partners Tradeshow—Marco Polo
9:30am–5:00pm

Coffee Break—Marco Polo
10:00am–10:20am

Lunch—Marco Polo
Noon–1:30pm

Coffee Break—Marco Polo
2:30pm–2:50pm

Poster Take Down—Four Square Hallway
4:10pm–5:00pm

Banquet-Denver Museum of Nature & Science
Buses depart from the Curtis at 5:30pm
Buses shuttle back to the Curtis 9:00pm–11:00pm

Friday, June 23, 2017

Registration—SPNHC Registration Desk
7:30am–1:00pm

Special Interest Groups
9:00am–9:45am
Herbaria Curation—Duck Duck Goose

9:45am–10:30am
IMLS Grant Chat—Duck Duck Goose

9:00am–10:30am
U**ncover the invisible—**
What do we know about deterioration processes in mammal skins and hides?—Four Square
SPNHC Wiki Hack-a-Thon—Hopscotch
Storage Techniques for Art, Science, and History Collections (STASH)—Red Rover
Collection Fact Sheets as Useful Collection Management Tool—Marco Polo

Coffee Break—Four Square
10:30am–11:00am

SPNHC Annual Business Meeting—Four Square
11:00am–12:30pm

Avenir Collections Center Tour—Denver Museum of Nature & Science
Buses depart from the Curtis at 12:30pm
Buses shuttle back to the Curtis 3:00pm–5:15pm

Saturday, June 24, 2017

Registration—SPNHC Registration Desk
6:00am–noon

Field Trips
7:00am–5:30pm: Florissant Fossil Beds National Monument (bus departs the Curtis at 7:00am)
7:00am–2:30pm: Nature to Nurture (bus departs the Curtis at 7:00am)
8:00am–2:30pm: People, Rocks, Fossils, Oh My! (bus departs the Curtis at 8:00am)
8:30am–2:30pm: Wild to Captive (bus departs the Curtis at 8:30am)
11:00am: Denver Botanic Gardens Behind-the-Scenes Tour (free admission from 9:00am–9:00pm with your SPNHC badge)
3:30am–5:30pm: Afternoon Add-On: Microbrews in RiNo (meet at Ratio Beerworks, 2920 Larimer St., at 3:30pm)

DETAILED SCHEDULE

Saturday, June 17th

Time	Event
6:00pm–8:00pm	Registration Desk Open

Sunday, June 18th

Time	Event	Location
7:00am–6:00pm	Registration Desk Open	
8:00am–1:00pm	Workshops:	
	Natural History Collections Club Network: Strategies for Building Undergraduate Interest and Participation in Natural History Collections	Hopscotch
	TDWG Working Session (Part 1)	Duck Duck Goose
	Natural History Biodiversity Informatics 101 (Part 1)	Red Rover
9:30am–10:00am	Coffee Break	Marco Polo
NOON–1:00pm	Lunch	Marco Polo
NOON–6:00pm	Speaker Ready Room Open	
NOON–5:00pm	Workshops:	
	Standards and Best Practices for Fluid Preservation	Hopscotch
	TDWG Working Session (Part 2)	Duck Duck Goose
	Natural History Biodiversity Informatics 101 (Part 2)	Red Rover
3:00pm–3:30pm	Coffee Break	Marco Polo

Monday, June 19th

Time	Event	Location
7:00am–6:00pm	Registration Desk Open	
8:00am–1:00pm	**Workshops:**	
	Getting It Paid For: Best Practices in Preparing Successful IMLS Grant Applications	Hopscotch
	Directors' Summit On Digital Data (Part 1)	Duck Duck Goose
	ARE YOU READY? Scenario Planning and Collaboration to Improve Disaster Preparedness (Part 1)	Red Rover
	Care of Historic Mammalian Taxidermy (Part 1)	DMNS Avenir Collections Center
	A Dentist's Nightmare: Volunteering for Cavities	DMNS Avenir Collections Center
	Legal Aspects of Shipping Preserved Animals and Tissues (Part 1)	DMNS Avenir Collections Center
9:30am–10:00am	Coffee Break	Marco Polo
NOON–1:00pm	Lunch	Marco Polo
NOON–6:00pm	Speaker Ready Room Open	
NOON–5:00pm	**Workshops:**	
	Writing for Successful Journal Publication to Promote Effective Change in Natural History Collections	Hopscotch
	Directors' Summit On Digital Data (Part 2)	Duck Duck Goose
	ARE YOU READY? Scenario Planning and Collaboration to Improve Disaster Preparedness (Part 2)	Red Rover
	Care of Historic Mammalian Taxidermy (Part 2)	DMNS Avenir Collections Center
	Legal Aspects of Shipping Preserved Animals and Tissues (Part 2)	DMNS Avenir Collections Center
3:00pm–3:30pm	Coffee Break	Marco Polo

Tuesday, June 20th

Time	Event	Location
7:30am–8:00pm	Registration Desk Open	
9:00am–10:30am	Opening Welcome & Plenary Session: • Introductory Remarks: **Kelly Tomajko**, Local Organizing Committee Chair • Welcome: **George Sparks**, President & CEO, Denver Museum of Nature & Science • Welcome: **Jennifer Ramp Neale**, Director of Research & Conservation, Denver Botanic Gardens • Remarks: **Linda Ford**, President, SPNHC • Remarks: **Austin Mast**, President, Society of Herbarium Curators • Remarks: **Eric Dorfman**, President, ICOM-NATHIST	Four Square
10:30am–11:00am	Coffee Break	Marco Polo
11:00am–NOON	Opening Welcome & Plenary Session (cont'd): • Remarks: **Emily Graslie**, Chief Curiosity Correspondent, The Field Museum • Keynote: **Kirk Johnson**, Sant Director, Smithsonian National Museum of Natural History	Four Square
NOON–1:30pm	Lunch	on your own
NOON–6:00pm	Speaker Ready Room Open	
1:30pm–5:00pm	Sponsoring Partner Set-Up	Marco Polo
1:30pm–2:30pm	Committee Meetings:	
	Legislation & Regulations	Hopscotch
	Long Range Planning	Duck Duck Goose
	Membership	Red Rover
2:30pm–3:30pm	Committee Meetings:	
	Conservation	Hopscotch
	Professional Development	Duck Duck Goose
	Best Practices	Red Rover
3:30pm–4:30pm	Committee Meetings:	
	Conference	Hopscotch
	Web	Duck Duck Goose
	Emerging Professionals	Red Rover
4:30pm–5:30pm	Committee Meetings:	
	Publications	Hopscotch
	International Relations	Duck Duck Goose
	U.S. Federal Collections	Red Rover
6:00pm–8:00pm	Ice Breaker Reception	Four Square

Wednesday, June 21st

Time	Event	Location
6:30am–6:00pm	Registration Desk Open	
7:00am–8:00am	Poster Set-Up–Group 1	Four Square Foyer
9:00am–5:00pm	Sponsoring Partner Tradeshow	Marco Polo

8:00am–NOON	MORNING TECHNICAL SESSIONS			
ROOM	Four Square	Hopscotch	Duck Duck Goose	Red Rover
THEME	Advances in Digitization Worldwide: an iDigBio Symposium	Disaster Preparedness	Public Access to Collections	New Solutions|Collections Management
8:00am	**Jennifer Ackerfield** - Herbarium Link - a novel system for the digitization workflow of herbarium specimens	**Peter Giere** - Disaster Preparedness in museums–risks and incidences in natural history collections and beyond. An introduction	**Stephanie Tessier** - Collections for the future: specimens and data going fully digital	**Suzanne Ryder** - The next generation in collections assessment
8:20am	**Sarah Phillips** - Everyday operational issues associated with managing the digital collections of one of the largest herbaria in the world	**Clare Valentine** - How to write a disaster plan! Business continuity and collections salvage in a European perspective	**Bernhard Zipfel** - *Homo naledi*, a new human relative - recovery, curation, and dissemination	**Terry Childs** - Survey is in! Design, results & next steps for DOI collections
8:40am	**Michael Denslow** - Interoperability between GEOLocate and Symbiota software; collaborative georeferencing within a large scale digitization project	**Julie A. Page** - To protect and preserve: U.S. collaborative efforts to build and sustain cultural heritage emergency network	**Sali Underwood** - Nevada's neglected Lepidoptera herbarium	**Carrie Eaton** - Federal collections stewardship at a university museum: developing department-wide policies for the care and management of research specimens from public lands
9:00am	**Jonathan Brecko** - Wiki-handbook of best practices and standards for 3D imaging of natural history specimens	**Anja Friederichs** - Emergency preparedness at the Museum für Naturkunde, Berlin: the end of a long and winding road–a case study	**Emily Smith** - Keeping "History" in "Natural History": scientific specimens as artifacts of cultural heritage	**Christina Fidler** - Preserving and promoting access to field notes in natural history collections
9:20am	**Jonathan Blundell** - Automating 3D collection capture: developing systems for 3D digitization at scale	**Robert Morris** - Planning for the Shaky Isles: disaster preparedness at the Otago Museum	**Rachel Poutasse** - The Marcus E. Jones Project: an innovative approach to public engagement with herbaria and archives	**Matthew Pace** - Adapting to APG IV: curating the second largest herbarium in the world
9:40am–10:00am	Coffee Break–**Marco Polo**			
10:00am	**Christina Lutz** - Novel Use of Inselect in digitization of paleontology collections	**Colleen Carter** - Quick disaster response: DMNS adds a tool	**Treloar Bower** - Beyond access	**Julianne Snider** - Working toward best practices of collection stewardship to ensure the sustainability of a university collection

ROOM	Four Square	Hopscotch	Duck Duck Goose	Red Rover
THEME	**Advances in Digitization Worldwide: an iDigBio Symposium**	**Disaster Preparedness**	**Public Access to Collections**	**New Solutions|Collections Management**
10:20am	**Marc Pignal** - e-ReColnat: a multiparty approach	**Leslie Schuhmann** - Earthquake response and repair project at the Smithsonian Institution's Museum Support Center (MSC)	**Rich Busch** - All access: transcending the present	**Russell D. "Tim" White** - The present is the key to the past: the evolution of best practices at the Yale Peabody Museum of Natural History
10:40am	**Gary Motz** - Responding to the invisible infrastructure: research libraries as preservation partners in the curation of physical specimen biocollections data	**William Moser** - Fungal growth associated with ethanol based collection storage facilities	**Greg Lovell** - Let them see the stuff	**Gregory Watkins-Colwell** - Bones, boxes, and barcodes: the recuration of herpetology and ichthyology skeletal specimens at Yale Peabody Museum of Natural History.....so far
11:00am	**Paul J. Morris** - Developing Standards for Data Quality Tests and Assertions using a Fitness for Use Framework	**Rebecca Kaczkowski** - The value of PRICE: preparedness and response in collections emergencies at the Smithsonian	**Colleen Carter** - Girls & science	**Shusheng Hu** - George Wieland and the cycadeoid collection at the Yale Peabody Museum
	Innovative Uses of Collections Data: an iDigBio Symposium			
11:20am	**Kathryn Estes-Smargiassi** - Innovative inventory: shedding light on dark data and creating new collection tools	**Jen Tobias** - Friends in Need: a practical guide to getting help from neighbors when disaster strikes	**Liz Davis** - Access Granted: sharing your unique collections with an audience	**Nicole Tarnowsky** - What once was lost can now be found in the cloud (part 1 of 2)—handling unidentified legacy herbarium collections at the New York Botanical Garden.
11:40am	**Gary Motz** - Starting from scratch: digitization of an entire collection ecosystem	**Anthony Akpan** - The impact of ICTs-based communication modes on citizen participation in flood risk management: a case study of Delfland (The Netherlands)	**Jodi Schoemer** - Using audience input to determine traveling exhibition enhancements	**Charles Zimmerman** - What once was lost can now be found in the cloud (part 2 of 2)—new protocols for exchange of herbarium specimens and data in the digital age

Time	Event			Location
NOON–1:30pm	Lunch			Marco Polo
NOON–1:30pm	Emerging Professionals Luncheon			Four Square
NOON–6:00pm	Speaker Ready Room Open			
1:30pm–3:50pm	AFTERNOON TECHNICAL SESSIONS			
ROOM	**Four Square**	**Hopscotch**	**Duck Duck Goose**	**Red Rover**
THEME	**Innovative Uses of Collections Data: an iDigBio Symposium**	**Impacts of Changing Regulations**	**Public Access to Collections**	**New Solutions|Collections Management**
1:30pm	**J Ryan Allen** - Analyzing the University of Colorado Herbarium (COLO) digital collection	**Breda Zimkus** - The ABCs of ABS: the Nagoya Protocol on access and benefit-sharing and its relevance to natural history collections in the U.S.	**Michael Denslow** - The Notes From Nature project: evolutions and revolutions in enhancing engagement with data providers and citizen scientists	**Paul Mayer** - Planning for and justifying a large fossil donation
1:50pm	**Ann Molineux** - A digitized collection: where next?	**Lynda Knowles** - Legal and regulatory update on the Convention on Biological Diversity and the Nagoya Protocol	**Kari M. Harris** - Strategies to engage high school students in natural history collections	**Christina Piotrowski** - I'll take 40 barrels of invertebrates to go please: a case study for large wet collection transfers
2:10pm	**Stephanie Leon** - From the scrub to the web: Digitizing the collection at the Archbold Biological Station	**Dirk Neumann** - Access and Benefit Sharing–chances and challenges for biodiversity research, collections and collection management under the Nagoya Protocol	**Elizabeth Ellwood** - Worldwide Engagement for Digitizing Biocollections (WeDigBio)—the biocollections community's citizen science space on the calendar	**Mare Nazaire** - Engaging our future to preserve our past: curation and preservation of historically significant collections through student participation at the Rancho Santa Ana Botanic Garden Herbarium
2:30pm	**Sylvia Orli** - Deep learning with botanical specimen images	**Matthew Brown** - The Paleontology Resources Preservation Act and you	**Gabriela Hogue** - Measuring the success and impact of crowdsourced transcription using CitSciScribe	
2:50pm–3:10pm	Coffee Break–**Marco Polo**			
3:10pm	**Randy Singer** - Fantastic fishes and where to find them: a dynamic inventory of United States fish collections	**Pamela Horsley** - The role of the registrar—a new position for the University of Michigan Museum of Zoology and Herbarium	**Noelia Aponte-Silva** - Extending the capacity of collections staff: best practices in volunteer recruitment, screening, and placement	**Jessica Cundiff** - Fossils on the move: managing the paleontology collection moves at the Museum of Comparative Zoology, Harvard University
3:30pm	**Shelley James** - Georeferencing for Research Use (GRU): innovative geospatial training using natural history collections		**Shana Hawrylchak** - Increasing capacity: a fresh look at effectively managing collections volunteers and interns	**Rebecca Newberry** - How to move a *Triceratops*

Time	Event	Location
3:50pm–5:00pm	Poster Session–Group 1	Four Square Foyer
5:00pm– 5:30pm	Poster Take-Down–Group 1	Four Square Foyer
5:00pm–7:30pm	Sponsoring Partners Reception	Marco Polo
6:00pm–8:00pm	SPNHC Council Meeting	Hopscotch

Thursday, June 22nd

Time	Event	Location
6:30am–5:30pm	Registration Desk Open	
7:00am–8:00am	Poster Set-Up–Group 2	Four Square Foyer
8:00am–9:20am	Poster Session–Group 2	Four Square Foyer
9:30am–5:00pm	Sponsoring Partner Tradeshow	Marco Polo

9:20AM–NOON	**MORNING TECHNICAL SESSIONS**			
ROOM	**Four Square**	**Hopscotch**	**Duck Duck Goose**	**Red Rover**
THEME	**Best Practices for Integrating Collections into Education: an SCNet Symposium**	**New Solutions|Sustainable Facilities**	**Demo Camp**	**New Solutions|Conservation**
9:20am	**Roland Roberts** - NSF Initiatives for Improving education and broadening participation	**Bernhard Zipfel** - Advancing research and knowledge in South Africa–towards a natural science collections facility	**John Wieczorek** - Kurator-Web: Making data quality-control accessible	**Robert Waller** - Effective preservation decision strategies
9:40am	**Gabriela Hogue** - From obscurity to prosperity—innovat-ive approaches to broaden diversity and the future of natural history collections	**Dacha Atienza** - How to use historical buildings to create a scientific venue	**Qian Zhang** - Kurator-YW: Using YesWorkflow hybrid queries to reveal data lineage from data curation activities	**Corey Scobie** - An evaluation of pre-preparation refrigerated storage conditions for ornithological specimens
10:00am–10:20am	Coffee Break–**Marco Polo**			
10:20am	**Anna Monfils** - Integrating biodiversity data into the undergraduate curriculum: opportun-ities for collaboration	**Jeffrey Hirsch** - Collection centers: what museum professionals should know about design and construction	**Steve Dilliplane** - More than a map: adventures in biodiversity informatics visualization	**Taylor Soniat** - Assessing levels of DNA and RNA degradation in frozen tissues archived in natural history collections
10:40am	**Debra Linton** - Best practices for designing educational modules using collections data: a suggested workflow	**Walter Crimm** (panel moderator) - DMNS Avenir Center—post occupancy evaluation	**Matthew Collins** - Jupyter.idigbio.org: hosted Jupyter Note-books with biodiversity datasets for reproducible research in R and Python	**Mariana Di Giacomo** - Using FTIR to identify slide mounting media: a first step towards best practices in the care of slide mounted specimens
11:00am	**Elizabeth Ellwood** - Natural history collections data and Biodiversity Literacy in Undergraduate Education (BLUE)	**Walter Crimm** (panel moderator) - Design for flexibility: what can be learned from what has been done	**Talia Karim** - iDigPaleo: in the classroom and on the sofa	**Jean-Marc Gagnon** - Deteriorating micro-scope slide mountants at the Canadian Mus-eum of Nature: experi-menting with some remedial approaches

ROOM	Four Square	Hopscotch	Duck Duck Goose	Red Rover
THEME	**Best Practices for Integrating Collections into Education: an SCNet Symposium**	**New Solutions|Sustainable Facilities**	**Demo Camp**	**New Solutions|Conservation**
11:20am	**Wendy Gram** - Using Big Data in undergraduate courses	**Walter Crimm** (panel moderator) - Design for flexibility: what can be learned from what has been done	**Jason H. Best** - Evaluating herbarium cabinet capacity using computer vision and data visualization	**George Dante** - A new trick for old eyes - contact lenses for taxidermy
			New Solutions|Collections Management	
11:40am	**Tanya Dewey** - Asking and answering questions: using a flexible querying tool to support data exploration and hypothesis testing in a variety of courses	**Walter Crimm** (panel moderator) - Design for flexibility: what can be learned from what has been done	**Richard Levy** - An economical method for creating custom QR code labels	**Christine Haynes** - 3D printing as a means for casting proportional replicas used in the conservation of articulated skeletons
NOON–1:30pm	Lunch–**Marco Polo**			

1:30pm–4:10pm	AFTERNOON TECHNICAL SESSIONS			
ROOM	FOUR SQUARE	HOPSCOTCH	DUCK DUCK GOOSE	RED ROVER
THEME	**Best Practices for Integrating Collections into Education: an SCNet Symposium**	**New Solutions|Sustainable Facilities**	**New Solutions|Collections Management**	**New Solutions|Conservation**
1:30pm	**Joseph Kerski** - Best practices for integrating GeoTechnology into education	**Walter Crimm** - Design for flexibility: what can be learned from what has been done	**James A. Macklin** - TDWG 101: the Importance of biodiversity information standards (TDWG) to SPNHC	**Thomas Gnoske** - Chicago's bushman revisited
1:50pm	**Heather Lerner** - Promoting research and outreach that uses collections by teaching under-graduate collections-based courses and supporting outreach modules within existing classes	**James Calder** - What is an Environmental Management System?	**Amanda Millhouse** - Analysis of fossil data standards at the Smithsonian NMNH Department of Paleobiology	**Fran Ritchie** - Developing a best practice for historic mammal taxidermy
2:10pm	**P. Roxanne Kellar** - Synthesizing student-generated data from herbarium specimens and data from GenBank to investigate phylogenetic diversity	**Jeff Joplin** - Recycled water, ground source heat pumps and sustainability in the Avenir Collections Center	**Kathy Hollis** - More than just specimens in drawers: creating a digital framework to connect analog archival data to fossil specimens in the USGS Paleontological Collection at the National Museum of Natural History	**Sally Y. Shelton** - Conservation, preservation, and interpretation of paper shale fossils at Florissant Fossil Beds National Monument, National Park Service, Colorado
2:30pm–2:50pm	Coffee Break–**Marco Polo**			

ROOM	FOUR SQUARE	HOPSCOTCH	DUCK DUCK GOOSE	RED ROVER
THEME	**Best Practices for Integrating Collections into Education: an SCNet Symposium**	**New Solutions|Sustainable Facilities**	**New Solutions|Collections Management**	**New Solutions|Conservation**
2:50pm	**ShaunAnn Peters** - Bringing natural history collection-based research to the community college learner	**Lukasz Bratasz** - Evaluation of energy consumption in Yale Peabody Museum of Natural History	**Stefanie Krause** - On the way towards common principles in collections management—A handbook facilitating and promoting the creation and implementation of management policies on digital collections	**Jean DeMouthe** - Natural geologic materials in art, anthropology, and historical collections: issues & communication
3:10pm	**Amy Bolton** - Putting digitized collections to work in K-12 learning environments		**Siro Masinde** - Discovering non-digitized collections: a metadata approach	**Katharine Corneli** - Between a rock and a stone: preparators and conservators in practice
3:30pm	**Austin Mast** - How to bring the Worldwide Engagement for Digitizing Biocollections (WeDigBio) event into your classroom		**Genevieve E. Tocci** - Addressing complex collections: separating the concerns of research and collection management in natural science collections data	**Yvette Harvey** - A lure to take the biscuit: a *Stegobium paniceum* pheromone trial at WSY herbarium
3:50pm	**Teresa Mourad** - More bang for your buck: leveraging resources with professional societies		**James A. Macklin** - DINA: open source and open services—a modern approach to natural history collection management systems	**Alyson Wilkins** - Adaptation: modifying pest management strategies to specific situations

Time	Event	Location
4:10pm–5:00pm	Poster Take-Down–Group 2	Four Square Foyer
5:30pm–11:00pm	Banquet - buses leave The Curtis at 5:30pm	DMNS

Friday June 23rd

Time	Event	Location
7:30am–1:00pm	Registration Desk Open	
9:00am–9:45am	Special Interest Group: Herbaria Curation	Duck Duck Goose
9:00am–10:30am	Special Interest Groups:	
	Uncover the Invisible—What do we Know about Deterioration Processes in Mammal Skins and Hides?	Four Square
	SPNHC Wiki Hack-a-Thon	Hopscotch
	Collection Fact Sheets as Useful Collection Management Tool	Marco Polo
	Storage Techniques for Art, Science, and History Collections (STASH) Preventive Conservation and Storage: STASH Flash I	Red Rover
9:45am–10:30am	Special Interest Group: IMLS Grant Chat	Duck Duck Goose
10:30am–11:00am	Coffee Break	Four Square
11:00am–12:30pm	Annual Business Meeting & Luncheon	Four Square
7:30am–5:00pm	Sponsoring Partner Tradeshow–Breakdown	Marco Polo
12:30pm–5:00pm	Avenir Collections Center Tours–buses leave The Curtis at 12:30pm	DMNS

Saturday, June 24th

Time	Event
6:00am–NOON	Registration Desk Open
7:00am–5:30pm	Fieldtrip: Florissant Fossil Beds National Monument (bus departs The Curtis at 7:00am)
7:00am–2:30pm	Fieldtrip: Nature to Nurture (bus departs The Curtis at 7:00am)
8:00am–2:30pm	Fieldtrip: People, Rocks, Fossils, Oh My! (bus departs The Curtis at 8:00am)
8:30am–2:30pm	Fieldtrip: Wild to Captive (bus departs The Curtis at 8:30am)
11:00am	Fieldtrip: Denver Botanic Gardens Behind-the-Scenes Tour (free admission from 9:00am–9:00pm with your SPNHC conference badge)
3:30pm–5:30pm	Fieldtrip: Afternoon Add-On: Microbrews in RiNo (meet at Ratio Beerworks, 2920 Larimer St., at 3:30pm)

SPNHC
ADVANCING COLLECTIONS CARE

The Society for the Preservation of Natural History Collections (SPNHC) is an international society whose mission is to improve the preservation, conservation and management of natural history collections to ensure their continuing value to society. SPNHC takes a leading role in promoting collections care issues to the academic community, governments, and the general public. SPNHC members—curators, collection managers, preparators, database administrators and directors from 22 countries—are dedicated to training and mentoring the next generation of collections professionals. The Society holds annual meetings and sponsors symposia and workshops to foster the exchange of ideas and information related to the preservation, conservation and management of natural history collections. To learn more about SPNHC or to become a SPNHC member, please visit http://www.spnhc.org/.

Executive Council	*Members-at-Large*
Linda S. Ford, *President*	Julian Carter (2014–2017)
Barbara Thiers, *President-Elect*	Melinda Peters (2014–2017)
Andrew Bentley, *Past President*	Bethany Palumbo (2015–2018)
Ruth O'Leary, *Treasurer*	Rusty Russell (2015–2018)
Cindy Opitz, *Secretary*	Miranda Lowe (2016–2019)
Christine Johnson, *Managing Editor*	Kelly Tomajko (2016–2019)

POSTER PRESENTATION

Wednesday, June 21st

No.	Name	Theme	Title of Abstract
1	**Mariel Campbell**	Disaster Preparedness	A vapor phase nitrogen cryogenic biorepository for the Division of Genomic Resources, Museum of Southwestern Biology
2	**Rachel Delovio**	Public Access to Collections	Rediscovering collections in curation: a cache of Pleistocene locusts
3	**Bryan Brunet**	Advances in Digitization Worldwide: an iDigBio Symposium	Crowdsourcing carabid collections
4	**Erica Krimmel**	Advances in Digitization Worldwide: an iDigBio Symposium	Better quality, less work: how to improve collections data with the efficient use of resources provided by aggregators and consortia
5	**Holly Seyler**	Advances in Digitization Worldwide: an iDigBio Symposium	Digitizing Paleogene mammals from the Rocky Mountain Region
6	**Jessica Utrup**	Advances in Digitization Worldwide: an iDigBio Symposium	Increasing data robustness for concretions using Inselect
7	**Adam Cohen**	Innovative Uses of Collections Data: an iDigBio Symposium	Update on the Fishes of Texas Project
8	**Jude Southward**	New Solutions|Conservation	Treatment of the American Ethnology Collections at DMNS
9	**Lindsey Frederick**	New Solutions|Collections Management	Applying best practices to data migration: a relational database for the New Mexico Museum of Natural History and Science
10	**Kaylen Jones**	New Solutions|Collections Management	Building critical infrastructure for endangered species management: an event-based model
11	**Christopher Thigpen**	New Solutions|Collections Management	Preserving natural history collections through student involvement and public interest
12	**Annie E. Savage**	New Solutions|Collections Management	Project Macroinvert: bringing aquatic macroinvertebrate collections out of the dark at Arkansas State University
13	**Ashton B. Smith**	New Solutions|Collections Management	DNA collection from field to freezer: an example using fish
14	**Daniel L. DiMichele**	New Solutions|Collections Management	Fishes DNA collection loan processing
15	**Carolina Arjona**	Public Access to Collections	Yes! you can touch these (developing a hands-on exhibit with pelts)
16	**Walter G. Berendsohn**	Public Access to Collections	Natural history in Europeana
17	**Melissa Casarez**	New Solutions|Conservation	Strategy for managing an ichthyology collection with space limitations
18	**Joy Bloser**	New Solutions|Conservation	Putting the monkey back in the classroom: the conservation and restoration of a mounted guenon monkey
19	**Marie-Helene Hubert**	New Solutions|Collections Management	Tackling the challenging process of preparation of old, fluid-preserved whale bones
20	**Diane Erwin**	Public Access to Collections	Enhancing public access to UCMP's fossil insect collections through digitization and social media
21	**Lindsay Walker**	Public Access to Collections	Curating the Cretaceous aeas of California at the Natural History Museum of Los Angeles County
22	**Jessa Watters**	Public Access to Collections	Citizen science involvement in Oklahoma amphibian infectious disease screening

Thursday, June 22nd

No.	Name	Theme	Title of Abstract
1	**Katelin D. Pearson**	Innovative Uses of Collections Data: an iDigBio Symposium	On the front lines of discovering change: biodiversity specimen collectors as the Anthropocene's outlier detectors
2	**Jennifer C. Taylor**	New Solutions|Collections Management	Project Macroinvert: unlocking geospatial data from the aquatic macroinvertebrate collection at Arkansas State University
3	**Christine Haynes**	New Solutions|Conservation	Strategies for the conservation and storage of taxidermy: beaver case study
4	**Emily Frank**	New Solutions|Conservation	Conservation of two taxidermy spitting cobras: skin repair with limited access
5	**Logan Kursh**	New Solutions|Conservation	Strategies for the conservation and storage of taxidermy: flying squirrel case study
6	**Laura Abraczinskas**	New Solutions|Collections Management	Storage improvements for paper records and documents at the Michigan State University Museum
7	**Meredith Mahoney**	New Solutions|Conservation	Challenges, successes, and lessons learned in integrated pest management at the Illinois State Museum
8	**Kelly Martin**	New Solutions|Conservation	Bringing curation to a university prep lab: bridging conservation and preparation
9	**Nicole Ridgwell**	New Solutions|Conservation	Long term conservation challenges in the Carnegie Quarry, Dinosaur National Monument, Utah, USA
10	**James Erdmann**	Public Access to Collections	The Southeastern Louisiana University Vertebrate Collections: a small collection with a big agenda
11	**Sladjana Subotic**	New Solutions|Conservation	Novel method of bioremediation and characterization of bacterial communities on arsenic-impacted museum collections
13	**Ben Frable**	New Solutions|Collections Management	Incorporation of the orphaned UCLA Fish Collection into the Marine Vertebrate Collection, Scripps Institution of Oceanography
14	**Jazmin Sproule**	New Solutions|Collections Management	Restoration of the Oregon State Aquatic Invertebrate Collection
15	**Heather Cole**	Public Access to Collections	Supporting genomics, research, and public access through the digitization of national collections
16	**Saskia R. Harris**	New Solutions|Collections Management	RHS Herbarium: creating beautiful specimens fit for purpose
17	**Leanna McMillin**	New Solutions|Collections Management	Moving 20,000 specimens: curating the former North American '*Aster* L.'
18	**Nasreen Phillips**	New Solutions|Collections Management	Developments on rehousing the ethanol collections at the Academy of Natural Sciences of Drexel University
19	**Michael Quigley**	Disaster Preparedness	Responding to a potential disaster: moths in the ethnographic collections at the American Museum of Natural History
20	**Jennifer Wilkinson**	New Solutions|Collections Management	Precision sampling of herbarium specimens of plant pathogenic fungi to minimize damage and maximize extraction of target DNA
21	**Genevieve Tocci**	New Solutions|Collections Management	Managing microscope slides: physical and digital issues
22	**Tim White**	New Solutions|Collections Management	International collections moves: the return of the Machu Picchu artifacts to the people of Peru
23	**Gretchen Anderson**	New Solutions|Conservation	Once in a lifetime: examination and treatment of a museum icon

ABSTRACTS

WORKSHOPS, June 18 and 19

Natural History Collections Club Network: strategies for building undergraduate interest and participation in natural history collections

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The NHCCN is focused on generating and maintaining student interest in biodiversity collections by providing them access to curators and mentors and to other students with similar interests. The purpose of a multi-institution network is to increase accessibility of intellectual resources for club advisors and graduate and undergraduate student members. Through their involvement with Natural History Collections Clubs (NHCCs), students are empowered to take leadership roles in their universities' natural history collections. The current network is made of several clubs that are curator-advised, student-driven organizations aimed at enhancing local natural history collections by helping to train student volunteers to assist in curating and managing them. This workshop will explore the advantages and challenges of starting a NHCC at your institution as well as other strategies for getting students more involved in collections.

TDWG working session

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Arthur Chapman
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The TDWG (Biodiversity Information Standards (TDWG)) Annotations and Data Quality interest groups will hold a joint working session at SPNHC 2017. The TDWG Data Quality Interest Group has been producing a Fitness For Use Framework, which provides formal descriptions of data quality needs, mechanisms, and reports, and has been formulating a list of standard biodiversity data quality tests and assertions generalized from tests in use by the Atlas of Living Australia, The Global Biodiversity Information Facility, OBIS, iDigBio, and VertNet. The TDWG Annotations Interest Group is concerned with formal representation of assertions about biodiversity data, and is exploring the applicability of a W3C (World Wide Web Consortium) standard for annotating internet documents to biodiversity data. The primary focus of this working session will be exploring the representation of Fitness For Use reports and assertions as annotations of biodiversity data.

Natural History Biodiversity Informatics 101

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The short course will provide an introduction to natural history biodiversity informatics. The course is designed for museum professionals that need a better understanding of the natural history informatics landscape or the resources available for digitizing and digitally sharing natural history collections data. Topics will cover the basics of natural history collection data and digital object lifecycle management, including digitally archiving and mobilizing collections data and participation in global initiatives. The course will be led by museum and informatics professionals with experience in natural history collections digitization and informatics.

Standards and best practices for fluid preservation

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The insights and results presented in this workshop were initiated by Chris Collins (then of The Natural History Museum, London) in a Clothworkers Foundation funded project that combined the expertise of different people dedicated to fluid preservation during a workshop in London in 2013. Challenges for fluid-preserved collections were previously presented at the SPNHC conference in Cardiff (http://conservation.myspecies.info/node/33) in 2014. First outcomes to develop a framework to categorise sustainable approaches towards fluid preservation benchmarks and standards were presented during a workshop at the SPNHC conference in Berlin in 2016. In this next step, we will present effective and achievable standards and a consensus about what baseline standards should be.

Getting it paid for: best practices in preparing successful IMLS grant applications

Connie Cox Bodner
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This participatory workshop will examine the strategies, logistics, and best practices involved in preparing successful IMLS grant applications for natural history collections projects. First, we will examine the process in manageable units, beginning with conceptualizing a project and ending with the successful submittal of the application. Then using abbreviated examples of actual applications for natural history collections projects, we will replicate peer review panel activities so that participants can develop a solid understanding of what's involved in the analysis and evaluation of competitive, fundable applications. At each stage, there will be opportunities to brainstorm ideas, draft application elements, discuss our reactions, and ask questions. Participants will receive sets of worksheets and PowerPoint slides for the day's activities as well as for future reference.

Workshop participants will understand:

- the nature and goals of IMLS grant programs for museums, including new initiatives and emphases;
- how to assess the fit between their funding needs and the agency's opportunities;
- how to conceptualize and describe a fundable project in writing;
- how an application is reviewed and evaluated.

Directors' summit

Gil Nelson
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The primary purpose of the Summit is to enlist the expertise and leadership of museum directors and administrators in outlining strategies for the creation, management, mobilization, and long-term sustainability of digital collections data at the institutional level, to include:

- Exploring strategies for institutionally specific digitization activities;
- Enhancing strategies for the mobilization and aggregation of digital biodiversity data;
- Exploring gaps in available digitized data for biodiversity research;
- Exploring strategies for ensuring long-term digital data archiving and management;
- Providing leadership for institutionally specific digital asset management;
- Providing leadership for the incorporation of biodiversity informatics and bioinformatics managers within museums' staffing plans.

ARE YOU READY? Scenario planning and collaboration to improve disaster preparedness

Julie Page
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Will your disaster plan work in a real disaster situation? It's better to find answers now than after a disaster has occurred! Attend this scenario-based collaborative workshop to improve disaster preparedness and response for collections. Julie A. Page, Co-Coordinator, California Preservation Program (CPP) and Western States & Territories Preservation Assistance Service (WESTPAS), will be leading workshop participants through disaster vulnerability assessments, testing institutional emergency plans with various scenarios, and discussing mechanisms for collaboration across institutions. WESTPAS is funded by the National Endowment for the Humanities. Participants should bring one copy of their institutional emergency plan to this daylong workshop. Participants will complete a simple risk assessment assignment in advance of the workshop.

Care of historic mammalian taxidermy

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The American Museum of Natural History (AMNH), in partnership with the Yale Institute for the Preservation of Cultural Heritage (IPCH) and the Institute for Museum and Library Services (IMLS), is presenting a one-day workshop for a limited number of participants that is focused on preventive care and basic conservation treatment of historic mammalian taxidermy. Each participant will leave the workshop with a working knowledge of the preservation needs of historic mammalian taxidermy and how to address common condition issues, as well as a Resource Kit of conservation references, samples, and common treatment materials. The workshop will focus on hands-on experience. Therefore, two pre-workshop webinars on background and safety information will be offered for registered participants. In the weeks leading up to the workshop, participants also will be asked to share a brief summary of their working history with mammalian taxidermy. This information will help organizers tailor the workshop content to the appropriate level for the group.

The targeted participants are those who occasionally or regularly work with historic taxidermy collections, and are seeking to increase their knowledge and confidence in its preventive care and basic conservation. Conservators and professionals in allied fields such as collection managers, preventive care professionals, museum preparators, exhibition technicians, and taxidermists are invited to participate.

A dentist's nightmare: volunteering for cavities

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Jeff Phegley
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Learn about and experience how the DMNS Anthropology Department has streamlined custom storage cavity mount making with volunteers in mind. Anthropology Collections Assistant, Jeff Phegley, and Anthropology Collections Manager, Melissa Bechhoefer, will walk through our process from pulling artifacts out of existing storage, measuring, designing the mount, making custom boxes and cavity mounts, all with a volunteer workforce. As part of the workshop, you will get hands-on experience building a custom box and mount for an object in the DMNS Ethnology collection. Our 50+ volunteers have rehoused over 8,000 objects in the last two years—come learn how!

Legal aspects of shipping preserved animals and tissues

Dirk Neumann
Zoological State Collection Munich, München, Germany; dirk.neumann@zsm.mwn.de

Stephanie Carson
American Museum of Natural History, New York, NY, USA; scarson@amnh.org

Peter Giere
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The workshop gives a comprehensive introduction to relevant regulations and international laws that researchers and institutions should consider when shipping specimens internationally. Covered areas include customs law, veterinary and animal by-product regulations, CITES and species protection legislation, IATA Dangerous Goods Regulation (including an initial training for A180 shipping of ethanol preserved specimens) and practical advice for packaging and shipping of specimens. The final presentation will discuss potential effects of the Nagoya Protocol on the exchange of specimens. All presentations will be made available for self-training after the workshop.

Writing for successful journal publication to promote effective change in natural history collections

Christine Johnson
American Museum of Natural History, New York, NY, USA; cjohnson@amnh.org

This workshop will focus on how to present your work through journal publication to promote effective change in natural history collections. A journal article communicates an author's overall idea, the execution of the author's work or study, and the value the work lends to the broader natural history community. We will offer strategies for presentation of ideas, tips on how to create effective graphs, figures, and tables, and basic data analysis. Participants will be given a topic and some 'data' at the beginning of the workshop. At the end of each presented topic, participants will have a few moments to put this information into the respective manuscript section form (abstract, introduction, methods, results, discussion, graph or table), which will be critiqued and discussed at the end of the session.

PLENARY LECTURES AND SPEAKER BIOS, June 20

SPNHC and ICOM NATHIST: potentials for partnership

Eric Dorfman
President ICOM NATHIST and Director Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA; dorfmane@carnegiemnh.org

On February 27, 2016, the Society for the Preservation of Natural History Collections (SPNHC) signed a memorandum of understanding with the International Council of Museums Committee for Museums and Collections of Natural History (ICOM NATHIST), in recognition of the alignment of our goals and potentials for synergizing on matters of mutual importance. ICOM NATHIST has existed, in one form or another, since 1937 with the aim of being a global nexus for communication and activities that champion best practice in natural heritage. Initiatives have included drafting the ICOM Code of Ethics for Natural History Museums (2013), releasing a white paper on natural history museums and wildlife trafficking (2016), as well as publications including the upcoming book, The Future of Natural History Museums (2017).

Among the initiatives covered in the MOU are: mutual ex-officio representation on the respective boards of each organization; collaboration on conferences; joint initiatives and projects. A major impetus for creating this is agreement is to give greater weight to the natural history museum sector in the face of increasing global environmental degradation, ever greater interest and engagement from the public and pressure to increase activity with fewer resources. The agreement will give each of us the chance to expand our focus, while keeping true to our core missions.

The time is ripe for our two organizations to consider what projects, initiatives, and messaging might benefit from our collaboration. For instance, in October this year, ICOM NATHIST will be holding its annual conference at Carnegie Museum of Natural History, on the theme of the Anthropocene. The impending acceptance of the Anthropocene as a new geological epoch encourages renewed consideration of the pervasiveness and interconnectedness of human impacts on the planet, touching collection-based research, in situ conservation, artistic expression, and philosophy. Natural history museums are at the center of these considerations, researching arcane ecological and evolutionary concepts, and interpreting them for the public. The conference program will feature opportunities for our colleagues to think about the goals and agency of our practice.

In this talk, I will use the relationship between ICOM NATHIST and SPNHC to explore this and other ideas about current objects and collections, where collecting institutions might be heading in the future, and how the two societies might increase collaboration to advance the cause of natural history museums and their collections.

Dr. Eric Dorfman is Director of Pittsburgh's Carnegie Museum of Natural History and President of the International Council of Museums Committee for Museums and Collections of Natural History (ICOM NATHIST). Dorfman did a Masters in marine ecology in Monterey California and a doctorate on waterbirds in eastern Australia. He undertook postdoctoral research on waterbirds in both Australia and South Africa and his current research interests focus primarily on museology and interactions between humans and the natural world.

Dorfman is active in the natural history museum sector internationally, authoring the ICOM Code of Ethics for Natural History Museums, as well as chairing the ICOM NATHIST Wildlife Trafficking Working Group and a Board Member of ICOM USA.

He is an author of popular books on natural history, scholarly papers on museum operations, public programming, and the ecology of wetland birds. His most recent book is as editor of Intangible Natural Heritage (Routledge 2012) and he is currently editing The Future of Natural History Museums, also for Routledge. Prior to his current position, he was Director of Whanganui Regional Museum in New Zealand and lectured in the Museums and Heritage Studies Department of Victoria University of Wellington.

SPNHC & best practices: united in history & integrated for the future

Linda S. Ford
President, Society for the Preservation of Natural History Collections (SPNHC); lford@oeb.harvard.edu

The Society for the Preservation of Natural History Collections (SPNHC) is an international organization that represents natural history collection care professionals and the collections they serve to protect. As a Society, we are devoted to the preservation, conservation, and management of natural history collections because well-curated collections and their associated data are critical for scientific research, education, and community outreach. Since its founding in 1985, SPNHC has been unique among natural history professional organizations, by virtue of its international scope and multidisciplinary approach to collections management and care, including an active pursuit of best practices. Many of the best practices established for objects and their associated data have become an integral part of the day-to-day care of natural history collections. The Society continues to explore new and innovative ways to vigorously promote, progressively care for, and widely disseminate knowledge about these best practices and the collections that they preserve.

I've always loved natural history. In graduate school at the University of Texas at Arlington, my colleagues and I used to work in the collections for fun. It was exciting to be able to figure out a problem or at least document its status. The idea that the result of this work could potentially be utilized by other researchers, both today and in the future, was exhilarating. When I moved to the University of Kansas, I met John E. Simmons, who introduced me to best practices in collections work and to SPNHC. I was intrigued to find a group of like-minded people, who were striving to standardize concepts that I considered fun and to ensure that these standards had lasting and constructive effects on collections. I was converted and proud when John and I published a paper advocating for managers of such collections to be seen as professionals in their own right. After study at the American Museum of Natural History in New York, I became the project manager on an NSF project to digitize a natural history collection. At that point my career path was set. I not only love natural history collections, but I learned to believe in museums and feel committed to their mission.

Since joining SPNHC in 1997 and attending my first meeting in 1998 in Edmonton, Canada, the dedication and commitment of the society's members to further its mission has been a constant motivation for my own involvement. It is the understanding that we are all working on something bigger than ourselves and a commitment to do our very best to infuse meaning into the concept of "in perpetuity" that continues to fuel my continued involvement. I'm very honored to do my part in my new role in the Society and look forward to SPNHC continuing to advocate for the improvement and advancement of our treasured collections.

The next generation in best practices

Emily Graslie
Chief Curiosity Correspondent, The Field Museum, Chicago, Illinois, USA; egraslie@fieldmuseum.org

Technology is evolving at an unprecedented pace - and so must our ability to react to the dramatic changes it has had in our environments, including digital. In order to maintain relevance in the ambiguous social digital sphere, oftentimes these changes must happen spontaneously, in the absence of formal permissions, approvals, schedules, and strategic plans. Emily Graslie is the Field Museum's Chief Curiosity Correspondent and host and creator of the YouTube science channel, The Brain Scoop. Launched in January 2013, The Brain Scoop aims to share the research and collections work of natural history museums with a broad audience. To date, Emily and her team have created more than 170 videos, which have been viewed 18 million times by passionate learners from all over the world. Join Emily as she shares some of her challenges and achievements in creating educational videos for an online audience within the confines of a century-old institution.

Emily Graslie is Chief Curiosity Correspondent for The Field Museum, and the creator, host, and writer for its educational YouTube series, The Brain Scoop. *Launched in January 2013,* The Brain Scoop *aims to share the research and collections work of natural history museums with a broad audience, and across a variety of digital platforms. To date, Emily and her team have created more than 170 videos, which have been viewed 18 million times by passionate learners from all over the world.*

The Great Lakes of Natural History: digitization of museum collections and the future of natural history science

Kirk Johnson
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Museums represent a fundamental tool to understand and preserve Earth's natural and cultural heritage. The International Commission of Museums estimates that there are at least 55,000 museums in 202 countries and more than 7,000 of them contain natural history collections. The museums that exist today are largely the products of the Enlightenment, with the first examples appearing in the late 17th and early 18th centuries. Urbanization, industrialization, exploration, the rise of science, and a growing awareness of the need for conservation and public education led to the founding of many large natural history museums in the late 19th and early 20th centuries. As a result of this timing, most natural history collections were made as the world was being transformed by a burgeoning human population. Ironically, and sometimes intentionally, museums became the undertakers of endangered and extinct species and demolished habitats. Some of Colorado's last bison were some of the first specimens of the Colorado Museum of Natural History, when it opened its doors in 1908. Collections grew during the "great acceleration" of the 20th century and must continue to do so now as the pace of global change quickens. In spite of this need, many museums now find themselves on the endangered list as they see a decline in their numbers of expert curators, collection managers, and the funds to support the collections. The public perception of museums as educational experiences masks their deeper value to human society as the keepers of our knowledge of the world. The very large natural history museums of the world, those with more than 10 million specimens, number only in the dozens. These deep reservoirs of knowledge, the Great Lakes of natural history, hold a surprisingly large percentage of the record of our species' attempt to understand its planet. The tail of the collection curve is held

in thousands of smaller museums, herbaria, and living collections. With a rapidly growing world population, food security, infectious diseases, and invasive species are problems that may find their solution in the genomics of biodiversity housed in museum collections. In a time when languages are rapidly becoming extinct, cultural collections can revitalize communities by reconnecting them with their heritage. Collections of minerals, meteorites, and fossils are the physical evidence of the planet's history, climate, biological evolution, and resource base.

The potential of natural history collections will never be reached if museums do not build the industrial pipelines and open-source platforms to digitize and share natural history data globally. To date, digitization has been a short-term, boutique, zero-sum game for most museums which, forced by budget, must choose between digitization and the traditional modes of collection care and growth. We have reached a moment where the technology exists to transform natural history collections into scientific infrastructure and knowledge that can play a significant role in the solution of 21st century problems. In the face of an increasingly digital era, museums are one of the last bastions of the real thing. Ironically, this is why they must digitize their collections. Electronically, the world's collections can become one world collection.

Dr. Kirk Johnson is the Sant Director of the Smithsonian National Museum of Natural History. He oversees more than 460 employees and a collection of more than 128 million objects—the largest natural history collection in the world. Johnson is a paleontologist who has led expeditions in 11 countries and 19 states that resulted in the discovery of more than 1,400 fossil sites. His research focuses on fossil plants and the extinction of the dinosaurs. He is known for his scientific books and articles, popular books, museum exhibits, presentations, and collaborations with artists. In 2010–11, he led the Snowmastodon Project, the excavation of an amazing ice age site near Snowmass Village, Colorado. This dig recovered more than 5,400 bones of mammoths, mastodons and other ice age animals and was featured in the NOVA documentary, Ice Age Death Trap*, and in Johnson's book,* Digging Snowmastodon, Discovering an Ice Age World in the Colorado Rockies*. Most recently, Johnson hosted the three-part NOVA series* Making North America*, which aired on PBS networks in November 2015, and authored the book* Ancient Wyoming: A Dozen Lost Worlds Based on the Geology of the Bighorn Basin*. Before coming to the Smithsonian, Johnson was vice president and chief curator at the Denver Museum of Nature & Science, where he established the museum's first comprehensive, long-term research and collections plan.*

Emerging resources inspire fresh aspirations—natural history collections as sustainable centers of place-based education and up-to-the-minute research results

Austin Mast
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Does your natural history collection have a Vision Statement? Those ideas—sustainability and education and research relevance—might be elements of it. I will discuss four initiatives that have the potential to inject new purpose and excitement into natural history collections. Two of these are focused on the sustainability of individual collections and their activities: the Society of Herbarium Curator's strategic planning guidance for individual collections and the SHC's training webinar series for our next generation of curators. The third is pilot partnerships with amateur enthusiast groups (e.g., native plant societies) and science classes that engage members in digitizing specimens of interest and value and then adding present-day observations to the historical baseline. The final initiative is a campaign

to recognize collectors and preparators as on the front-lines of observing, documenting, and reporting change in the natural world. I will illustrate these new initiatives using personal experience as a curator and collector and as President of the Society of Herbarium Curators. It is these kinds of fresh initiatives that inspire each of us to take a new look (or a first look) at our collection's aspirations. Vision Statements are an organizational best practice. Think about yours as you participate in SPNHC 2017.

Austin Mast is a Professor in Florida State University's Department of Biological Science, Director of FSU's Robert K. Godfrey Herbarium, Executive Committee Member of iDigBio, and President of the Society of Herbarium Curators. Austin's recent collaborations have produced innovative education and outreach opportunities for the natural history collections community, including the Worldwide Engagement for Digitizing Biocollections (WeDigBio) Event, the Libraries of Life Augmented Reality Cards and Mobile App, and the Biospex Project Management Software. Austin teaches courses on the topics of Field Botany, Plants and Society, and Citizen Science using field opportunities in the species-rich Florida Panhandle.

ORAL PRESENTATIONS, June 21 and 22

Advances in Digitization Worldwide:
an iDigBio Symposium

Herbarium Link - a novel system for the digitization workflow of herbarium specimens

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The Colorado State University (CSU) Herbarium recently developed a novel system for the digitization workflow of herbarium specimens, termed Herbarium Link. Herbarium Link includes three finished components that speed digitization workflow and make the herbarium's online database more accessible to users. First, Herbarium Link associates barcodes with imaged specimens, without requiring that the barcode be re-scanned after the specimen is imaged. Second, from each 20-megapixel specimen image, Herbarium Link creates thumbnail and medium-size renditions as well as 460 tiles for use by OpenSeadragon to enable seamless deep zoom viewing while minimizing upload time. Third, Herbarium Link checks each specimen's assigned taxonomic name against the Encyclopedia of Life (EOL) and Integrated Taxonomic Information System (ITIS) reference databases and generates a list of conflicts for the database administrator to resolve. Herbarium Link also associates the common names and synonyms recognized by the EOL and ITIS with each taxon so that online users may successfully use those terms in their searches. The online database is designed similar to a reference collection of herbarium specimens with a representative thumbnail image present at each level of taxonomy (family, genus, species) in the search. This parallels our in-house reference collection for Colorado. This is a stand-apart collection of specimens, with one specimen represented for every species in the state, which expedites the identification of plants while saving historical specimens from unnecessary handling. Herbarium Link may be readily modified to work with other databases and the source code is freely available at: http://herbarium.biology.colostate.edu/svn/

Disaster Preparedness

The impact of ICTs-based communication modes on citizen participation in flood risk management: a case study of Delfland (The Netherlands)

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The focus of this thesis is therefore to investigate the types of ICTs-based communication modes currently being used by authorities and their impact on the level of citizen participation in flood risk management. This research used Delfland as a case study. Open-ended questions were asked in semi-structured interviews, targeting various categories of citizens, including working class, pensioners, and students, as well as officials of relevant national and regional government organisations. The analysis was carried out based on qualitative empirical research. Findings from the study established that the ICTs-based communication modes used have very little impact on the extent of citizen participation in flood risk management as citizens appear to be listening as spectators. The findings further indicate that there appears to be a lack of awareness on flood risk issues by citizens. Authorities placed much emphasis on flood prevention with no investment in building the resilience of citizens to participate actively in flood risk management. Another finding appeared to be the fact that two-way interaction between the citizens and authorities using these ICTs-based communication modes happened only at the regional level with the Regional Water Authorities (RWAs) and was initiated by the citizens when reporting non-flood risk related complaints and incidents. At the institutional and regional level obstacles identified to impede the use of ICTs-based communication modes and citizen participation included the non creation of awareness by the

authorities of the ICT tools used by them for engagement with citizens. Recommendations on how to deal with the obstacles identified are also presented in this thesis. The main recommendation is for national and regional authorities responsible for communicating flood risk issues with citizens to incorporate awareness creation in their current institutional framework as a strategy.

Innovative Uses of Collections Data: an iDigBio Symposium

Analyzing the University of Colorado Herbarium (COLO) digital collection

J Ryan Allen
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The University of Colorado Herbarium (COLO) has received two ADBC grants and one IMLS grant to assist in the digitization of its collection. At roughly halfway through the process of digitizing our approx. 550,000 specimen collection we have learned some steps and strategies that have helped to create successful workflows and we are now looking into ways to use our data. COLO has digitized the majority of its Colorado material and we are starting to use this information to look for trends within the state and potentially interesting areas of the state to explore. With the completion of georeferencing it is now possible to spatially explore specimen data not just on political boundaries such as state and county, but to analyze the collection using GIS layers such as ecoregion and geology. As we turn our focus from how to digitize the collection to how we will use these data, it seems fitting to better understand what we have and what we can learn about the collection itself. • How are the collections distributed through space and time? • Can we identify underrepresented areas of the state that may be candidates for future field work? • Are there areas of the state that have not been collected? • Are we able to locate potential gaps in species distributions within the state using GIS and digitized specimen data? We will present our findings on collection metrics such as densities, collection biases, and methodologies we hope to use to direct the future of collections at COLO.

Public Access to Collections

Extending the capacity of collections staff: best practices in volunteer recruitment, screening, and placement

Noelia Aponte-Silva
Denver Museum of Nature & Science, Denver, Colorado, USA; noelia.aponte-silva@dmns.org

The Denver Museum of Nature & Science is supported by more than 1,800 volunteers across its entire operation. The Research and Collections Division alone is supported by nearly 700 citizen scientists who volunteer under the direction of the Museum's staff. These volunteer citizen scientists extend the capacity of Research and Collections Division staff through the collective contribution of nearly 80,000 hours annually. This time contribution is equivalent to the support of an additional 40 full-time staff members.

Noelia Aponte-Silva, the manager of volunteer placement for the Denver Museum of Nature & Science, will present best practices in the field of volunteer recruitment, screening, and placement. We will look at ways you might effectively harness the power of the people in your nearby community who are dedicated to supporting the mission of your organization.

New Solutions|Sustainable Facilities

How to use historical buildings to create a scientific venue

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During the last century the Natural Science Museum of Barcelona has become bigger, with a lot of buildings, places, and venues around the city. However, this new idea of a museum "without walls" was also becoming a real problem in the scientific area of the museum that remains spread out in different historical buildings. The museum is working to coordinate and increase the conditions of its collections and to create the new and reborn scientific venue while utilizing its historic buildings. Collections, research, and the scientific library are located in

two different historical buildings situated in Ciutadella Park, while all the public departments are located in a new building, Museu Blau, which is far away from the others. During the last four years the museum has been working on a project to concentrate all the scientific areas into one building, with the objective to improve conditions for collections and staff. The best option is to use The Castell dels Tres Dragons. It was built between 1887–1888 as a Café-Restaurant for the 1888 Universal Exposition of Barcelona by Lluís Domènech i Montaner. At the end of exhibition the building was used to present industrial arts workshops related to architecture and later it was dedicated to museum purposes, being a museum of history, archeology, biology and natural sciences. During the Spanish Civil War it was closed after suffering bombing damage by Franco. Architects and the museum staff are working to define a real and conservative project to renovate this historical and patrimonial building to be used as a modern facility to work and conserve our natural collections. The first stage of the project started in 2016 and is still in progress.

Demo Camp

Evaluating herbarium cabinet capacity using computer vision and data visualization

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Tiana F. Rehman
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The effective curation, use, and growth of a natural history collection is inherently constrained by the physical space allocated for the collection. Without a precise accounting of space utilization, curators face challenges in managing their collections and are hindered in their ability to strategically plan for collections growth. To address these challenges at the Botanical Research Institute of Texas (BRIT), we developed a process utilizing computer vision technology to analyze digital images of open herbarium cabinets, allowing us to quantify the amount of available space within each cubby. Using various computer vision techniques, the images are analyzed to determine the cabinet and cubby boundaries and the fullness of each cubby. The cabinet identifier is extracted from QR codes and human-readable text on labels affixed to each cabinet. This information, when combined with data gathered from all the collection's cabinets, provides BRIT with a valuable tool to help identify segments of the herbarium with limited capacity for growth and areas that might be better utilized. These data, when viewed with a data visualization application created at BRIT, can help determine the physical and financial impact of accessioning new collections and thus better equip curators and administrators to anticipate future funding and curatorial needs.

Advances in Digitization Worldwide:
an iDigBio Symposium

Automating 3D collection capture: developing systems for 3D digitization at scale

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3D digitization of museum collections is largely a boutique operation with lengthy capture and processing times resulting in a high cost and low throughput process for creating 3D digital surrogates. In addition, the raw data created from many 3D scanning methods is proprietary. As processing 3D data inherently involves some amount of interpretation, it is important to maintain accessible raw data. In the fall of 2016 the Smithsonian's National Museum of Natural History Department of Paleobiology and Digitization Program Office collaborated on a two-week pilot project to address these shortcomings and create a path towards scalable 3D collection capture which produces robust, durable data. During the two weeks, 118 high resolution photogrammetry-based datasets were captured of fossil specimens in the Smithsonian collection in a

consistent, standardized fashion. These datasets are now being used to drive the creation of an automated processing pipeline as well as a repository for 3D data at the institution. This presentation will outline the tools and workflows used during production and the resulting developments in processing automation and 3D data management.

Best Practices for Integrating Collections into Education

Putting digitized collections to work in K-12 learning environments

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Kari Harris
Arkansas State University, Jonesboro, Arkansas, USA

Natural history collections are currently undergoing a digital transformation and sharing their specimens online through data aggregators like iDigBio and GBIF. Online collections are more accessible to a variety of audiences and have created many new outreach opportunities. One such audience is K-12 education represented by over 50 million students and 3 million teachers in the United States alone. However, many collections professionals are unfamiliar with how to reach out to, and work within, the K-12 community. In this presentation we will share best practices for reaching out to K-12 audiences including how to incorporate appropriate educational theory, apply effective design and technology approaches, and integrate evaluation and assessment for collections-based learning. We will also provide case studies as examples of how to effectively engage the K-12 students and teachers using digitized natural history collections. These recommendations come from a white paper created collaboratively by collections, education, and digital resources experts that were brought together during a two-day workshop sponsored by iDigBio and Smithsonian Institution.

Public Access to Collections

Beyond access

Treloar Bower
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Using objects to tell stories and engage the public enlivens our museums and delights guests. This session will explore some techniques you can use to take "access" to the next level. The value and richness of the experiences we can provide through collections can be unlocked through creative application of storytelling techniques and historical imagination. Close partnerships between education and programming departments and collections staff can result in powerful and evocative uses for collection items. This session will explore this nexus through the lenses of story and visitor impact.

New Solutions|Sustainable Facilities

Evaluation of energy consumption in Yale Peabody Museum of Natural History

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Tim White, Catherine Sease, Nathan Uthrup, Susan Butts, Richard Boardman
Peabody Museum of Natural History, Yale University New Haven, Connecticut, USA

Stefan Simon
Institute for the Preservation of Cultural Heritage, Yale University, New Haven, Connecticut, USA

In 2016, Yale University was the first institution of higher learning to start a Carbon Charge Project which aim is to test the effectiveness and feasibility of carbon pricing on the Yale campus. Using the university as a living laboratory for applied research, the project aims to inform energy policy, climate change mitigation, and environmental economics by testing multiple models of carbon pricing. The Yale Peabody Museum of

Natural History (YPM) main building is among 20 other university buildings taking part in the project. When carbon charge is fully implemented, it will put additional economic pressure on all Yale museums and libraries. Those institutions are predominantly located in historic buildings, which—combined with the aim of providing strict climate control for the preservation of collections—results in high energy demand. As a consequence, museums and libraries belong to the least energy-efficient institutions on the Yale campus. Therefore, there is an acute need for reduction of energy consumption and lowering CO2 emissions while at the same time maintaining high standards of the collection care.

In this presentation, analysis of energy consumption associated with climate control in the Yale Peabody Museum buildings will be presented. By comparison, both the Environmental Science Center and Kline Geology Laboratory use almost three times more energy than the Peabody Museum building. The main reasons —including occupancy, mixed-use function, and design decisions of the climate control systems—will be identified as well as potential scenarios for improvement and relative impacts.

Impacts of Changing Regulations

The Paleontology Resources Preservation Act and you

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The management of fossil resources on federal land in the United States has been regulated under numerous authorities over the years, beginning with the Antiquities Act of 1906. Since then, agencies have generally developed their own policies independently, consistent with the land management mandates for which they were established. The missions of the National Park Service (NPS) and Bureau of Land Management (BLM), for example, share the goal of preservation of natural resources. However, the NPS does this with a more conservative approach, prohibiting activities like logging, grazing, and mining that the BLM allows under permit. Similarly, the NPS prohibits casual collecting of fossils from its lands, while the BLM allows collecting of common invertebrate and plant fossils for non-commercial personal use up to specified limits. To more consistently manage federal fossils, in 2000 a report to Congress from the Department of Interior (DOI), Forest Service, and Smithsonian was commissioned, providing recommendations for the scientific study, collection, and storage of fossils from federal lands, and served as a reference for draft legislation to protect fossil resources. The resulting Paleontological Resources Preservation Act (PRPA) was signed into law in 2009. The US Forest Service promulgated rules under PRPA in 2015, and the DOI published proposed rules for public comment in December of 2016. These rules aim to coordinate and streamline the diverse policies of the DOI agencies (NPS, BLM, Bureau of Reclamation, Fish and Wildlife Service) and the Forest Service. The rules establish uniform definitions, agency authority, guidelines, and procedures for issuing collecting and research permits, reporting responsibility, and approval of repositories, and also outline penalties for prohibited acts.

Public Access to Collections

All access: transcending the present

Rich Busch
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For a number of years now, we collections professionals have pondered how we might increase access to our collections. Indeed, many white boards and job descriptions alike, have, at one point, held the phrase "facilitate access to collections". But what does this exactly mean? Chances are, you're currently thumbing your way through the gyri of your brain thinking to yourself, "it means a variety of things!" And you'd be not entirely wrong. However, I can probably guarantee there are at least a couple words you didn't think of that you need to start thinking of. These absent words, however few and small they are, represent a few key recognitions that we must internalize if we are to be successful in making our collections accessible. In this talk, I will review a few definitions of what it means

to have accessible collections—and perhaps most importantly: why the "build it and they will come" paradigm is no longer valid. Do not despair, we are on the right path. But we are not there yet—there is still work to do. You might say being stewards of natural history collections is an—evolving—process… I will also explore a few projects that the Education Collections at the Denver Museum of Nature & Science is experimenting with. While not polished products, we feel they will help re-frame what museums should be considering when we say our collections are accessible.

New Solutions|Sustainable Facilities

What is an Environmental Management System?

James Calder
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In 2009, the Denver Museum of Nature & Science implemented an Environmental Management System (EMS) which is a foundation for proactively managing activities that are associated with environmental quality. An EMS is a process the Museum uses to integrate environmental considerations into its day-to-day operations.

The Museum operates its EMS under the International Standards Organization (ISO) 14001 management system guidelines. ISO 14001 is a guiding standard for environmental management systems used by businesses, governments, and companies worldwide. Under the Plan-Do-Check-Act management concept, the standard requires routine EMS audits and continuous performance improvement based on findings.

To meet the criteria of the Plan-Do-Check-Act cycle, the Museum establishes annual objectives and targets in an effort to improve its environmental performance and work towards fully realizing a sustainable business model.

Annual objectives and targets are usually focused on energy and emissions, natural resource stewardship, materials and waste management, land use and transportation, and leading by example.

Audits are conducted by an independent 3rd party and take into account successes and failures of annual plans, compliance issues, and lessons learned.

The Museum is also a Gold Level Leader in the Colorado Environmental Leadership Program, which requires its members to establish, implement, and maintain an Environmental Management System.

Colorado is rapidly gaining national attention as an innovator when it comes to environmental stewardship, with Denver becoming the first large American city to obtain ISO14001 certification of its municipal operations.

Through its EMS and participation in the State Environmental Leadership Program, the Museum demonstrates its commitment to being a role model of sustainability and enhances Colorado's leadership in environmental stewardship.

Public Access to Collections

Girls & Science

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Peggy Day, Treloar Bower
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There have been many conversations regarding the disproportionate number of women in the workforce vs STEAM careers (science, technology, engineering, art and math). Many believe one of the main problems is that as young girls age into middle and high school they lose their affinity for science. At the Denver Museum of Nature & Science (DMNS) for the past three years (2015–17) we have hosted a multi-organizational event with our local CBS affiliate called Girls & Science in an effort to connect girls with women in STEAM careers. This creative take on a career fair invites mentors to create "Science Clubhouses" where girls and their families explore a variety of STEAM careers. These Role Models and their teams work with DMNS educators, programmers, and collections managers to envision, develop, and furnish a Clubhouse

environment that represents their careers with cool "tools of the trade," activities, and visuals that embody who they are. The DMNS has offered the use of its extensive Education Collections to enhance the hands-on experience. Attendance for the one day event in 2015 was 7,400 and jumped to a staggering 11,500 in 2016. This event has given local girls a connection to real female STEAM professionals, giving parents and families a way to encourage the interests of their young girls, and has brought the museum national and international media attention. Hear from the DMNS organizing team, along with a past role model and collections professional.

Disaster Preparedness

Quick disaster response: DMNS adds a tool

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Jude Southward
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Well done! You have a disaster plan in place. Well thought out disaster plans are essential tools for preparing for unthinkable disasters and are the foundation of an institutional disaster response program for collections and business recovery. The DMNS (Denver Museum of Nature & Science) added the new Avenir Collections Center in 2014 and saw an opportunity to evaluate its emergency preparedness plans and supplies. As part of the DMNS disaster plan, staff have access to the Emergency Response and Salvage Wheel™ and the Field Guide to Emergency Response as tools to protect the collections. The DMNS identified the need for quick information that could be distributed broadly. Therefore the DMNS is augmenting its disaster preparedness plan by adding a tri-fold pocket-response guide that is specific to the DMNS collections and facilities. The template used can be shared with sister institutions in the event of a regional disaster in the Denver area. We will discuss how the DMNS is creating a pocket guide to accompany its current Disaster Response Plan and the considerations that go along with its creation.

New Solutions|Collections Management

Survey is in! Design, results & next steps for DOI collections

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The bureaus of the US Department of the Interior (DOI) estimate that they hold 195 million objects and archives in trust for the public, including archaeological artifacts, archives, and paleontological and other natural history specimens. The DOI bureaus work hard to make these museum collections available for research, exhibition, and education nation-wide, particularly through many partnerships. An old problem for the DOI is to be accountable for all its collections, including where they are located, what they contain, and that they are periodically inventoried. DOI currently knows that some 23 million objects and archives are curated by over 900 non-federal partners, such as museums, laboratories, and university departments, many of which are SPNHC members. However, DOI auditors have challenged the bureaus to find all their collections. As a result, DOI recently surveyed more than 200 repositories to locate unknown or little known collections and is devising new solutions to addressing accountability of its collections housed at partner repositories. Terry Childs, Program Manager/Curator, US Department of the Interior Museum Program (IMP), will discuss the Office of Inspector General's report and findings that prompted the survey, as well as other corrective actions. Elizabeth Varner, Staff Curator, US Department of the Interior Museum Program (IMP), will discuss the survey methodology, process, and findings. Speakers will also invite audience input on the next steps to be undertaken that will contribute to new solutions to the old problem.

Demo Camp

Jupyter.idigbio.org: hosted Jupyter notebooks with biodiversity datasets for reproducible research in R and Python

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As part of the Global Unified Open Data Architecture (GUODA) collaboration, iDigBio provides hosting for Jupyter notebooks to the biodiversity community. Jupyter is a popular web-based platform for developing data analysis scripts and applications in R, Python, and other languages. Notebooks implement the literate programming paradigm which combines code, outputs, and documentation all together in the same place similar to a physical lab notebook. The website jupyter.idigbio.org lets users create and run Jupyter notebooks on the GUODA infrastructure based around Apache Spark. Spark is a highly parallel and distributed processing framework and the GUODA infrastructure combines its power with pre-formatted versions of large biodiversity data sets like iDigBio and the Biodiversity Heritage Library (BHL) to let researchers focus on their analysis without the burden of managing data and performance considerations. This demo will show the Jupyter notebook interface hosted at iDigBio, how code development is integrated with version control and public access through the GitHub website, what data sets are already available, and how custom data sets can be uploaded and downloaded from the system.

New Solutions|Conservation

Between a rock and a stone: preparators and conservators in practice

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The field of conservation began with paintings and fine art, but in the last two decades, with an increase in training opportunities and a greater recognition of necessity, it now encompasses so much more. Conservators treat nearly every type of museum object: ethnographic and archaeological artifacts, photographic and digital materials, wall paintings, textiles, and a diversity of natural history specimens. In the field of paleontology, however, the preparator rules. Much of a preparators' work looks like that of a conservator specializing in stone or archaeological material. Indeed, one might imagine the methods to treat (or "prepare") a fully mineralized fossil might be very similar to those used to conserve (or "restore") a stone sculpture while subfossil specimens might be treated like archaeological material. Yet a review of conservation literature across these disciplines shows a stark difference in best practice. Professionals in each field have a wealth of knowledge and a particular skill set that is not only crucial to conserving their chosen material but also has interdisciplinary worth. As paleontological museums move toward the future, conservators and preparators must establish an open dialogue to enhance knowledge in both fields and to best preserve the most ancient past.

New Solutions|Sustainable Facilities

Design for flexibility: what can be learned from what has been done

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Tim White
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The trend of the past decade has been to design collections care spaces, labs, and storage areas for flexibility, enabling current and future users to make changes as processes, staffing, and collections care techniques change. Four presenters from different institutions will discuss how the spaces they built were (or were not) designed for flexibility, and the impact of the range of design solutions on their ability to tailor their space for their evolving needs. Each presenter will provide a ten-minute overview of how their institution addressed

space flexibility during design, and the key design elements that provide their definition of flexibility. A panel discussion of key questions will follow: •Was the design criteria for flexibility important, or was it a concept that has not been needed? •What are the most critical elements to make flexible and what drove those needs? •What building systems changes are required or can these changes be avoided? •Is it more about furnishings and equipment and less about walls and building systems? •Is flexibility more important when space is limited? •How would you define flexibility now? •What would you do differently to improve flexibility? Following the panel discussion, the audience will be invited to ask questions and offer their own experiences.

New Solutions|Sustainable Facilities

DMNS Avenir Center—post occupancy evaluation

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Design with staff engagement requires time commitment and a responsive design team to achieve the best outcomes. Perfection is impossible: solutions are often somewhat compromised based on poor early scope definition, unrealistic expectations, costs, staff being over-ridden by leadership or design team, and other factors. Avenir had extensive staff engagement, and some challenges to ideas based on costs, codes, and other issues. This session will present post-occupancy evaluation results based on interviews with several collections staff in 2017 as to the performance of the Avenir Center based on early goals and final outcomes. Key topics to be discussed are: public access, lab layouts, shared workspaces, flexibility in collections management workspaces, and sizing of various spaces. This honest appraisal will provide the basis for recommendations applicable to any project of any size.

New Solutions|Collections Management

Fossils on the move: managing the Paleontology Collection moves at the Museum of Comparative Zoology, Harvard University

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The Museum of Comparative Zoology's Invertebrate Paleontology and Vertebrate Paleontology collections moved to a new collections space in 2014 and 2015. This was part of a major rehousing of all or parts of eight MCZ collections to space in the adjacent Northwest Building on Harvard's campus. The state-of-the-art facility consists of laboratories, special preparations areas, a classroom, work areas for curatorial staff, students and visiting scientists, and climate-controlled collections storage rooms. The collection move process was a coordination between MCZ staff and a professional moving company. The paleontology collections were the last collections slated on the move timeline and had the benefit of learning from the other collection moves. This presentation will cover the process used for moving the MCZ's paleontology collections—specifically, what worked well to keep the specimens safe and the move on schedule.

New Solutions|Conservation

A new trick for old eyes—contact lenses for taxidermy

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In taxidermy, the eyes are the focal point of the piece. In older taxidermy, delamination of the posterior portion of the glass eye yields a cloudy cataract-like appearance. Correction of this problem is a challenge and no known method has been shown to be safe and effective. The most common and logical solution is to remove the existing eye and either repair it, or replace it with a new eye altogether. This task is extremely

invasive, and can be damaging to the specimen. Due to this risk, we are proposing a new method of restoring eyes involving creation of a thin reversible lens which overlays the existing damaged eye. Our process begins by making an alginate mold of the specimen's eye. The mold captures not only the glass shape, but also the shape of the opening, lid placement, and angle of set. A positive is then cast from the mold and tooled to be used as a vacuum formable part. Various lens materials will be tested for stability and aesthetics. The lenses will then be painted and adhered to the existing eye with minimal material around the perimeter of the eye opening. Variations are also being tested using photographs printed on fabric and adhered to the back of the lens, thus eliminating the process of painting. The anticipated results will be an undetectable prosthetic that corrects a problem, is stable, and completely reversible.

Public Access to Collections

Access granted: sharing your unique collections with an audience

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One of the fundamental characteristics of any public program at the Denver Museum of Nature & Science (DMNS) involves incorporating and featuring our unique collection and staff assets. We preserve and tend to so many incredible objects—so many with a compelling a story to tell. DMNS After Hours and Science Lounge programs reflect the interests of our adult audience—and these attendees expect us to deliver some unexpected, "holy cow" moments. DMNS program staff have for years worked alongside research and collections staff to select objects that enhance program themes. Often it is an object from our collection, or a conversation with collections or research staff that delivers the "I-can't-wait-to-tell-people-about-this!" moment. Within the bounds of protocol, we allow the audience to interact with objects in a way that is fun and meaningful to them, including asking questions, touching objects, if appropriate, and, of course, selfies. Here's a tip—an articulated, mounted ground sloth is uber-popular for selfies! The Director of Museum Programs will share program highlights and answer your questions about how to provide new and engaging ways for adult audiences to access and appreciate your museum's treasures.

New Solutions|Conservation

Natural geologic materials in art, anthropology, and historical collections: issues & communication

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Geologic materials can be found in many forms in fine arts, historical, and anthropology collections. They may be used in their original natural forms, or they may be included in composite objects. Some geologic materials have been modified by carving or cutting. In this category are traditional stone sculptures and decorative work, such as gemstones, beads, intarsia, mosaic, spheres, etc. In some cases, minerals or rocks have been ground into powder for use as pigments or as painting ground. There are also instances where an artist uses a raw piece of mineral or stone as a surface on which to paint or draw. The standards of care for geologic collections may not conflict or differ from standards used for care of art, anthropology, and historical objects. However, there are some issues that are unique to geologic materials and so may be unfamiliar to someone caring for these other types of collections. It is important that natural history collection professionals make themselves available to other curators and conservators in other institutions. This usually involves some outreach and possibly cross-discipline education.

Advances in Digitization Worldwide: an iDigBio Symposium

Interoperability between GEOLocate and Symbiota software: collaborative georeferencing within a large scale digitization project

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The Southeast Regional Network of Expertise and Collections (SERNEC) is a Thematic Collections Network (TCN) focused on digitization of over 4 million herbarium specimens from the southeast United States. In order to meet SERNEC's primary goal of generating a research ready dataset for public use, all metadata records will be georeferenced. Given the large number of specimens to be digitized and the size of the herbarium network, GEOLocate's collaborative georeferencing tool is well suited for the network's needs. Symbiota is a platform for creating specimen-based biodiversity information communities online. SERNEC is utilizing both of these tools in order to meet its goals. Newly built functionality between these two software packages will provide a stable and efficient platform for georeferencing specimens. Specifically, interoperability between GEOLocate and Symbiota was extended by adding a set of web services to their API libraries that allow project managers to coordinate real-time data augmentation through the two applications. Several user interfaces were created within Symbiota that give collection managers the ability to push data packages of non-georeferenced occurrences from a Symbiota portal into a targeted GEOLocate community expedition. Global unique identifiers and Darwin Core Archive transfer protocols are implemented to enable coordinated record flow between the two applications. The collaborative georeferencing tools also allow SERNEC to engage with its wider group of stakeholders to crowdsource the georeferencing tasks within online communities that are built within the system. We will give an overview of these newly built functionalities and present how these create an efficient workflow for georeferencing in a collaborative environment. We will also describe how data provenance is handled in the system and how other projects can leverage these new tools.

Public Access to Collections

The Notes From Nature project: evolutions and revolutions in enhancing engagement with data providers and citizen scientists

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Notes from Nature (http://www.notesfromnature.org; NFN) is a citizen science tool focused on public engagement and label transcription of natural history specimens. The project was developed collaboratively by biodiversity scientists, curators, and experts in citizen science within the well-established Zooniverse platform. This project currently brings together digital images representing a wide variety of biodiversity records such as ledgers, herbarium sheets, pinned insects, and fossils. Volunteer citizen scientists transcribe textual data contained in the specimen images. Since its launch in 2013, NFN has amassed >1.2 million transcriptions from tens of thousands of volunteers worldwide. This

talk focuses on innovations aimed to improve the platform—some incremental and others totally changing the way Notes from Nature works. We discuss improvements such as: 1) Tools to build consensus and quality metrics for the transcriptions to further enhance data quality for museum curators; 2) Better workflows to support image loading and repatriation of data to our providers; 3) Improved engagement about biodiversity by bringing in rich content from external sources such as Encyclopedia of Life and Map of Life. We also discuss engagement efforts and interoperability with other biodiversity informatics tools and databases that are important to our partners' curation needs. Such improvements help NFN take its place as a critical component of an ecosystem of tools needed to unlock the vast legacy biodiversity data for broad public good.

Best Practices for Integrating Collections into Education

Asking and answering questions: using a flexible querying tool to support data exploration and hypothesis testing in a variety of courses

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The Animal Diversity Web (ADW, animaldiversity.org) is a large, global, digital natural history database developed at the University of Michigan Museum of Zoology. It is a systematic, online collection of animal natural history that is built through the participation of students and faculty across North America. The result is a rich, structured database that brings information that originates in museums, including primary research results in comparative biology and specimens in collections, into classrooms around the world. By making these data both accessible and discoverable, ADW has transformed the way that students learn biology and expanded access to critical education resources in institutions that lack museum resources. With ADW's querying tool, built on the database, students can discover for themselves the fundamental patterns and concepts taught in organismal biology, evolution, ecology, and conservation biology courses. This is an important innovation that addresses the national emphasis on transforming the teaching of science. We must train students to become fluent in the practice of science through formulating questions, finding and analyzing relevant data, and communicating their conclusions. The ADW model, in which a mechanism for collective contributions to a well-structured database is created and implemented as a way of organizing information and materials, could readily be adopted by other museum disciplines. The resulting resources can then be used to significantly enhance public awareness of museum resources and their importance in society. Once those organized, digital collections are created, they can be used as important tools to transform and improve the way that we teach. Students can then find and explore materials on their own and ask new, unanticipated questions.

New Solutions|Conservation

Using FTIR to identify slide mounting media: a first step towards best practices in the care of slide mounted specimens

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Since the first half of the nineteenth century, researchers have been interested in observing specimens under microscopes. This created the need to find substances to mount the specimens for future observation. However, not all substances worked the same way for all the specimens, pushing the need to find better ones to either improve stability or clarity of the mounts. Today, many slide collections contain multiple mounting media. A survey is underway at the Smithsonian NMNH to learn which media have preservation issues and what kinds of issues these present. This survey includes

identifying the mounting media to understand those prone to rapid deterioration and those appropriate for long-term storage. The identification is performed both visually and with the help of an Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR-FTIR) instrument. So far, 50 samples have been taken from either discarded slides or from vials containing mounting media. ATR-FTIR identification has shown that mounting media are easily confused visually. Canada Balsam may be visually equivalent to Euparal. The synthetic media that have excellent long-term preservation like Eukitt, Flo-texx and Shandon synthetic mountant can be confused with one another. ATR-FTIR has been shown to be a poor method for identifying Hoyer's. However, ATR-FTIR is a quick and efficient way to identify many media, help understand deterioration, and aid in the preservation potential of the media, thus informing remediation plans and efforts to define best practices for care of these collections.

Demo Camp

More than a map: adventures in biodiversity informatics visualization

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Visual analysis can play an import role in evaluating biodiversity dataset scope, quality, and fitness-for-purpose. We present a series of interactive data visualizations exploring techniques to characterize available collection data, illustrate the status of collection digitization, and identify potential gaps in data for particular use cases. Examples are drawn from The Academy of Natural Sciences of Drexel University's historic collections and data available through aggregating portals such as GBIF and iDigBio.

New Solutions|Collections Management

Federal collections stewardship at a university museum: developing department-wide policies for the care and management of research specimens from public lands

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Academic museums and collections are integrated within their departments or colleges to varying degrees. For those that share specimens or management practices with an academic department, the changes to policies regarding samples collected on public or protected lands can present challenges to coordinating sample management among the collection's contributors. The University of Wisconsin Geology Museum (UWGM) was founded in 1848 as part of The Department of Geology (now Geoscience). The UWGM collection hosts thousands of publicly-owned specimens, and Department of Geoscience faculty routinely also collect research specimens from public lands. It was vital to adopt uniform standards for the collection and management of such specimens across both units to better manage available repository space, streamline annual reporting requirements, and preserve essential sample data for the long term. The UWGM, together with the Department of Geoscience Repository Committee, developed department-wide policies for collecting, documenting, and reporting on samples collected from public and protected lands. Together, we have improved the management and oversight of publicly-owned samples, created institutional buy-in for best practices in sample management, and eased the burden of departmental reporting requirements by leveraging the curatorial expertise of the UWGM staff. Such policies could be similarly applied for permanent collections that share resources with a central academic or research institution.

Best Practices for Integrating Collections into Education

Natural history collections data and Biodiversity Literacy in Undergraduate Education (BLUE)

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Natural history collections (NHCs) are one of the richest sources of information for documenting earth's biodiversity across both space and time. As collections data become more accessible through the many digitization efforts (such as NSF's Advancing Digitization for Biological Collections Program), many new research and educational applications for specimen data are being realized. When data from NHCs are combined with emerging ecological data resources (NEON, USGS, etc.) the power to address research questions of global concern and engage students in data-based independent and guided inquiry is profound. With the publication of the NSF/AAAS document, *Vision and Change in Undergraduate Biology: A Call to Action*, the recent American Institute of Biological Science initiative, "Leadership in Biology," and other federal reviews of STEM education in the US, there is national recognition that the next generation of college graduates must be skilled in communication and collaboration, have quantitative competency, possess the ability to understand and interpret data, and be comfortable working with large databases. Specimens and data from NHCs can serve a unique role in addressing Vision and Change recommendations as museum specimens and associated digital data provide significant opportunities for authentic undergraduate research experiences, and provide a valuable resource to teach about the iterative process of science, data literacy, critical thinking, quantitative biology, communication in the sciences, and biodiversity informatics. These skills can be integrated within the context of exploring topics, including climate change, spread of disease, species conservation, interspecific interactions, and invasive species. The place-based capacity of collections data combined with the social and societal relevance of biodiversity can also serve a role in creating inclusive, culturally relevant, and socially conscious educational materials that engage a broad audience in biodiversity science. Biodiversity Literacy in Undergraduate Education (BLUE; biodiversityliteracy.com) is a new initiative that brings together communities of biodiversity, data, and education specialists to develop effective strategies for sustained development and implementation of biodiversity and data literacy education. Here, we present examples of activities developed by BLUE, and BLUE partners, that highlight the use of NHC data in undergraduate biology courses. We will also discuss ways one can join the BLUE network, participate in BLUE activities, and share and disseminate resources through the growing BLUE network.

Public Access to Collections

Worldwide Engagement for Digitizing Biocollections (WeDigBio)—the biocollections community's citizen science space on the calendar

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Digitization of biocollections, including herbarium specimens, is an ongoing and critical task that has been galvanized by technological advances and new resources, including innovations in crowdsourcing and citizen science. Involving citizen scientists in the digitization process increases their awareness of the number, kinds, and value of biodiversity specimens in collections, advances scientific literacy, increases support for biocollections, and builds sustainability for digitization activities. In turn, growing digital biocollections databases have direct implications for the global community who make use of those data for botanical research, education, and to inform policy. To build support for biocollections and their digitization activities and to increase digitization rates, we organized the annual Worldwide Engagement for Digitizing Biocollections (WeDigBio) Event. In the two years of the event, dozens of museums and classrooms have hosted onsite digitization events where participants transcribed specimen labels using one of five online platforms (DigiVol, Les Herbonautes, Notes from Nature, Smithsonian Institution's Transcription Center, and Symbiota). Thousands of additional citizen scientists also contributed online from more than one hundred countries, completing tens of thousands of transcription tasks. Planning and executing WeDigBio events required us to find efficient ways to integrate disparate transcription and participant data across platforms and projects. Here, we present information on the process of organizing an international citizen science event, an analysis of the event's effectiveness (e.g., transcription rates before, during, and after the event), lessons learned, and future directions.

Innovative Uses of Collections Data:
an iDigBio Symposium

Innovative inventory: shedding light on dark data and creating new collection tools

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The Invertebrate Paleontology collection at the Natural History Museum of Los Angeles County was estimated to contain between 3 and 4 million specimens in 2014, upon the arrival of a new collections manager. Over the past two years the collections staff, with the help of volunteers, have undertaken a detailed drawer-level inventory project, which has gathered data on geography, stratigraphy, lot and specimen counts, taxonomy, curatorial quality, and archival needs. That estimate has now grown to be between 6 and 7 million total specimens, and the inventory has also generated rich contextual data about the collection's composition, curatorial needs, and research potential. Although the inventory is currently 80% complete, it has already proven invaluable as a collection management and research tool. The inventory has helped prioritize specimens entering the digitization workflow and increased efficiency as part of the NSF EPICC Thematic Collections Network project. It has also buttressed additional funding requests in allowing precise estimates of collection size and composition, required conservation materials, and workflow time analysis. Progress has begun towards the goal of allowing the inventory to be searchable on the NHM website, together with whole-drawer imagery, permitting unprecedented access for researchers and others interested users across the entire collection. A detailed inventory that can be regularly updated allows for the streamlining of processes that were once arduous, such as searching for localities or fulfilling researcher requests. More importantly, this innovative use of data enables us to see and present the collection to researchers in new and exciting ways.

New Solutions|Collections Management

Preserving and promoting access to field notes in natural history collections

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Collection managers are often charged with managing and preserving field notes and other primary source materials. Archival materials require the same level of curation as specimens in natural history collections, but many museums are not prepared to manage them. The Museum of Vertebrate Zoology (MVZ) formalized its archival collections in 2012, which has significantly increased the use of our collections and allowed us to document our process. Focusing on field notes, we will share our best practices for managing, preserving, and digitizing archival collections. Specifically, we will provide tools for collection managers who lack resources for institutional archives and library services. We will (1) provide a workflow for accepting and accessioning materials, (2) discuss how archivists conduct surveys and appraisals, with examples of forms used for these activities, (3) cover Deeds of Gifts documenting the transfer of records to establish provenance of materials, (4) discuss descriptive standards and systems used for managing archival collections, and (5) describe basic preservation measures for ensuring long-term access. We will focus the second half of our presentation on digitization and access to field notes, and will (1) provide guidelines for choosing file types and resolutions that allow digital preservation and access, (2) discuss volume versus page level metadata, and (3) present examples of online access to field notes for the library, archival, and scientific communities. Our goal is to foster discussion on the needs of collection managers and on how the SPNHC community would benefit from a portal aggregating these types of materials.

Disaster Preparedness 4

Emergency preparedness at the Museum für Naturkunde, Berlin: the end of a long and winding road – a case study

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Despite numerous smaller and larger incidents during the 200 year history of the Museum für Naturkunde in Berlin, disasters affecting collection specimens were dealt with in a fatalistic way rather than in an organized and well-planned manner. In the absence of disaster plans, collection staff reacted to disasters small and large in an ad-hoc fashion based on their joint experience and their knowledge of available equipment, resources, and manpower. This is caused in part by the unique history of the museum being located just behind the former Berlin Wall but also due to the fact that recent issues of preventive conservation only slowly trickled into the management of collections over the past decade. Facing a history that includes fires, floods, bomb hits, war action, and a crumbling building shell under leaking roofs, an upgrading program of the infrastructure went under way. At the same time, different aspects of preventive conservation were addressed in workshops and seminars leading to a greater awareness towards the need to be prepared for disasters affecting collection specimens. In a joint effort, a disaster plan was drafted for the collections halls on different scales and equipment for the recovery and initial treatment of specimens was purchased. This presentation by the disaster preparedness team highlights the development and current implementation of a disaster plan for the collections of the museum.

New Solutions|Conservation

Deteriorating microscope slide mountants at the Canadian Museum of Nature: experimenting with some remedial approaches

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The Invertebrate Collections at the Canadian Museum of Nature contain a wide variety of taxonomic groups, and with that, as well comes specimens (or parts) mounted on microscope slides. The corresponding mounting media also appear to be quite varied: from traditional, natural

resins like Canada balsam, to water-based glycerol, to synthetic products such as Permount. Unfortunately, the selection of these mounting media by individuals donating slides to museums is rarely based on long-term preservation; some of the factors involved often include ease of use, refractive index, rapid curing, low toxicity and ability to preserve stains. Over time, many slide mounts show deterioration in the form of annular rings, typically resulting from gradual crystallization, crazing or shrinkage of the mounting medium from the outer edge of the cover slip toward the center. Through this process, the mounted specimens obviously risk losing all value. To develop remediation techniques to mitigate this risk, we experimented on two sets of slides that already showed advanced deterioration: a "freezer treatment" was applied to a set presumably mounted with Permount, while a "water-solvent treatment" was applied to another set with a glycerol-based mounting medium. In both cases, after the deteriorated mountants were manually removed under a stereomicroscope, the specimens were successfully remounted in Canada balsam (still our preferred mounting medium), especially when they were not yet fully contained within the deteriorated portion of the mounting medium. The methodologies are summarized and discussed, along with the dos & don'ts and further suggestions to improve results.

Disaster Preparedness 1

Disaster preparedness in museums—risks and incidences in natural history collections and beyond: an introduction

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Museum collections are subject to a number of potential threats. These include natural agents of deterioration, such as pests, human misdemeanor, like vandalism and theft, and the exposure to physical forces, such as shock, vibration, or even fire and water. These factors can quickly lead to situations that are disastrous to the collections specimens. To limit the damage in case of a disaster in a museum collection, museum staff are advised to take some action prior to a disastrous event in order to be prepared for a possible emergency. This ensures quick and adequate response to the individual situation and prevents avoidable time loss in the aftermath of an incident. Thus, disaster preparedness in the form of individual emergency plans for each collection storage area, networking, and trained personnel will assist in immediate and state-of-the-art disaster response. Numerous examples from natural history and other types of collections that were affected by smaller or larger disasters illustrate the need for increased awareness of potential hazards and, on the practical side, a need for good planning and networking to be prepared when disaster strikes.

New Solutions|Conservation

Chicago's Bushman revisited

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Changing public access to Bushman, a singular and significant taxidermy specimen at The Field Museum of Natural History (FMNH) in Chicago, led to an in-depth investigation of his condition, preservation, taxidermy, previous repair materials, treatment choices, and lighting decisions. This investigation was accomplished in collaboration with collection managers, curators, library archivists, exhibition team members, and two contract conservators. This paper reviews Bushman's original preparation, describes analyses confirming the materials, presents unique film footage of the process, and reviews the recent conservation treatment. Bushman is a Chicago icon. He was brought to Chicago's Lincoln Park Zoo in 1930, rescued by missionaries' when orphaned as an infant in Cameroon. His death in 1951 was mourned

throughout the city. After his death, he was prepared as a specimen for exhibit at the FMNH by Leon Walters, Frank C. Wonder, and Joseph B. Krstolich. The preparation involved innovative skin replication techniques that were developed at FMNH by Walters for preparing reptilian skins using colored layers of cellulose nitrate to replicate the delicate and complex colors. Walters modified this technique to create individual characteristics in skin and facial patterns. For this project, archival information about Walters and Bushman was assembled, including photographic documentation, in-house memoranda, preservation and tanning recipes, and unique film footage. In addition, in-house analyses of hair, synthetic resin, and paint samples informed current conservation and preservation choices.

Best Practices for Integrating Collections into Education

Using big data in undergraduate courses

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NEON, the National Ecological Observatory Network, is an NSF-funded large facility designed to provide standardized, persistent, broad-scale data, samples, and research infrastructure that enables detection of changes in ecosystem services. NEON collects data and samples using a combination of field sampling, sensors, and airborne remote sensing measurements at varying space and time scales from 81 field sites across the U.S. for the next 30 years. A primary product of NEON is freely available, open access data—data that are complementary to natural history collection data across the U.S. In addition, some NEON specimens and samples from field sites will be available by request for further analysis and research. Using NEON data, however, may not be an easy task for students and faculty who are not familiar with "big data" access, management, and analytic methods. The same challenges also face people using large, diverse collection databases. Furthermore, ecological data is usually messy in the sense that variability and uncertainty are important components of data analysis and interpretation. Given these challenges, how do we accelerate the use of diverse, "big" data in undergraduate courses?

Public Access to Collections

Strategies to engage high school students in natural history collections

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Many high school science teachers do not regularly use natural history collections to engage their students. It is our observation that connections can be made between the NextGen Science Standards and natural history collections. In the spring of 2017 we will be collaborating with local area teachers to demonstrate how collections and online citizen science platforms such as Notes from Nature can be used in high school classrooms. These hands-on and real-world experiences provide a great opportunity to spark student interest in biodiversity and the natural world. They also provide us with the opportunity to express the importance of collections to the next generation.

New Solutions|Conservation

A lure to take the biscuit: a *Stegobium paniceum* pheromone trial at WSY herbarium

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An effective pheromone lure has not been available for several decades to control the breeding population of the traditional herbarium (biscuit) beetle. That is,

until now. The Royal Horticultural Society's herbarium (WSY), based in the Laboratory at RHS Garden Wisley, has recently taken part in a small trial of a pheromone lure, currently commercially unavailable in the UK, to attract male *Stegobium paniceum*. The herbarium contains over 83,000 ornamental plant specimens that have been pressed, dried, and mounted on thick card. Although annually frozen, a population of Stegobium has been able to thrive in the collection area. This made the herbarium ideal to trial the new pheromone lures. The trial was undertaken during August and September 2016. Lures were attached to crawling insect monitor glue pads, held within a hanging frame, and positioned around the collection area. Control traps lacking the lures were placed in close proximity to the traps with lures. Results indicate that many more Stegobium were attracted to the lures over and above the traps without the pheromone. Beetles were still being caught long after the manufacturers' recommended replacement time of one-month, indicating the potential effectiveness of the pheromone lure. The trial has indicated where the epicentre of the problem is likely to be, in addition to culling some of the breeding stock. This is enabling the RHS to target specific areas for treatment.

Public Access to Collections

Increasing capacity: a fresh look at effectively managing collections volunteers and interns

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The EcoTarium is a small to midsized museum in Worcester, MA. Three years ago they hired their first Collections Specialist in over 13 years for a 3-day-a-week position. As with many small museums, the task ahead for this employee was enormous. Approximately 50,000 pieces which had never been inventoried, and less than 1,000 objects were entered in the Collections Management Database. Through a two-year IMLS grant, the Museum has been able to focus on streamlining collections volunteer and intern management through the creation of a new Volunteer-Based Inventorying System (VBI). The department is now consistently inputting over 3,000 database entries a year on top of its normal functions through the use of volunteers and interns. This talk will focus on lessons learned through this grant and applicability to other institutions both large and small. Although the speaker will briefly mention areas including recruitment and infrastructure upgrades which were part of the grant, the main focus will be on volunteer training including creation of training guides, instituting a system of checks and balances, identifying issues with project workflow, and data security and management.

New Solutions|Conservation

3D printing as a means for casting proportional replicas used in the conservation of articulated skeletons

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The anatomical accuracy of natural science specimens is important for their use in education and display. This presentation will explore the use of laser scanning and 3D printing to recreate missing elements of an articulated brant goose skeleton (*Branta bernicla*) from an educational collection in the Ornithology Department at the American Museum of Natural History (AMNH). The articulated skeleton was conserved during a treatment course at the Conservation Center of the Institute of Fine Arts, New York University (NYU). In current practice at the AMNH, molds taken from other specimens of the same species are often used to cast reproductions to replace elements missing from an articulated skeleton. However, the goose specimen in this case study is larger than other brant specimens at the AMNH, so casts made in the usual way would not have been proportional to the skeleton. To create replicas of the required size, the analogous bones from a smaller specimen were laser

scanned at NYU's LaGuardia Studio, a facility providing advanced digital media services to faculty, students, and visiting artists. The scans were enlarged using modeling software and then used to 3D-print a model of each bone in ABS plastic. Because the plastic used in 3D printing has poor long-term aging characteristics, the printed models were then used to create silicone molds from which casts were made in a stable epoxy. This presentation will explain the application of the 3D printing process to this conservation treatment, as well as the benefits and disadvantages of the method.

New Solutions|Sustainable Facilities

Collection centers: what museum professionals should know about design and construction

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Designing and then building a collection facility brings with it a host of challenges that demand the close participation of museum professionals throughout the process. Architects, engineers, and other consultants will lead the effort, but collection managers, conservators, and others entrusted with protecting cultural heritage provide the functional requirements of the space and determine the qualities of the collection environment. Their participation is critical in making sure the design team has a full understanding of institutional goals, the specific needs of its collections, and the way people within the organization work. It's a tall order for people who usually approach capital projects with little (if any) previous experience with building design and construction, with tremendous institutional pressure to deliver a successful project, and with a job that already demands a great deal of time.

This session will use the story of DMNS's Avenir Center as an example of how a strong and collegial relationship between the museum, its design team, and ultimately its construction team can manage the many pitfalls that threaten a project: budget, schedule, ambitious energy and sustainability goals, and an urgent criteria to give Denver a flexible and robust facility to accommodate the next 25 years of collection growth. Because DMNS staff were prepared for the project ahead of time, immersed themselves in the design team's investigations, and stuck with the effort to the end allowed them to get what they wanted out of the project.

Best Practices for Integrating Collections into Education

From obscurity to prosperity—innovative approaches to broaden diversity and the future of natural history collections

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Curators and collections managers were once thought to be hidden in the dank and dusty basements of museums, relics taking care of relics. Over the years, this stereotype has eroded. Our professions have been increasingly showcased in the media, educating the public about our roles as museum professionals and our contributions to society. As the light has begun shinning into our "basements" why have we not seen a significant shift in the demographics within our careers? Is there a way that we can use our collections to raise awareness about our professions to underrepresented populations, thus allowing students to experience these niches in the biological sciences hands-on? Yes! I have had the privilege of being on the steering committee for a project, funded by iDigBio through a grant from the National Science Foundation, which focused on broadening minority participation in the biological sciences. The project included three workshops and two shadowing opportunities. Here I will discuss the evolution of these workshops and shadowing opportunities, from idea, to marketing, and final implementation. I will outline ways

that these ideas can be implemented across institutions that maintain natural history collections. Using our collections in this manner is a way in which we can help guide and broaden the diversity of the next generation of curators and collections managers. Such an effort is paramount if we are to create and maintain a vibrant and diverse community of museum professionals.

Public Access to Collections

Measuring the success and impact of crowdsourced transcription using CitSciScribe

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Over the past decade we have seen more and more museums turn to the power of the crowd to solve one of our oldest problems—data transcription. Across the world thousands of volunteers have transcribed hundreds of thousands of records. These initiatives create a wonderful avenue through which to engage citizen scientists, however the cost effectiveness of crowdsourced data is often contentious. We, at the North Carolina Museum of Natural Sciences, decided to become involved in utilizing the power of the crowd and our transcription project, CitSciScribe, launched in June of 2016. The project uses a three-tiered model where participants transcribe data records, then expert citizen scientists review the transcriptions, and accept or reject them based on the rate of error. Finally, collections curators add the approved transcriptions to the online database, making the data globally available. Here I evaluated the impact of our project from both a museum and citizen scientist perspective. First, I quantified the error rate and time invested in data clean up. By comparing these data against the staff time necessary to yield equivalent transcriptions, I created a cost effectiveness model of CitSciScribe. Second, survey data gathered from transcribers allowed me to address the success of outreach and educational goals. My analyses provided a framework for measuring efficiency and designing improvements for our project. As museums continue to struggle with limited staff and funding, crowdsourcing may be the option that propels long-dormant paper data into the digital realm.

New Solutions|Collections Management

More than just specimens in drawers: creating a digital framework to connect analog archival data to fossil specimens in the USGS Paleontological Collection at the National Museum of Natural History

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The Smithsonian Institution National Museum of Natural History Department of Paleobiology (NMNH Paleo) manages the largest fossil reference collection for U.S. Geological Survey (USGS) paleontology and stratigraphic research and geologic mapping. The importance of these fossils and associated records is invaluable for our understanding of the geology and paleobiology of North America, particularly because these collections were made within the context of decades of incomparable, cumulative USGS research and mapping activities. The contextual data associated with the fossils is rich and is contained within USGS field books, reports, maps, stratigraphic columns, and publications. These associated records—data that make the specimens important for scientific research—are often weakly associated to the physical specimens. The specimens at NMNH are organized based on USGS schemes and institutional knowledge. To determine where a specimen was collected, you must refer a number written on the specimen to paper records stored at a separate facility. Often, NMNH has fossil specimens, and USGS has the associated data (field books, annotated maps, etc.), or vice versa. NMNH Paleo is working with the USGS to curate specimens and archival material and manage the collection

data in Specify 7 so the collections are accessible for new research and are discoverable through the many contextual links to USGS research. Meeting this goal requires the use of archival data standards for associating records and datasets (such as field books and annotated maps) and utilizing natural history informatics best practices for mobilizing the specimen data online.

Impacts of Changing Regulations

The role of the Registrar—a new position for the University of Michigan Museum of Zoology and Herbarium

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The University of Michigan Museum of Zoology (UMMZ) and Herbarium (MICH) have recently experienced an organizational change, which resulted in the hiring of a Registrar in August of 2016. This position was primarily created to maintain relevant permits and ensure compliance in an ever-changing landscape, oversee specimen transactions, standardize museum policies and procedures, and be a liaison within the department. However, after nearly 180 years of seven individual collections operating autonomously from one another under the umbrella of two different museums, how does insertion of a single Registrar for all of these entities work? How does a Registrar convince these individual groups to cooperate and unify their procedures after so many years of independence? Each collection within the UMMZ and MICH has their own nuances and independent needs, which now have to be combined and streamlined by the Registrar in order to update the policies and procedures for each museum. Further complicating matters, the UMMZ is in the midst of moving all collections off-campus to a newly renovated facility with MICH; all the while, both museums have also recently transitioned to Specify for specimen databasing and transactions. While this timing appears hectic, it is relatively convenient for initiation of changes that will increase the organization and maintenance of collections records moving forward. Regardless, the Registrar has their work cut out for them!

New Solutions|Collections Management

George Wieland and the cycadeoid collection at the Yale Peabody Museum

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With over 900 trunks and more than 1000 thin sections and glass negatives, the Yale Peabody Museum of Natural History has the largest collection of cycadeoids in the world. These trunks have provided more than 5000 cut blocks and fragments for study. The significant holdings of cycadeoid specimens from France, Italy, Japan, United Kingdom, and United States result in part from the collection and research by George Wieland, the Peabody Museum's first paleobotanist. The majority of these cycadeoid specimens were collected from the Black Hills, South Dakota during the late nineteenth and early twentieth centuries by H. F. Wells, an agent of Othniel Marsh, and George Wieland. Additional US cycadeoid specimens were also collected from Arizona, Colorado, Maryland, Kansas, Nebraska, Texas, and Wyoming. Since 2014, the Division of Paleobotany has been conducting a project of curation, cataloging, and digitization of the cycadeoid collection, through the support of a Bureau of Land Management grant and the Yale Peabody Museum Hawkinson Fund. To date, all trunks have been cataloged and rehoused. Additionally, more than 800 thin sections and glass negatives have been cataloged and digitized. Finally, a searchable database of the cycadeoid collection has been established. This local database will aid researchers and students wishing to locate the specimens and collections staff managing them. In this presentation, we will discuss many of the challenges documenting this historic collection, the methodology of curation, and the rehousing of heavy and robust specimens, such as cycadeoids.

Innovative Uses of Collections Data:
an iDigBio Symposium

Georeferencing for Research Use (GRU): innovative geospatial training using natural history collections

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Natural history collection (NHC) data is utilized in new and innovative research projects for the understanding of biodiversity and society. To date, training of professionals to generate essential geospatial data for every occurrence record has focused on best practices to create point/radius and polygon data. Researchers, however, need the skills to retrieve, combine, clean, visualize and assess geospatial data for research. Collections professionals need the skills and software to clean and visualize NHC datasets and the ability to respond to data quality feedback from data users and aggregators. The community-driven Georeferencing Working Group (GWG), hosted by iDigBio, created and facilitated a short course to combine georeferencing best practices for legacy and new data with the critical skills necessary to produce and maintain geospatial NHC data fit for research and downstream use. The GWG recognizes that the geospatial and collections communities will benefit from cross-disciplinary collaboration to develop the skills, data, computational literacy, and software needed by NHC staff and researchers to work with spatial data. This presentation outlines the findings and successes of the Georeferencing for Research Use Workshop, hosted by National Center for Ecological Analysis and Synthesis (NCEAS) in October 2016, and goals for future training.

Advances in Digitization Worldwide:
an iDigBio Symposium

Wiki-handbook of best pratices and standards for 3D imaging of natural history specimens

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For years now, Natural History (NH) museums have digitized their collection specimens for scientific as well as curating purposes. This way, objects otherwise beyond display become widely accessible and create lasting records. However, various imaging techniques exist and technical development is fast. Small objects such as little insects provide other challenges in digitizing than big bones of dinosaurs with a weight of several hundred kilograms. Consequently, each type of object may be digitized using various techniques with different workflows and protocols. Within the European SYNTHESYS 3 project, a handbook on best practices and standards for

3D imaging of NH specimens has been produced using the Biowikifarm platform to which registered users have access to write their chapters independently. The interface of the Wiki was provided by the Museum für Naturkunde Berlin (MfN), which also controls the access to change or add contents, thus ensuring that the knowledge shared through the Wiki is solid and of good quality. It is a working document which will change over time due to technical development. To date the handbook covers methods such as Focus Stacking, Infrared Scanning, Photogrammetry, Structured Light Scanning of large and also small objects as well as µCT Scanning. The best practice handbook for 3D digitization will also result in a printed version with more background information on the several 3D scanning techniques available to date.

New Solutions|Sustainable Facilities

Recycled water, ground source heat pumps and sustainability in the Avenir Collections Center

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Sustainability is a key concept in the design, construction and operation of any newly built environment. The Denver Museum of Nature & Science's Avenir Collection Center and Morgridge Family Exploration Center were built with specific sustainability goals including the utilization of recycled water as the heat sink/source for an innovative ground source heat pump system. Supporting 126,000 square feet, the system is believed to be the first application to utilize recycled water as the heat sink/source in the United States. For the Museum and the local utility, the use of recycled water in this type of system presented new and unique challenges to address, including the seasonality for recycled water, water quality, temperature and reliability, rates and billing for non-consumptive use, and regulatory concerns. Ultimately, the system is successfully installed and operates to the design standards, plus with a few added benefits. Lessons have been learned and identified for the next application of recycled water use in ground source heat pumps systems for the built environment.

Disaster Preparedness

The value of PRICE: preparedness and response in collections emergencies at the Smithsonian

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The Smithsonian recognizes the need for a collections emergency management plan integrated into the Smithsonian's existing Emergency Management Program that focuses on the safety and security of staff and visitors. A robust program that includes collections emergency training, preparedness, mitigation, and response capability at a centralized level has been deficient in recent years. To foster best practices, the Smithsonian Collections Emergency Management Working Group was established in 2012 to study and make recommendations for improving collections emergency management, planning, preparedness, and response. This interdisciplinary group jointly co-chaired by the National Collections Program (NCP) and the Office of Protection Services developed Preparedness and Response in Collections Emergencies (PRICE). The purpose of PRICE is: • To strengthen and support museum-level and pan-Institutional collections emergency mitigation, preparedness, response, and recovery capabilities, including policy, procedures, training, and logistics; • When activated, to provide collections support, response, and recovery as requested by the NCP and/or by individual museum Emergency Operation Centers (EOCs); • To promote and foster improved communication and collaboration among Smithsonian museums and with first-responders, sister cultural institutions, and professional organizations. The PRICE team is part of the Smithsonian Emergency Operations Center and is generally available

for advice, consultation, and assistance related to collection emergencies. In its first nine months, PRICE has developed multiple initiatives to revitalize collections emergency management at the Smithsonian.

Demo Camp

iDigPaleo: in the classroom and on the sofa

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iDigPaleo was developed by the Fossil Insect Collaborative TCN to serve as a pre-aggregator for data generated by the TCN project and also to provide a test case for a modern paleontology-based education and outreach portal. iDigPaleo aggregates specimen data and makes them available via a user-friendly web interface that utilizes faceted searching, including common names (at all taxonomic levels) harvested from Encyclopedia of Life. This enables users without technical expertise to easily explore collections records—an important feature that makes iDigPaleo unique from most other collections portals. The user experience is being tested and refined based on input from elementary and high school educators, high school students, college faculty, and avocational paleontologists to create an easy and enjoyable to use interface. Students, teachers, and the general public can gain access to additional tools and features by registering. Each audience is provided with a suite of tools designed specifically for them. Common tools include annotation and commenting on specimen records, measuring tools, and options for sharing records on social media. Audience-specific tools include options to curate data/image sets and create assignments for classroom use. Curated sets and assignments can be presented and shared online, or exported as PDF, Excel, or PowerPoint files as desired by the user. Development of this project in association with the Cretaceous World TCN will include browser-embedded 3D morphological data sets which can be printed for classroom use.

Best Practices for Integrating Collections into Education

Synthesizing student-generated data from herbarium specimens and data from GenBank to investigate phylogenetic diversity

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Tree of life data are becoming prevalent throughout high-quality ecology, evolutionary biology, and biodiversity investigations and in the educational development of versatile student-scholars. Phylogenies are serving a relatively new role in enhancing biodiversity assessments for conservation planning and ecological investigations. DNA sequences for phylogenetic inference can be generated by students from herbarium specimens and augmented with data from GenBank. DNA markers sequenced by students will fill gaps in GenBank's database for common plant taxa. At the same time, students conduct an authentic research project following the steps of the scientific method. In this talk, a teaching plan along with lectures, activities, and assignments will be presented for implementing a semester-long, student-driven phylogenetic diversity project based on the CURE (course-based undergraduate research experience; Auchincloss et al., 2014) model. Components of the course may be utilized individually for one-, two-, or multiple-week labs and include the following: 1) the scientific method, 2) biodiversity assessment metrics, 3) mining GenBank for DNA sequence data, 4) comparing soil characteristics, 5) obtaining leaf material from herbarium specimens, 6) DNA extractions/running gels, 7) PCR amplification and preparing products for sequencing, 8) DNA sequence alignment, 9) phylogenetic analyses, and 10) using R to calculate phylogenetic diversity metrics. By working together and using scientific tools, students will

apply concepts covered in lectures to a genuine research investigation, ultimately gaining an understanding about the scientific method and building their confidence in conducting scientific research.

Best Practices for Integrating Collections into Education

Best practices for integrating GeoTechnology into education

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Geotechnologies, including mapping and geographic information systems, offer powerful ways to investigate the "whys of where"—the patterns, relationships, and trends that may exist in collections data from local to global scales on a wide variety of themes from invasive species to climate to water to energy. Web GIS tools offer the advantage of being in the cloud, running in a web browser with no software installations required. They work on any device and are tied to live services that work anywhere at any time. Web GIS tools also offer many ways of geo-locating specimen data. This presentation will focus on four such ways: (1) how to map spreadsheet data, (2) how to geo-locate photographs and videos, (3) how to create multimedia story maps to communicate research results, and (4) how to collect data in the field via smartphone apps and map it. This presentation will offer practical ways to work with these technologies in your own research and instruction.

Impacts of Changing Regulations

Legal and regulatory update on the Convention on Biological Diversity and the Nagoya Protocol

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The Convention on Biological Diversity (CBD) entered into effect in December of 1993. The CBD was designed to conserve biological diversity, encourage sustainable use of the earth's biological resources, and provide access to and equitable sharing of benefits arising from genetic resources. The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) went into force in 2014 and further refines what equitable sharing is. These international agreements represent an attempt to balance the interests of countries with genetic or biological resources and the interests of countries with the technology/funding to develop them. Natural history museums collecting and using biological or genetic resources need to ensure that their work is done in accordance with the CBD and Nagoya Protocol. Balancing these interests have proven difficult in practice. But the CBD and Nagoya Protocol apply to collection activities in the countries where the CBD is in effect. It is worth noting that over 196 countries have signed the CBD. The United States has signed but not ratified. Regardless, museums in the U.S. will need to understand these international agreements for collection work in countries that are parties. Natural history museums will need a good grounding in two key treaty concepts: Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT). I will discuss recent developments in these areas, and agreements that have been reached between natural history museums and governments regarding biological and genetic resources. Another concept, traditional knowledge, or TK, is also addressed under the CBD. This issue raises questions of ownership in intellectual property rights and limitations on use. This will also be addressed as it further complicates the regulatory landscape applicable to natural history museums under the CBD and Nagoya Protocol.

New Solutions|Collections Management

On the way towards common principles in collections management—a handbook facilitating and promoting the creation and implementation of management policies on digital collections

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With increasing importance of modern technologies and a growing network of natural history (NH) institutions and user communities, the nature of NH collections as well as their management changed enormously in the past decades. An ever-expanding amount of digital data related to the physical collections needs to be stored sustainably and made available to diverse user groups with various needs. To face this challenge, the Network Activities' branch of the European project, SYNTHESYS 3, which aims to support and to develop the NH infrastructure in Europe further, also fosters a coherent, integrated, and sustainable management approach to digital collections. Management Policies on Digital Collections (MPDC) address various aspects of the management of digital data, which are dealt with and produced during the curatorial, scientific, and other work on NH collections. These aspects may concern, for example, the documentation and storage of data, strategic priorities during digitization efforts as well as property rights and licensing. MPDC create a definite framework which clarifies authorities and responsibilities, establishes workflows and routines, facilitates decision processes, and ensures highest professional standards. Within the context of the SYNTHESYS 3 Network Activities, the Museum für Naturkunde Berlin and its partners developed a handbook with Recommendations on Management Policies on Digital Collections. This guideline was designed to serve as a reference tool for NH institutions to create their individual MPDC. The document proposes a structure, key elements and contents of a MPDC, and gives argumentative support as well as advice on a successful realisation. Supplementary links to relevant external sources and proposed phrasings of several regulations are provided. The guideline was created using the common working platform Biowikifarm and will be freely available as online handbook in the near future.

Advances in Digitization Worldwide:
an iDigBio Symposium

Responding to the invisible infrastructure: research libraries as preservation partners in the curation of physical specimen biocollections data

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Data management and curation work is part of the invisible infrastructure in the research enterprise and is often under-valued and unappreciated despite being critical to ensure long-term viability of data for the data users who benefit from them. The Indiana University Center for Biological Research Collections began a partnership with IU Libraries in 2013 to address the digital curation of more than 1.5 million natural history specimens. The scientist-curators recognized their needs for the libraries' trusted expert support for a quality technology stack for the preservation of 2-D and 3-D digital image assets and the management and analysis of their metadata. This technical session will explain numerous benefits realized in this arrangement for the co-curation of digital collection objects. Highlights include: specifications for the best practice of capturing images in original high-definition formats, preserving them on university maintained tape-based storage systems, the assignment of persistent unique identifiers suitable for the semantic web, simplifying scientific workflows through metadata-aware infrastructure services, responding to state and federal conservation laws, and providing broad dissemination of the specimen data to data aggregators such as iDigBio, GBIF, and OCLC WorldCat. We will provide a practical reproducible roadmap for other institutions with physical specimen biocollections and a willing partnering library to model. Additionally, the technology stack for accomplishing this work will be soon available for use in a virtual machine residing on the NSF-supported Jetstream cloud environment for advanced computing tools (NSF Award #ACI-1445604).

Innovative Uses of Collections Data:
an iDigBio Symposium

From the scrub to the web: digitizing the collection at the Archbold Biological Station

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The collection at Archbold Biological Station (ABS)—a biological field station—is an on-site, multi-taxon, specimen-based natural history collection. Comprising over 250,000 specimens of arthropods, thousands of preserved bird skins, herptiles and fish, and an herbarium, the ABS natural history collection is unusually large for a field station, and exceptionally rich in on-site biodiversity (representing the endangered Florida scrub). We present here the progress to date in collection digitization, imaging, and internet posting via Symbiota portals, supported by a recent NSF award and with the assistance of iDigBio. Primary goals are to: produce a holdings list; focus on rare endemics of Florida's Lake Wales Ridge; catalogue the Florida ants; and train research interns in basic curatorial skills, digitizing methods, and collections-related research. Beyond these goals, the size and taxonomic comprehensiveness of the collection, with its focus on specimens that include ecological data, is beginning to fulfill its promise of novel collection-based research projects such as networking analyses of flower-visiting insects (more than 12,000 records), and the community of arthropods specializing on deadwood. Undoubtedly, one of the most rewarding aspects of digitizing a field station collection is the increased coupling that occurs between curatorial work and field ecology. There is a renewed commitment by ecologists to the importance of specimens and the need to build, expand, and curate the collection. Equally important is the emerging recognition of specimen-based data that can help define and drive exciting field research, and direct new priorities for field station infrastructure and education.

Best Practices for Integrating Collections into Education

Promoting research and outreach that uses collections by teaching undergraduate collections-based courses and supporting outreach modules within existing classes

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Biodiversity collections are critically important resources for documenting and evaluating environmental change and gathering community support for museums and scientific research, but proper methods of collection, preservation, and use are infrequently taught. Without exposure to best practices in collections care and use, researchers are unlikely to incorporate historical collections and their data into modern research projects or they may do so in a less than optimal way. Museum Studies, Biology, and Geology programs can help address this gap by offering courses that specifically train students in these areas. I will describe such a course that is currently taught at Earlham College and the Joseph Moore Museum for undergraduates in the sciences and museum studies programs. The course structure has 6 units that could be used independently as 1-2 week modules inside of other courses. I will also describe an undergraduate course that teaches students from any discipline how to design and deliver outreach programs that feature museum collections. Both courses have an emphasis on research with objects and public communication. Finally, I will describe several ways in which faculty from the sciences, environmental studies, art, and languages, who do not have museum or collections roles, have been encouraged to implement one-day to multi-week collections-based modules into their existing courses. Participants are encouraged to use and improve upon the presenter's course materials.

New Solutions|Collections Management

An economical method for creating custom QR code labels

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Providing a means for information to be readily available and easily obtained directly from a specimen can require complicated and demanding systems. Bar codes have offered an enormous benefit, allowing for quick and reliable retrieval of identifier information that can easily be worked in to a wide array of curatorial workflows. However, bar codes are limited in the amount of information they can provide. Additionally, the cost of custom ordered bar codes, matrix, or QR codes can be a large obstacle, especially for small museums or collections with limited resources that strive to meet the standards of best practices. Here I demonstrate a method to create custom, unique, and data rich QR codes for little or no cost to the institution. Utilizing the free web-based application Google Sheets, one can generate QR images to be used for a range of applications—from an alternative catalog number to encoding bar codes to encapsulating an entire row of comma-separated data values.

Best Practices for Integrating Collections into Education

Best practices for designing educational modules using collections data: a suggested workflow

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Natural history collections data can be used to teach many of the core concepts of biology through active and inquiry-based investigations. This type of student-centered pedagogy is one of the key recommendations of Vision and Change, based on evidence arising from undergraduate biology education research that has identified a suite of student-centered pedagogical techniques shown to be effective in promoting student learning. The natural history collections community has an exciting opportunity to partner with educators and education researchers to explore how biodiversity data can be incorporated into the development and evaluation of educational materials that engage students in investigations of authentic, complex, global, and interdisciplinary questions. Such questions are the topic of current collections-based biodiversity research and are ripe for incorporating collaborative learning activities, community participation, and use of societally-relevant case studies and science in action. Students can generate their own hypotheses about a variety of evolutionary, ecological, and environmental questions and test them using the biodiversity data available from digitized natural history collections. BLUE (Biodiversity Literacy in Undergraduate Education) is an interdisciplinary group of biodiversity scientists, collections professionals, and biology education specialists focused on integrating these types of biodiversity data into undergraduate biology curricula. In this session, we will present a suggested workflow, developed by BLUE based on the principles of backwards design and scientific teaching, for the development of educational materials using biodiversity data.

Public Access to Collections

Let them see the stuff

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Creating experiences for our donors and members that strengthen their connection to the Denver Museum of Nature & Science helps us fulfill our mission and meet our strategic objectives. And, experiences that feel exclusive and special, like behind-the-scenes access to our facilities and collections, are among the most valued and appreciated. The feedback we receive during

and following the events where we offer these limited opportunities affirms donor and member support of our programs and services. We often hear that our behind-the-scenes offerings are their favorite and lead to renewed commitment to their membership or giving level. The Development & Membership Department offers 5 annual evening events at which we facilitate access to the Avenir Collections Center: • Spring & Fall New Member Night • Members-Only Open House • Young Professionals Behind the Scenes Night • Giving Club Behind the Scenes Night For each of these special events, we focus on one or two of our sciences and make those collections and areas accessible. We request the presence of the Museum's scientists (Curators), the area's Collection Managers, support staff, and volunteers to fully activate the spaces and to highlight collections for the evening. Appreciating and honoring the privilege that this access means, we work to balance the experiential elements with the logistics, including: • Security—what elevators and stairwells are we using?; what doors will be unlocked/locked?; where are stanchions and queues required?; • Environmental controls—controlling food and beverage; minimizing impact on humidity and temperature; managing area capacities; • Staffing—what additional volunteer and staff support are needed; and • Signage—what directional and instructional signage is needed?

Advances in Digitization Worldwide: an iDigBio Symposium

Novel use of Inselect in digitization of paleontology collections

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Inselect was developed by the Natural History Museum in London to facilitate whole-drawer imaging of entomological (pinned insect) collections. Using Inselect, drawers are parsed into individual specimens and metadata is applied at the object level. These workflows have been modified to expedite object imaging and data recording for a common paleontological digitization bottleneck—multi-specimen slabs and fossiliferous concretionary material. This presentation will describe the step-by-step process of Inselect digitization for paleontology collections and provide recommendations for similar applications in other disciplines. The process begins with the use of a Cognisys Stackshot rail to take images at several focal points and stack them together using Helicon Focus software. Depending on the specimen, several of these stacked images may be merged in Photoshop to create the most pixel-dense image for Inselect. Fossiliferous concretions are found frequently in the Cretaceous Western Interior Seaway targeted for digitization in the Cretaceous World TCN. The automated cropping process is not successful with these concretions, so we manually crop the individual specimens. Still, this increases the digitization process enormously. There have been more then seven hundred specimens on a concretion and these crops were completed in a couple hours. Scripts are then run to rename files, add scale bars and specimen numbers to crops, and batch upload to the collections database. This software has the potential to be utilized in many departments to aid in the process of digitization. Providing an efficient way of displaying data to researchers can aid in reconstructing the picture of what the past world looked like.

New Solutions|Collections Management

DINA: open source and open services—a modern approach to natural history collection management systems

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In the natural history community a high diversity of collection management systems exist. This enables institutions to choose from a large variety of systems, but this choice requires extensive effort to evaluate and commit to an appropriate system to cover all long-term requirements. As the different kinds of natural history data generated by a given domain and associated research-related data can typically not be handled within a single system, most institutions have several specialized software components and consequently have to cope with serious limitations in interacting and querying across the systems. This reality is costly and not sustainable! The DINA consortium ("DIgital Information system for NAtural history data", http://dina-project.net) is attempting to address these challenges by using a distributed open-source development model across multiple institutions in order to produce an open-source web-based information management system for natural history data. The conceptual basis is a compilation of comprehensive guidelines for application programming interfaces (APIs) to guarantee the interoperability of the components. At the core of the system is support for assembling, managing, and sharing data associated with natural history collections and their curation. Target collections include zoological, botanical, geological and paleontological collections, living collections, biodiversity inventories, observation records, and molecular data. The DINA consortium was founded in 2014 by six natural history collection institutions in Europe and North America and is open to additional members. We will present an overview of DINA focusing on the open-source software philosophy, our current achievements, challenges, and future developments.

New Solutions|Collections Management

TDWG 101: the importance of Biodiversity Information Standards (TDWG) to SPNHC

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The Biodiversity Information Standards body most often referred to by an historic acronym, TDWG (pronounced "TaDWiG") is traditionally responsible for the development and maintenance of standards for the exchange of biological/biodiversity data. However, this body has evolved over the past nearly 30 years and is now recognized as the global forum for biodiversity informatics. Several of the standards developed by the TDWG community are used by the natural science community every day, most notably the flagship Darwin Core and the more general ABCD (Access to Biological Collections Data) for documenting occurrences, including observations in nature, specimens, samples, and related information. More recently, the Audubon Core was developed to address the need to better document biodiversity multimedia resource use. TDWG also develops relevant technical guidance, best practice documentation, and training curricula for improving awareness of standards and promoting technical competency. The tools developed that embrace these standards are numerous and aid curators and managers of biological data to capture, assess, clean, manage, and disseminate occurrence data. The knowledge and expertise of the SPNHC community is an invaluable resource to TDWG as they represent a core group of data producers and managers of biological occurrence data as well as users of associated software tools. In 2018, TDWG and SPNHC will host a joint meeting in Dunedin, New Zealand providing an excellent opportunity for members of both communities to discover and learn from each other.

New Solutions|Collections Management

Discovering non-digitized collections: a metadata approach

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The world's biocollections institutions house about 2.5–3 billion specimens that document more than 300 years of the systematic biological exploration of the Earth. Only about 10% have been digitized and less than 10% of the digitized data is shared openly. The two main cited obstacles for digitizing and sharing data are lack of funding and time among collection personnel. Yet, discovery and knowledge of such non-digitized collections are essential, for which a metadata approach has been proposed by GBIF task forces and others in the biocollections community. Accordingly, collection metadata are captured in a standard format without necessarily digitizing at the specimen or object level, resulting in institutional, national, and global biocollections catalogues. Two current biocollection metadata initiatives are GRBio (http://grbio.org/) and GBIF's metadata model for datasets. Benefits of the metadata approach, articulated in a recent GBIF task force report on Accelerating the Discovery of Biocollections Data, are: a consequent rapid evaluation and assessment of the collection's physical state and curatorial status; enabling quick reporting on data gaps; providing a strategic framework for prioritizing specimen digitization; a rapid, concise dissemination and advertisement of an institution's collection holdings and their value for science and society, in turn key to attracting partnerships and resources for specimen-level digitization. We describe—and invite discussions on—the tiered metadata strategy to simultaneously characterize collections and plan digitization priorities, schedules, and workflows.

Best Practices for Integrating Collections into Education

How to bring the Worldwide Engagement for Digitizing Biocollections (WeDigBio) event into your classroom

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The Worldwide Engagement for Digitizing Biocollections (WeDigBio) Project is focused on engaging the public in creation of digital data about biodiversity research specimens. WeDigBio began as a collaboration among online transcription platforms (Notes from Nature, Smithsonian's Transcription Center, and others) to produce a 4-day, annual WeDigBio Event and supporting technology and other resources. The WeDigBio Event engages participants at local, onsite transcription events held at museums, universities, and classrooms, as well as others distributed anywhere around the world. The supporting technology created by the WeDigBio organizers includes the WeDigBio website (http://wedigbio.org), which features a dashboard to visualize event-wide transcription progress and resources for onsite event hosts, including teachers. The 2015 WeDigBio event engaged users in more than 125 countries to produce over 30,000 specimen transcriptions. While the initial focus of the WeDigBio events has been transcription of labels from specimen images, other digitization activities (e.g., digital imaging of specimens, georeferencing specimen collection localities) are viewed as in-scope for future events as supporting technologies and protocols are developed. The WeDigBio organizers are experimenting with ways to maintain the high digitization rates of the 4-day event throughout the year with WeDigInterest groups (e.g., the WeDigFLPlants group) and new resources for educators, including videos for high school (grades 9–12) STEM teachers in FL (available through Florida's CPALMS website). WeDigFLPlants is a collaboration between biocollections and the Florida Native Plant Society with the potential to provide local experts

to Florida's high school STEM classrooms engaged in WeDigFLPlants activities. We will present the classroom resources and reflect on successful strategies that we have used for engaging science classes from grades 6 through undergraduate, including Libraries of Life augmented reality content and exercises built on top of our Timeline Tracker and Geo Locator game cards.

New Solutions|Collections Management

Planning for and justifying a large fossil donation

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In the fall of 2014 a donation of over 8,000 Mazon Creek fossil specimens from a private collection was made to the Field Museum. This required a great deal of planning and work both before and after the donation was accepted. Our plan included: 1. Determine if collection should be accepted by museum. 2. Estimate size of collection and storage requirements for housing collection. 3. Transport collection to Museum. 4. Unwrap specimens and re-house them in standard boxes and drawers. 5. Re-number specimens and add labels. 6. Catalog and digitize specimens 7. Sort specimens into systematic collection. Step one is the most crucial. Why is this private collection an important addition to the Field Museum's collection? Our fossil invertebrate collection has over 2 million specimens including 40,000 Mazon Creek fossils. How big is big enough? We collect specimens for two reasons: aesthetic appeal and information. The aesthetic appeal is obvious when looking at the beautiful fern fossils, but our collection is large enough that we have many beautiful fossils. We need collections large enough to study the diversity of the Mazon Creek biota and the variation that occurs within individual species and the whole ecosystem. This collection builds on our strength and includes many rare, unusual, and very well-preserved fossils, plus many unique faunal associations, and specimens from localities not represented in our collections. Even with relatively common species, a range of specimens is needed to show the largest and smallest specimens and their variation. Additional fossil specimens are important if they are exceptionally preserved, have unique faunal associations, or are preserved in different or unique orientations. The collector understood this and spent decades collecting hundreds of thousands of concretions, saving only his best 8,000 fossil discoveries. It would be nearly impossible to duplicate this type of collection today.

New Solutions|Collections Management

Analysis of fossil data standards at the Smithsonian NMNH Department of Paleobiology

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As stewards of paleontological data we have a responsibility to maintain high quality collections information and to enable the sharing of that information to stakeholders and communities to promote research, education, and preservation. An essential element of this effort is the establishment of best practices for collecting and documenting specimen information in an interoperable format. At the Smithsonian National Museum of Natural History Department of Paleobiology, we have developed new data standards through an approach that included evaluating our collections database (EMu), assessing data management procedures, and reviewing data sharing initiatives. As part of this, we also looked at what standards exist or are lacking, how data are structured in a variety of sources, and how Darwin Core does or does not reflect our data needs. In this discussion, we will give an overview of our new paleo data standards and share our approach to reviewing data practices within and outside of our department. With more collaboration, the paleo community can implement best practices and standardization across organizations and collections information systems to improve data mobility and interoperability.

Innovative Uses of Collections Data:
an iDigBio Symposium

A digitized collection: where next?

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Data is more valuable when it is accessible, interconnected, and reusable. Over the last few years digitization of the Non-vertebrate Paleontology collections at the Jackson School Museum of Earth History at the University of Texas at Austin has been the main focus of curation. The collections contain a broad range of samples, invertebrate, paleobotanical, microfossil, other geological, and associated documents. The latter include images, SEM, CT and laser scans, videos, field notes, maps and sections, letters and derived materials, such as thin sections and powdered samples for analysis. These provide a wealth of information for research, teaching, and public education. Currently use of these data include many that are innovative or unusual. 1. Combining data sets from multiple disciplines: e.g., pairing historical maps with current information that illuminate aspects of the original data. 2. Creating maps of both archive and field sites provides ready access to samples. 3. Creating whole drawer images to provide quick access for inventory and conservation. Images provide a convenient tool to select samples as the archive is not located on campus. 4. Generating distribution maps as a basic tool box for research projects. 5. Embedding image scales and multifocal images of key specimens for global analysis and visibility. 6. Creating 3-D laser imagery that is accessible online and generating models of those samples for disabled students; e.g., 3-D sample prints with embedded braille descriptions. 7. Creating digitized field trips from field notebooks as web and mobile apps; integrating these with previously developed geological resources. 8. Providing dynamic web access to sample data plotted in current and paleo deep time locations. This leads to new questions and perspectives; e.g., range extensions explained by seaway connections. 9. Adding global unique identifiers to samples provides a link between publications and the archival location of the original sample.

Best Practices for Integrating Collections into Education

Integrating biodiversity data into the undergraduate curriculum: opportunities for collaboration

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The biodiversity sciences have experienced a rapid mobilization of data that has increased capacity to investigate large-scale issues of critical importance in the 21st century (e.g., climate change and its impacts, zoonotic disease transmission, sustainable resource management, impacts of invasive species, and biodiversity loss). The volume, complexity, and variation in the biodiversity data requires sophisticated data skills to ensure accurate and reproducible science. To address the needs of the biodiversity research community and develop a data literate workforce and research community that can access, aggregate, and analyze emerging data resources, we need to work across sub-specialties to integrate resources in research and education. We will introduce several new and emerging collaborative efforts to partner with educators and education researchers to explore how biodiversity data can be incorporated into educational materials that engage students in investigations of authentic, complex, global and interdisciplinary questions. Drawing from ongoing efforts across the biodiversity community we will review existing resources and potential needs in the development and integration

of collections based educational materials. In summation, we will discuss the need for continued collaboration and integration of efforts within the larger education, collection, and biodiversity science community to identify educational gaps and strategies for integrating these competencies into an already crowded curriculum.

Advances in Digitization Worldwide:
an iDigBio Symposium

Developing standards for data quality tests and assertions using a fitness for use framework

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After the availability of data, 'data quality' is the top concern of most users of natural science collections data. Capturing and maintaining quality electronic data has been a central concern of natural science data curators since at least the 1970s. Members of the Biodiversity Data Quality Interest Group of TDWG (Biodiversity Information Standards (TDWG)) are producing three sets of products relating to data quality. The first is a framework for describing Fitness for Use of biodiversity data, the second a suite of standard tests and assertions concerning the quality of biodiversity data, and the third, a suite of case studies of the application of data quality to the needs of particular user communities.The Fitness for Use Framework is a conceptual framework linking quality components to fitness for use, for example, the quality needs that arise from the use of biodiversity data for species distribution modeling. The framework provides for formal descriptions of use cases that identify specific data quality needs for specific uses (e.g., quality needs of species distribution modeling), mechanisms (e.g., data quality software) that support those needs, and the structure and components for data quality reports. Such reports contain assertions about measurements, validations, and amendments that pertain to a particular set of biodiversity data in the context of a defined need. The list of standardized tests and assertions has been filtered from an analysis of tests in use by data consumers including the ALA (The Atlas of Living Australia), GBIF (Global Biodiversity Information Facility), iDigBio (Integrated Digitized Biocollections), VertNet, OBIS (Ocean Biogeographic Information System), and CRIA (Centro de Referência em Informação Ambiental). The tests are fully described and related to the concepts of measurements, validations, and amendments in the Fitness for Use Framework. The case studies form a 'reality check' of the framework and the tests.

Disaster Preparedness 5

Planning for the Shaky Isles: disaster preparedness at the Otago Museum

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The Otago Museum is the fourth largest Museum in New Zealand and houses over 1.5 million objects and specimens spanning both cultural and natural history. The Museum is located in one of the most seismically active countries in the World. For many years the Museum's collections were managed by a skeleton crew, none of whom had any formal conservation training but all of whom were acutely aware of the risks from natural disasters. In more recent years the Museum has re-engaged with its collections, increased staffing across the division and appointed two Conservators. As well as assessing the conservation needs of the collections in its broader sense, a priority has been the development of an effective Disaster Plan, ensuring cross divisional input within the Museum, and engaging with our stakeholders across the city. Equally important has been engagement with the communities we serve, particularly those whose collections are in trust by the Museum on their behalf. This presentation will outline the key components of the Disaster Plan, from the makeup of the Disaster Response and Salvage Operation teams, to incident reporting, salvage and business continuity plans etc. Opportunities to collaborate with like institutions, to share equipment and people, is also explored in this paper.

Disaster Preparedness

Fungal growth associated with ethanol based collection storage facilities

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Modern collection storage facilities have environmental systems that strictly control temperatures, humidity, and light exposure for museum specimens. These systems assist in the long-term preservation of museum collections by limiting the exposure of an object to damaging conditions. A recent long-term high heat and humidity event within an alcohol collection storage facility at the Smithsonian Institution, Museum Support Center is associated with a large scale fungal growth in the interior of the building. Some types of the fungal growth inside the building appear to exist in the presence of ethanol vapor which does not dissipate readily since it is heavier than air. In order to combat this problem, we have replaced materials such as paper and wood to control the interior fungal growth. Fungal growth outside the building also occurs, most present near the rooftop ethanol-laden air exhausts. The outdoor fungus is thought to be *Baudoinia panamericanensis*, related to the commonly known "whiskey fungus," which has long been a problem in distillation facilities and the surrounding residential areas. Attempts to clean outdoor surfaces and structures contaminated with *B. panamericanensis* are only temporarily successful as the contamination returns. One solution is to eliminate the primary catalyst that leads to its rapid growth. To accomplish that task, the HVAC system

must be adapted to house a thermal oxidizer that would break down the vapor flowing through and out of the facility into more basic components such as water and carbon dioxide.

Innovative Uses of Collections Data: an iDigBio Symposium

Starting from scratch: digitization of an entire collection ecosystem

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The Indiana University Paleontology Collection (IUPC) contains one of the most extensive mid-continent collections of Carboniferous marine environments in North America, but until the last five years none of our holdings were available digitally. In addition to the fossil specimens housed in the IUPC are thousands of slides, collecting locality photographs, SEM micrographs, field notebooks, and drawings from the very earliest days of the collection to the present. With the exception of a 1980s Borland desktop database inventory of type and figured specimens (approx. 6,000 specimens in total), all other pertinent collections metadata are handwritten on specimen labels and in a ledger of approx. 20,000 specimens. Since 2010, the IUPC has successfully leveraged crowd-sourced label transcription services, high-throughput specimen photographic practices, fully-automated and ultra-high resolution specimen macrophotography (of microfossils!), machine-learning algorithms for handwritten text recognition of catalog ledgers, 3D object scanning and photogrammetry in order to simultaneously develop a digital catalog and repository for digital objects that is at the cutting edge of museum informatics. Critical and central to the numerous digitization fronts ongoing at IU has been the creation and implementation of a robust, preservation-grade digital content repository. Our digital repository, Imago, has enabled this collection of physical and digital objects to be tied to publications, researchers, cores, outcrops, and localities using persistent, globally unique identifiers. This linked, open data format also facilitates readily customizable and curated exhibits of digitized specimens online and for use in novel curricula for university faculty and STEM educators in K-12 classrooms.

Best Practices for Integrating Collections into Education

More bang for your buck: leveraging resources with professional societies

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This presentation will highlight key educational programs of the Ecological Society of America and discuss ways that the Natural History Collections community might take advantage of these resources to broaden its reach and impact on undergraduate faculty and students. ESA is a part of the Biodiversity Literacy for Undergraduate Education Network and is involved in several initiatives involving natural history collections. These include the Dig into Data Faculty Mentoring Network in collaboration with QUBES and the 3D naturalists citizen science Research Coordination Network that engages professionals and minority students at the national parks. Additionally, we will explore how the EcoEd Digital Library, the Life Discovery—Doing Science Education conference, and opportunities at ESA meetings may be venues of engagement for the NHC community.

New Solutions|Collections Management

Engaging our future to preserve our past: curation and preservation of historically significant collections through student participation at the Rancho Santa Ana Botanic Garden Herbarium

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The importance of plant collections for advancing research cannot be overstated. Collections of historic significance offer a lens into the past and a means to envision the future. These functions are especially important now as we try to assess how biodiversity will change with global shifts in climate and land use. As herbaria serve expanding needs for research, education, and conservation management, it is critical that collections of historic, taxonomic, and geographic significance are curated and digitized, thus ensuring their availability for research and, importantly, their long-term collection security. Through various sources, the Herbarium at Rancho Santa Ana Botanic Garden (RSABG) acquired 30,000 vascular plant specimens of historic, taxonomic, and geographic importance representing the collections of ten noteworthy botanists of the 20th century. 70% of these were collected from 15 of 34 designated world biodiversity hotspots; 30% represents the California Floristic Province biodiversity hotspot alone. Several specimens have been identified as type material thought to have been lost. Almost entirely through student participation, a three-year project funded by a recent NSF grant, aims to curate and digitize these specimens to make available to researchers, students, and the public. A large cadre of students at different levels in their academic career are participating in all aspects of the project, including specimen preparation, databasing, imaging, and georeferencing. Notably, this project has provided RSABG with an opportunity to expand on a successful undergraduate internship program by engaging at-risk and transitional aged youth at the high school level through a six-week summer junior intern program.

Impacts of Changing Regulations

Access and benefit sharing—chances and challenges for biodiversity research, collections and collection management under the Nagoya Protocol

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The Nagoya Protocol (NP) regulating the third pillar of the Convention on Biological Diversity (CBD)—the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (GR)—entered into force in 2014. It sets out a strong global legal framework on the accession of GR in-situ during own field work, or if utilised from ex-situ sources, regardless whether the user country is party to the NP, or not. This leads to new requirements for genetic research on samples originating in countries that established access laws. Moreover, there are a number of unclear issues and controversial discussions regarding the implementation of the NP, especially concerning the treatment of genomic information in the public domain—and uploading such data through online portals. It can be anticipated that the natural history community has to face further challenges in the

near future. Besides the justified origins and the original intentions to promote sustainability, the NP also gives room for opportunities because the permitting and documentation requirements largely agree with good practices already in place for the acquisition of specimens. Joint community based approaches ease the burden of single institutions to develop individual solutions. The Consortium of European Taxonomic Facilities (CETAF) run by the major European taxonomic institutions has developed a Code of Conduct and Best Practices and Material Transfer Agreements which were submitted for official recognition of the European Commission. This set of documents was uploaded to the ABS Clearinghouse of the Secretariat of the CBD and is open to be used by non CETAF members. It offers a flexible set of voluntary measures suited to reach ABS compliance and demonstrates due diligence under the regulations of Providing and User Countries. It also offers guidance for negotiations in Providing Countries and for publication of genomic data.

New Solutions|Collections Management

How to move a *Triceratops*

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In 1965, the Science Museum of Minnesota prepared the largest mounted skeleton of *Triceratops horridus*. The specimen, from the Hell Creek Formation in Montana, was immediately iconic and beloved by visitors. The Triceratops has hosted a fair number of researchers over the years and has faced a few preservation challenges. In 1976, nearby blasting for a new building damaged the specimen, resulting in extensive stabilizing treatments. During the move to SMM's new facility in 1999, the skeleton was deconstructed and reassembled in the new Dinosaurs and Fossils Gallery. In 2016, *Triceratops* was on the move again, to accommodate new exhibits. We faced the challenge of moving the skeleton 100 feet on a short time frame and a tight budget. Disassembly would be too time consuming. We have no full time fossil preparators. The Paleontology and Conservation Departments teamed with project managers and fabricators in the Exhibits Production Department to brainstorm the move. The result? We braced the skeleton, welded a stronger frame to the base, put it on high quality wheels and pushed it to its new location, all while on public view. We also corrected mistakes in the anatomy and created a new display ground with footprints. We raised funds for the work through donations solicited at the box office. The *Triceratops* stands in its new location and we have a new, well-documented way to move it.

Innovative Uses of Collections Data:
an iDigBio Symposium

Deep learning with botanical specimen Images

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From October 2015 to April 2017, the US Herbarium digitized over 1.1 million botanical specimens through the use of a digitization conveyor belt, creating a high resolution image of each specimen. Although the main use of these images is to provide access to the US Herbarium through virtual means, this wealth of image data lends itself well to creative ideas for herbarium management. The US Herbarium partnered with Smithsonian's Digitization Program Office and the imaging company NVidia to investigate the uses of "Deep Learning" for mass analysis of the botanical specimen images. Deep Learning, or deep neural networks, use algorithms and the computational power of the GPU to analyze large sets of data, and can be used for a variety of uses, from voice recognition to a self driving car. For the purposes of the US Herbarium, we implemented the Deep Learning analysis to differentiate mercury-contaminated botanical specimens from ones that are unaffected. Mercury solvents were originally applied to botanical specimens for preservation, but now can be a potential health risk to herbarium workers. Knowing the percentage and clusters of mercury contamination in the herbarium helps us mitigate the problem in the herbarium. By first "training" the Deep Learning system to recognize mercury contamination, and then filtering all of our botanical

images through the system, we are able to know the depth of our contamination issues, the collection times and places where mercury was most used, and the plant families most affected by this pesticide application.

New Solutions|Collections Management

Adapting to APG IV: curating the second largest herbarium in the world

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The Steere Herbarium of the New York Botanical Garden contains ca. 7.8 million specimens and is an unparalleled resource for plant systematics, with scientists sampling hundreds of specimens for use in dozens of molecular phylogenetic research projects every year. However, it can be challenging for large herbaria to adapt to the evolutionary relationships that are revealed by such research (e.g., generic changes between families), given the massive scale of the collection, limits in space, and curatorial staff time. This talk will discuss the efforts of the Steere Herbarium to adapt and curate the physical collection and electronic database to the newest Angiosperm Phylogeny Group classification system (APG IV). Examples from Monocots and Eudicots will be discussed.

Disaster Preparedness 3

To protect and preserve: U.S. collaborative efforts to build and sustain cultural heritage emergency network

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Floods, hurricanes, fires, and other disasters can harm or destroy irreplaceable cultural and historical treasures. But the institutions that safeguard books, documents, photographs, artifacts, and other historical collections can prepare for emergencies to avert or at least minimize damage. One of the keys to preparedness is a relationship with first responders and emergency managers. They are first on the scene at any event that threatens life or safety, and they represent a local system for planning, response, and recovery that has often overlooked a community's cultural and historic assets. The national Alliance for Response (AFR) initiative has established over 20 networks to work regionally on building these relationships and helping with regional disasters. The California Office of Emergency Services (Cal OES) has funded the California Preservation Program to reach out to California counties to build relationships between emergency services and cultural and historic resources. The American Institute for Conservation (AIC) established the National Heritage Responders, a group of conservators and emergency responders, to assist cultural institutions during the response and recovery phase. All of these initiatives serve as potential models for improving protection and preservation of collections.

Best Practices for Integrating Collections into Education

Bringing natural history collection-based research to the community college learner

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Community colleges play a vital role in educating the STEM workforce. Nearly 50% of all college and university educated students receive their introductory biology course in a community college environment. In this session, we will address challenges at the instructor and learner levels for increasing student access to collections and collection-based data in the community college setting. The community college fills an accessibility gap for a broad spectrum of learners by offering cost-effective, regional educational opportunities at the introductory college level. Even more so than at a four-year institution, community

college instructors interact with a diverse cohort of learners representing different levels of educational experience and abilities and often have both prospective biology majors and non-majors in the same classes. Some students come directly from, or are dual-enrolled in, high school while others are returning after years in the workforce. Community college instructors are also more likely to face reduced access to educational resources (i.e., computers in the classroom, reliable internet access, research lab space, professional development funding) and high teaching loads. In addition, over 50% of courses at community college are taught by part-time faculty, who face the added stressors of lack of job security and low compensation. These factors combine to create a unique challenge for the community college instructor looking to integrate collection-based science and research into their courses. We will describe ongoing efforts by BLUE (Biodiversity Literacy in Undergraduate Education) to develop and assess accessible and transferrable learner centered educational modules designed to integrate collections science and biodiversity data into the undergraduate community college core curriculum. Our goal is to create materials that acknowledge and address the unique needs of community college instructors and provide community college students with increased access to inquiry-based educational materials using real data (both in the classroom and in an online format). These learning experiences will result in a more data literate society and diverse data enabled workforce, as well as biology majors better prepared to make the transition to a four-year institution.

Advances in Digitization Worldwide:
an iDigBio Symposium

Everyday operational issues associated with managing the digital collections of one of the largest herbaria in the world

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We will present challenges related to prioritization, data curation and data quality in the context of the daily operation of digital collections management at Kew and discuss possible solutions. Over the last decade, digitization rates have increased dramatically with approx. 13% of the herbarium specimens now databased. However, these specimens are physically dispersed throughout the collection, having been selected for digitization based on specific scientific research and digitization project scopes or through individual requests. Stakeholders' priorities have not always matched those of the institution and this has led to a bias towards particular taxonomic or geographical units not necessarily representative of the whole collection. This digitization approach is not the most efficient as any one cupboard can be searched through multiple times for different specimens. The increasing volume of digitized collections also brings new challenges to curators such as keeping the digital records aligned with the physical collection. Currently, digitized and undigitized material is intermingled, leading to operational inefficiencies. We have trialed different approaches to capture label data from images, including outsourcing, crowdsourcing and working in collaboration with project partners and, to a smaller scale, individual researchers. These approaches all have their own challenges with differing depths of data capture, quality and formats of data returned. However, all require decisions on the level of data cleaning necessary before records are imported into the collections management system and made publicly available. Capturing label data post-imaging lends itself to user prioritization of transcription, where data is enhanced for specimens when there is an identified need. Future options for consideration include sharing the transcription and associated data validation, and working as a global community rather than at an institutional level.

Advances in Digitization Worldwide:
an iDigBio Symposium

e-ReColnat: a multiparty approach

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Evaluating biodiversity changes since the beginnings of the industrial era requires documenting occurrences of species over a large period of time. However, when dealing with species records, one faces the difficult problem of proper identification. There are approx. 2 billion specimens in natural history collections worldwide, of which 100 million are in France. The aim of e-ReColNat is to build a huge database consisting of species occurrence records through time, which will feed all kinds of research and expertise in biodiversity surveys, modeling global change, etc. The most serious impediment to the use of specimen-based information is that only a small fraction is currently databased and available for a large and diverse community. Museums and other similar institutions have already taken up the task of digitizing and indexing their collections. Yet, the huge mass of data that is still to be recorded makes that task a tens (if not hundreds) of years project at the current pace. New methodologies, based on « industrial » logic and logistics, are required in order to speed up the digitization process. The project is four-fold: 1) Acquiring raw data in the fastest and the most cost effective way. 2) Processing this huge mass of data (verifying, re-identifying, informing structured fields) to feed a database suitable for research and expertise. It requires mobilizing all resources available worldwide, professional and amateur taxonomists alike. In order to do so, we have built tools based on a Web 2.0 participative approach (i.e., quality control for digital imaging, Les Herbonautes). 3) Creating a digital platform to make biodiversity information freely and openly available to everyone. 4) Returning data to the providers after adding new species occurrence information (e.g., updated identification, revision, location) given by researchers with the aid of scientific tools available on the platform.

New Solutions|Collections Management

I'll take 40 barrels of invertebrates to go please: a case study for large wet collection transfers

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An extensive fluid invertebrate collection amassed by the Coral Reef Research Foundation, Palau, from global coral reefs during 22 years of research for the National Cancer Institute was recently transferred across the Pacific Ocean to its permanent home at the California Academy of Sciences. This unique collection has enormously enhanced the Academy's already rich coral reef invertebrate holdings, particularly the sponge, tunicate, and cnidarian collections. While the transfer was verbally committed to in 2008 and a legal contract was signed in 2010, years of planning, partnering, and institutional support at both ends were essential in preparing for this late 2015 acquisition. Various associated logistical challenges and setbacks were successfully overcome. Integration of the collections has been greatly facilitated by frequent communication and heroic efforts on the part of the donor institution to secure a permanent home for this one of a kind collection. A case study for the transfer of large wet collections is presented.

Public Access to Collections

The Marcus E. Jones Project: an innovative approach to public engagement with herbaria and archives

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As a project that involves both archives and herbaria, the Marcus E. Jones Archive Project at Rancho Santa Ana Botanic Garden (RSABG) represents an opportunity for researchers to enrich their studies and to introduce the public to a significant scientific collection within its wider historical context. Since 2012, staff, students, interns, and volunteers have catalogued and digitized the archives and herbarium of Marcus E. Jones (1852–1934), a prominent self-taught botanist who documented his travels over a fifty-year period through plant collections, photography, and writing. Jones collected plants throughout the western United States and northwestern Mexico, often in locations rarely visited by other botanists. Housed at the RSA-POM Herbarium since 1923, the collections of Marcus E. Jones consist of ca. 100,000 specimens, including ~1200 type specimens. RSABG archives contain his published and unpublished manuscripts, field notes, nearly 500 pages of correspondence, and more than 2000 photographs, lantern slides, and negatives, most of which have not been accessible online until recently. Images of herbarium specimens, photographs, slides, and documents are served through JSTOR to provide the research community and the public with access to these materials. A final and important piece to this four-year project is public engagement, featuring an exhibit paired with presentations and tours to highlight the life and work of Marcus E. Jones and give viewers a unique window into a rapidly changing West. The inclusion of historical context in our approach to public engagement encourages deeper appreciation and understanding of the importance of natural history collections.

New Solutions|Conservation

Developing a best practice for historic mammal taxidermy

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What are the common materials that professionals use to conserve and restore historic taxidermy? What techniques and procedures are successful? These questions surrounding best practices arise because there is a relative lack of published information on taxidermy conservation treatments compared to other specialties, yet the organic composition of these collections make them especially vulnerable to collection and exhibition risks. The American Museum of Natural History (AMNH), in partnership with Yale University Institute for the Preservation of Cultural Heritage, is engaged in an Institute of Museum and Library Services (IMLS) grant-funded project to research materials and methods used to preserve mammalian taxidermy. To understand the scope of treatment processes currently in use, AMNH conducted an online survey of conservators, master taxidermists, and exhibition specialists who regularly work on the conservation or restoration of taxidermy. The surveyed professionals indicated their preferences for cleaning, repairing, and restoring specimens, ultimately mentioning an array of materials and methods. The AMNH Natural Science Collections Conservation lab set out to test and compare these materials and techniques. This presentation will discuss the progress made on developing best practices for conserving mammal taxidermy, from professional input and testing, to future steps for buy-in and dissemination.

Best Practices for Integrating Collections into Education

NSF initiatives for improving education and broadening participation

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The goal is to highlight funding opportunities at NSF for improving education, workforce training, and providing opportunities for inclusion and broadening participation. The presentation emphasizes programs in the Division of Biological Infrastructure (DBI) within the Directorate for Biological Sciences (BIO)—Research Experiences for Undergraduates (REU), Research Coordination Networks—Undergraduate Biology Education (RCN-UBE) and Postdoctoral Research Fellowships in Biology (PRFB). In addition, prospects to achieve these goals through other priority research areas across BIO are discussed. The presentation also outlines opportunities in the Directorate of Education and Human Resources (HER) that contribute to achieving these goals. Requirements and criteria specific to all funding tracks are emphasized along with hints for competitive proposal writing.

New Solutions|Collections Management

The next generation in collections assessment

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Collection surveys have been used for many years in different forms to evaluate natural history collections. They are a useful tool to inform staff and funding bodies of the contents, condition and value of a collection. Collections grow and evolve and the uses identified for collections and the type of collections we store are ever increasing, so is there a new generation of collection assessment that is useful and informative? This paper presents two collections assessment tools used by the NHM, London. SYNTHESYS3—Collections self-assessment tool (CSAT). SYNTHESYS is an EC-funded project creating an integrated European infrastructure for natural history collections. SYNTHESYS3 has developed a free online self-assessment tool to enable institutions to assess their collections management against the SYNTHESYS benchmark. Providing valuable information that institutions can use in planning, management, and in seeking funding. It also provides SYNTHESYS with valuable data on collection management needs across Europe. Join the dots: This collections assessment methodology was designed by the Smithsonian (NHMH) and modified by the NHM London, to accommodate the specific needs of the NHM collections. The assessment framework was developed to provide direction and guidance by evaluating the current status and needs of collections, and plan for the necessary resources to support present and future holdings. The framework is intended to facilitate the consistent and comparable analysis of existing collections and associated documentation by looking at how well they serve the needs of curation, research, and outreach efforts now and going forward. A tool to help support the highest professional standards of collections care.

Public Access to Collections

Using audience input to determine traveling exhibition enhancements

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Traveling exhibitions appear at many institutions, but can appear strikingly different venue to venue. In addition to different physical configurations of the baseline exhibitions, venues have traditionally made different choices on whether to enhance traveling shows, and if so, to what extent. Additionally, priorities at different venues vary greatly in determining the types of enhancement. For example, venues could choose to showcase institutional collections, highlight museum research, utilize education collections for display or facilitation, integrate local connections, increase interactivity, engineer social media opportunities, engage

with early learners, or support sponsorships. Join the Denver Museum of Nature & Science to learn how quantitative evaluation and anecdotal feedback has informed institutional priorities to determine which traveling exhibitions get which types of enhancements when they appear in Denver, and how the Denver Museum of Nature & Science has explored the return on investment for different types of traveling exhibition enhancements coupled with different types of shows.

Disaster Preparedness

Earthquake response and repair project at the Smithsonian Institution's Museum Support Center (MSC)

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In August 23, 2011, a magnitude 5.8 earthquake hit Mineral, Virginia, about 90 miles southwest of Washington D.C. This quake was the strongest to hit east of the Mississippi since 1944 and was felt as far away as Canada. As a result, many of our national landmarks suffered intensive damage. The Smithsonian Institution's Museum Support Center (MSC) in Suitland MD, housing over 43 percent of the Smithsonian's collections, was severely impacted. This presentation will discuss the immediate response period at the MSC and the longer term seismic repair project.

New Solutions|Conservation

An evaluation of pre-preparation refrigerated storage conditions for ornithological specimens

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Specimens are acquired because they are important representatives of a species or are critical for ongoing research at an institution. Typically, these specimens can only be accessed once they have been prepared, but the rate of ornithological specimen acquisition often surpasses the rate at which specimens can be prepared and added to the collection. These specimens must then be stored in a frozen state until they can be prepared. The rate of specimen degradation varies with the type of freezer and type of wrapping in which the specimen is contained. This is an important topic of study because if a specimen degrades too much, the types of preparation becomes limited, and in extreme cases, may result in the loss of a specimen altogether. Our objective was to examine the efficacy of various techniques to conserve frozen ornithological specimens. To test this, we wrapped chicken wings using various methods and stored them in five different types of freezers, then monitored the amount of weight they lost due to desiccation. We found that freezer temperature had the greatest influence on desiccation, as the samples in the coldest freezers had the least amount of weight loss. We will further discuss our findings including the influence of other freezer variables (temperature, frequency, and duration of door opening) and wrapping methods on sample weight loss. The results of our study identifies effective techniques for storing frozen ornithological specimens, which will help ensure important specimens can be prepared in the manner intended when resources are available.

New Solutions|Conservation

Conservation, preservation, and interpretation of paper shale fossils at Florissant Fossil Beds National Monument, National Park Service, Colorado

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Florissant Fossil Beds National Monument (FLFO), established in 1969, preserves a late Eocene Lagerstätte-Konservat known for its high diversity and exquisite preservation of 1800 fossil species, primarily of plants and insects. More than 40,000 scientifically significant specimens are housed in at least 17 museums worldwide. The fossils are preserved in extremely thin and delicate paper shale with layers as thin as 0.1 mm. Various forms of cracking, microflaking, crazing, delamination, and breaking develop as the shale layers lift off of specimens under variable environmental conditions. Correcting these problems is important because small microflakes of shale can contain entire body fossils of insects, and these may include species new to science. Through NPS funding under the CESU program, a joint project with FLFO and the SDSMT Museum of Geology developed techniques to minimize damage and to stabilize and/or repair specimens. The project also measured the effects of temperature, RH, and other environmental factors on the stability of specimens in order to determine optimal storage conditions. This resulted in quantified recommendations for environmental control in FLFO's new museum collection facility, and supported the preparation and stabilization of a selection of important fossils in FLFO's collection. The project resulted in a comprehensive unpublished report, Handbook for the Care and Conservation of Paper Shale Fossils, that can be used at Florissant and at other sites and museums with similar collections.

Innovative Uses of Collections Data:
an iDigBio Symposium

Fantastic fishes and where to find them: a dynamic inventory of United States fish collections

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A recent survey of 36 digitized fish collections in the United States provides information on >30 million individual specimens contained in 2.5 million records. Since the last survey of fish collections (Poss & Collette, 1995), specimen holdings have increased, and several large infrastructure and collection data storage changes have occurred. Global digitization initiatives, like iDigBio, have dramatically influenced the accessibility of collections data through the use of digital databases and data aggregation via cloud-based resources. In addition, in the 21 years since the last survey, an increase in georeferenced material, genetic samples, and metadata have followed the steady increase in specimen records. Maintaining accurate reports of collection holdings will be paramount if the current trend of diminishing support and perceived value for collections continues. Effective communication on the value of fish collection specimens and data can be achieved through frequently updated inventories and publishing frequent descriptions of data use. The data from surveys of collections will be published regularly in a dynamic web resource that will aid collections staff in communicating collections value while simultaneously giving stakeholders a way to explore collections holdings as they relate to the institutions in which they are housed. This resource will allow collections to leverage their data to aid in the procurement of financial support and communicate collections value. In the future, other taxon-specific national collection inventories could be conducted to contribute to our national awareness of biodiversity collections.

Public Access to Collections

Keeping "history" in "natural history": scientific specimens as artifacts of cultural heritage

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Scientists are aware of the importance of natural history collections as repositories of tangible scientific data, evidence of earth's changing biodiversity over the course of time. But in telling the story of the natural past, scientists risk losing key opportunities for connecting with a diverse public—as well as valuable funding—if they overlook or downplay the cultural value of natural collections. In addition, the failure to appreciate the historical relevance of scientific specimens often leads to the loss of irreplaceable collections which are viewed by non-scientists as arcane or even morbid. In making collections accessible and relevant to the general public, the most dynamic approach in the field of natural history will blend scientific, cultural, and historical narratives to capture the interest and appreciation of the broadest possible audience. This talk explores ways to open a dialogue between scientists and anthropologists, historians, and heritage preservation professionals who are interested in developing exhibits, research work, and educational programs that interpret natural history as part of a shared human heritage.

New Solutions|Collections Management

Working toward best practices of collection stewardship to ensure the sustainability of a university collection

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The collections of the Earth and Mineral Sciences Museum & Art Gallery at Penn State embody the scholarly heritage of the university's geoscience researchers and educators. Promoting the collections as a unique resource of knowledge relevant to current and future research is dependent upon adopting and customizing collection stewardship practices that ensure the sustainability of the collections and associated data while meeting the standards and best practices of collections care. The collections, comprised of geological specimens (rocks, minerals, fossils), modern osteology, historic mining artifacts, and fine art, have been moved from sub-standard spaces on campus to a single off-campus storage facility. Developing strategies for housing the variety of material types in the collections is central to creating sustainable storage practices. Viewing the collections in terms of material type is crucial to defining storage environment requirements. Steps taken to improve collection storage include creating microclimate storage containers. Populating the collections database with textual and image data plus reclaiming disassociated collections data are steps toward improved collection management. Creatively incorporating specimens and objects from the collections into exhibits, curriculum, and other object-centered research, interpretation, and educational activities are steps toward improved collections awareness. The challenge of maintaining standards and best practices of collections care, while capitalizing on the attributes of the diverse EMS Museum collections and working within the constraints of limited staff, funds, and space, is crucial to maintaining the collections relevancy and sustainability as an agent of education, research, and cultural history.

New Solutions|Conservation

Assessing levels of DNA and RNA degradation in frozen tissues archived in natural history collections

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Frozen tissues archived in museum collections are a primary resource for researchers. They are used in a variety of disciplines, including phylogenomics, histology, and virology. Recently, liquid nitrogen freezers have been identified as best practices for long-term archival storage. Liquid nitrogen freezers allow tissues to be stored at a lower temperature, reducing the rate of degradation of DNA and RNA. Historically, many museums have relied on mechanical freezers that store tissues at -80 degrees Celsius, whereas liquid nitrogen freezers maintain temperatures of -190 degrees Celsius. The Natural Science Research Laboratory at the Museum of Texas Tech University recently obtained five liquid nitrogen freezers and staff members have been in the process of transferring the tissue collection from mechanical freezer storage into liquid nitrogen archival. The effects on sample integrity due to long-term storage at -80 degrees Celsius are not well characterized. To address this, we obtained liver and muscle samples collected at various time intervals (1986, 1996, 2006, and 2016). We maintained a sample size of 25 for each time interval; with the exception of 1986, where only seven samples were available. The samples have been sent to RTL Genomics, where DNA was robotically extracted, and a fragment analyzer is being used to assess the quality of the DNA. Statistical analyses will be performed to measure and compare the DNA quality from the different tissues to see if any degradation has occurred in older samples.

New Solutions|Collections Management

What once was lost can now be found in the cloud (part 1 of 2)—handling unidentified legacy herbarium collections at the New York Botanical Garden

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Just completing its 125th year, the New York Botanical Garden has had a long tradition of worldwide expeditions; with the last fifty years focused on regions of high diversity and endemism in the New World Tropics. The Garden has taken great care to process the collections made on these trips and have them identified by the world's specialists. Even with these efforts, we are left with a large legacy of specimens yet to be determined. These tend to be the most difficult specimens to identify as a result of gaps in expertise, and in some cases because the specimen does not match any known species. Our best practices in herbarium management have been to avoid distributing duplicates until a collection has been identified to species. In an era before databases, this ensured the most organized and efficient way to handle determinations. The drawback is that the specimens are stored in a cold storage room separate from the accessioned herbarium and are not seen by the wider botanical community. With such a large, actively growing herbarium, it begs the question, how long do you wait for a determination before distributing an unidentified collection? The last twenty years have continued to show us new ways databases can aid our work; now allowing us to change our protocols and get more legacy collections out of the cold room and into the herbarium.

Public Access to Collections

Collections for the future: specimens and data going fully digital

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Over the past several decades, natural history collections have increasingly embraced digitization as a necessary part of their daily activities. However, digitization objectives and approaches are inconsistent across collections. In the face of stochastic resources, efficient digitization strategies must also include plans to safeguard against lean times. Core data of most

(91%) of the Canadian Museum of Nature's Vertebrate Collections (CMNVC) are digitized. Since 2015, current CMNVC digitization practices have been revised to produce an innovative and long-term digitization strategy. Four indicators are used to assess the progress of the CMNVC digitization strategy: visibility, accessibility, usability, and sustainability. All specimens and relevant data, including geographical data and images (2D and 3D), as well as associated documentation, should be databased and made available online. Here, we review some strategic and innovative initiatives for a successful CMNVC digitization strategy, and highlight some challenges that remain unsolved. Digital tools are key to the success of our strategy. CMNVC data will soon be migrated to a new institutional database that will also distribute its data through biodiversity data portals. 3D scanning technology will be included as common practice in the CMNVC digitization process. The resulting 3D images will be useful for remote examination of specimens and morphometric analyses otherwise impossible to complete because of loan restrictions or because researchers are unable to visit the collection. 3D imaging also durably preserves the morphological integrity of specimens prone to damage during observation and use, particularly as a result of destructive sampling. Finally, we discuss ways to add value to existing digitized records to increase use and accessibility of collections.

Disaster Preparedness

Friends in need: a practical guide to getting help from neighbors when disaster strikes

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You've probably thought about how your staff would respond to a disaster, but have you considered getting help from neighboring institutions? Partnering with likeminded organizations to agree on mutual aid in the event of a disaster can offer a wide variety of resources that may not be otherwise be available to you. From freezer space to staff specializations, mutually beneficial aid agreements outline how and in what circumstances institutions can rely on one another's resources for assistance. But before you sign on the dotted line, there's a lot to consider—whose insurance covers what scenarios? What types of resources can you realistically offer? Who buys supplies? And how does this all tie into your disaster plan? This workshop will provide practical advice on thinking through the details of mutual aid situations before you find yourself in the midst of one. Participants will receive a mutual aid agreement template and related worksheets to help them move forward with forming partnerships to support their institution in the event of a disaster.

New Solutions|Collections Management

Addressing complex collections: Separating the concerns of research and collection management in natural science collections data

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Natural science collections are libraries of our knowledge of the natural world. Both the variable physical nature of the vouchers and thecuratorial practices amongst the various biological disciplines introduce apparent complexities into managing the digital information associated with the vouchers held in natural science collections. Many data models and database implementations are able to capture relatively complicated data, but only for subsets of the range of complexity of vouchers. This practice fails to capture

the full richness of variability in the artifacts produced by workers in different biological and geological disciplines. We will present a set of examples, from different biological and geological disciplines, of typical complex vouchers. These examples illustrate complex problems and shared patterns across disciplines on what data may need to be managed in a more thorough way than is available in many of the current collection management systems. We will describe some of the general ways existing systems try to manage this data and what potential problems exist through assumptions by collections staff and researchers about the data as well as the physical objects. A discussion of what some potential solutions for this problem, as well as what challenges it brings up for data sharing and adjusting existing data models, will move this problem forward and provide a way for collections staff, data managers, and developers to start working on solutions for the natural science community.

Public Access to Collections

Nevada's neglected Lepidoptera herbarium

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Natural history collections at the Nevada State Museum, Las Vegas are varied and mostly unknown to the staff and local researchers. This is the result of a lack of personnel, budget, field notes, splitting of collections, and inconsistent museum documentation. The museum houses a herbarium of approximately 2,000 Nevada Lepidoptera host plants and a Lepidoptera collection of about 20,000 specimens. This presentation will describe these collections, discuss the organizational methods, demonstrate the usefulness of partnerships in managing the collections, and will gather input into determining our next steps in the documentation process of these collections. It is the goal of the museum to inventory, catalog, and digitize the herbarium and any affiliated Lepidoptera specimens into a global database providing easy researcher access and to facilitate management of these collections. During this multi-year process, it has become clear that there is an association between the herbarium and Lepidoptera specimens removed to the McGuire Center for Lepidoptera and Biodiversity at the University of Florida, Museum of Natural History in Gainesville, Florida from the museum, upon the departure of former curator, lepidopterist George T. Austin (1943–2009). It is important to combine this data in a usable and accessible manner through partnerships and established museum management methods.

Disaster Preparedness 2

How to write a disaster plan! Business continuity and collections salvage in a European perspective

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Being aware of its responsibility to protect its vast collections, the Natural History Museum, London developed plans and procedures within a Business Continuity Management framework to assist in the salvage and initial treatment of affected collection material in the wake of a disaster. In an effort to facilitate its use, the NHM collections salvage plan follows the same format for each department that allows for shared salvage materials and equipment and works at different administrative levels. This approach is used to illustrate the components of a disaster plan and the issues to be considered when designing it. This is done against the background of a European perspective where information and experience gained in workshops on disaster preparedness during the Synthesys Network Activity C project was used to develop a template collection salvage plan. The benefits of cooperation between partner museums on the local level to speed up salvage but also on the national and international level with regard to shared training are discussed. Adequate staff training (e.g., during a salvage exercise) is crucial for a professional and effective response to a disaster.

New Solutions|Conservation

Effective preservation decision strategies

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Decisions about preservation issues are made both deliberatively and unconsciously. Heuristics operate as intuitive processes which are rapid and can be reliable and effective. Deliberative decisions require time to complete and can be described by an analytic-deliberative model. The characteristics of these two processes and their relevance to preventive conservation decision-making are discussed. Each of these two processes has its strengths and weaknesses. People naturally make decisions and utilise a range of strategies without necessarily having insight into the process. This paper provides a frame to help examine, describe, and reflect upon our own and others' decision making in order to improve both processes and outcomes.

New Solutions|Collections Management

Bones, boxes, and barcodes: the recuration of herpetology and ichthyology skeletal specimens at Yale Peabody Museum of Natural History.....so far

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Over the past 150 years, the herpetology and ichthyology skeletal collection at Yale's Peabody Museum of Natural History has grown from a small, but representative, collection mainly used for teaching, to a collection used by researchers and educators globally. The collection now consists of more than 5,100 specimens representing over 1,200 taxa. During the time since the collection's inception, the diversity of the collection was mirrored by the diversity of storage methods, ledgers, databases, note cards, Post-it notes, and the increasing need to track collection storage locations and use (especially "rogue loans": specimens borrowed by the user and not officially signed out). A grant-funded recuration project began in autumn 2016 with the expressed goal of upgrading storage conditions (including cabinetry), performing conservation of dirty, unfinished, or damaged specimens, imaging all specimens, and improving the tracking of specimen use and movements through the use of bar-code technology and "self-serve" checkout stations for students and curators. The project is projected to continue until March 2018. The story, thus far, will be presented.

New Solutions|Collections Management

The present is the key to the past: the evolution of best practices at the Yale Peabody Museum of Natural History

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Participation in SPNHC and other professional societies and sponsored-workshops has encouraged the need for improved standards, methods, and procedures for collections stewardship at the Yale Peabody Museum of Natural History. Over the past 35 years the Peabody Museum has completed major master planning and strategic planning exercises. The Museum has drafted and implemented a comprehensive collections policy and unified procedures for ten curatorial divisions. Significant infrastructure improvements to our facilities have improved our storage and management spaces. Participation in numerous technological innovations across the Museum and the natural history community have driven the accessibility of our collections to a broader audience through improved dissemination. Together, these museum-wide and community activities have driven our practices and promoted improved collections stewardship. Individual discipline procedures have been identified and informed shared practices across the Museum, and have led to several consensus best practices. From each activity a series of best practices has emerged and changed the way we operate at the Yale Peabody Museum of Natural History.

Demo Camp

Kurator-Web: making data quality-control accessible

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In the Kurator project, we are building data quality-control tools that can be readily used by many parts of the community with different levels of skill—tools that can be plugged into a curator's or researcher's data management processes at multiple places. One such tool is the Kurator-web application, which allows users without programming experience to execute data quality-control workflows. We will demonstrate the use of Kurator-web to run pre-existing data quality workflows, including workflows that align datasets with Darwin Core terms, workflows that list unique values in datasets, workflows that compare unique values in datasets with community developed controlled vocabularies, and workflows that perform tests from the developing TDWG set of standardized data quality tests and report results in terms of a fitness-for-use framework. We will also demonstrate a graphical workflow builder in the web interface for developing and tuning a workflow on the fly, by wiring together existing configurable components for data input, quality control, and output. Finally, we will look behind-the-scenes and examine the workflow configuration files used by the Kurator web application to execute quality control workflows using the Kurator-Akka engine.

New Solutions|Conservation

Adaptation: modifying pest management strategies to specific situations

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Ideal pest management strategies in museum collections include preventive conservation to avert infestations. Protocols exist to control pests when they inevitably infiltrate collections, but rarely do the circumstances of an individual outbreak match the situations outlined in pest management protocols. Pest management strategies are normally presented as a one-method-fits-all solution. As each museum collection is unique, so must be the response to an individual infestation. Ignoring the uniqueness of each infestation makes pest management strategies difficult to use and adapt to suit the variety of conditions comprising an infestation. Rather than relying on a single pest management protocol, a flexible response to infestation based on specific circumstances would be more efficient. Many museums already adapt standards based on their individual circumstances, but formal, flexible protocols are difficult to find. I present data obtained during the University of Kansas Biodiversity Institutes' recent infestation, along with its reaction

to variable circumstances, to elucidate how adapting current protocols to individual situations can result in a reaction to an infestation that effectively mitigates damage to specimens, regardless of museum collection size or contents. Presenting ways that standards can be adapted to variable circumstances will enable the entire museum community to make use of the protocols.

Demo Camp

Kurator-YW: using YesWorkflow hybrid queries to reveal data lineage from data curation activities

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The Kurator project provides a workflow framework (Kurator-Akka), suites of pre-defined workflows and actors (e.g., Kurator-Validation), and an associated web interface (Kurator-Web) to create and execute data quality-control workflows. Kurator-Akka also provides a query environment in which provenance recording and reporting capabilities reveal the changes curation workflows make to specific datasets, and the specific activities responsible for those changes. We will again demonstrate the use of the YesWorkflow (YW) toolkit to annotate data curation workflows in conventional scripts (e.g., Python, R, Java) and demonstrate its extension to YAML-based Kurator workflow configuration files. YW will render a top-level graphical view (prospective provenance) of the workflow structure or a combination of the Kurator-Akka workflow structure with the (script-based) workflow structures internal to each actor. YW also supports dynamic analysis and reporting on the results of the workflow (retrospective provenance) at various levels granularity (e.g., at the actor level, script level, data level, record level, file level, function level, provided that it has been configured at each). Provenance, like other metadata, appears to be rarely actionable or immediately useful for those who are expected to provide it. However, by refactoring and integrating runtime observables generated from retrospective provenance and context information from prospective provenance analysis into hybrid queries, we show how both elements can yield hybrid visualizations that reveal "the plot" of the whole execution. In this way, a comprehensive workflow graph and a customizable data lineage report are made actionable for a workflow run with meaningful provenance artifacts.

Impacts of Changing Regulations

The ABCs of ABS: the Nagoya Protocol on Access and Benefit-Sharing and its relevance to natural history collections in the U.S.

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The Nagoya Protocol, a supplementary agreement to the Convention on Biological Diversity (CBD), was developed to ensure compliance with fair and equitable sharing of benefits arising out of the utilization of genetic resource, which includes specimens in biological collections. This agreement establishes a legal framework for access and benefit-sharing (ABS), requiring countries to clarify access procedures, share benefits that arise from utilization of genetic resources, and ensure that users comply with provider country laws. The changing international landscape associated with ABS is greatly altering the way that researchers and collections can acquire and use traditional natural history specimens and their associated genetic samples. Therefore, all natural history museums, including those in the U.S., must be aware of the implications of the Protocol, regardless of whether it is ratified by their country. The presentation will give an overview of the ABCs of ABS (Access, Benefit-sharing, and Compliance), explain how the work in natural history museums can comply with this international agreement, and introduce relevant resources, guidelines, and tools.

New Solutions|Collections Management

What once was Lost can now be found in the cloud (part 2 of 2)—new protocols for exchange of herbarium specimens and data in the digital age

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Historic practices of collecting and disseminating plant specimen vouchers through wide distribution networks of participating herbaria have always greatly benefited botanical science. Even today, in the age of mass-digitization, the sharing of duplicates continues to enhance the accessibility of identifiable specimens to specialists and other researchers across the world. Open communication between institutions holding duplicates has always been an essential component in the functioning of this cooperative system. Nowadays, steady growth in collections held by one institution which are fully-digitized elsewhere makes it increasingly important that we design herbarium management practices to specifically leverage these distributed efforts. One major obstacle is that the majority of exchanged and newly accessioned specimens are not accompanied by digital data. Fortunately, as standards such as Darwin Core become more universal, many previous hurdles to direct inter-institutional data-transfer have eased. Arguably, the most significant complications with database harvesting relate to identifying metadata concurrencies between specimens (i.e., collector and collection #) which are usually only available following complete digitization. While it is likely impossible to completely eliminate repetitious efforts to fully-digitize duplicate vouchers, some surprisingly simple practices could help reduce redundancy through facilitating concurrent exchange of herbarium data and dramatically improve overall efficiency within and between institutions.

New Solutions|Sustainable Facilities

Advancing research and knowledge in South Africa—towards a Natural Science Collections Facility

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Natural Science Collections in South Africa amount to approximately 18 million specimens. Of these, 12 million have been surveyed. They are housed in 40 institutions with 5 million records in databases. Approximately 3 million are plants, 8.5 million are animals, and 0.5 million are rocks and fossils. They therefore represent a significant portion of the national (and global) research infrastructure. Of these collections, more than half are not databased. The South African Research Infrastructure Roadmap (SARIR) was launched in 2016 at the International Conference on Research Infrastructure. Points were noted regarding open science, data driven initiatives, and addressing broader issues around serving society (poverty, inequality, unemployment). To this end, there is a government initiative to establish a distributed and centrally co-ordinated national Natural Science Collections Facility (NSCF) that realizes the full potential of the collections. This is in the process of being developed to ensure that collections contribute, through high quality research and data, to addressing issues of socio-economic importance. The objectives of the NSCF are: 1. Collections secured and accessible for research in healthy and safe environments, 2. Database of collections accessible and used for managing collections, research, and decision-making, 3. Research on collections and data carried out to address issues of national and global relevance, 4. Collections used to provide identification services for biological specimens, 5. Collections valued for serving society through education, citizen science, and public understanding projects. This project is still in its planning stages. But once implemented, it will go a long way in the preservation and promotion of the country's natural science collections.

Public Access to Collections

Homo naledi, a new human relative—recovery, curation, and dissemination

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In November of 2013, the Dinaledi Chamber of the Rising Star Cave, South Africa, yielded more than 1550 identifiable fossil elements of the newly described species Homo naledi. This represents the largest single collection of fossil hominin material found on the African continent to date. The almost inaccessible chamber and moist environment in which the fossils were found presented significant practical and methodological limitations regarding the recovery, as well as challenges for subsequent curation. The six carefully chosen palaeoanthropologists-cavers who entered the chamber followed strict protocols in the excavation process to ensure the successful recovery of the fossils without loss of context or damage. Recording of fossils and the excavation process was achieved through the use of white-light photogrammetry and laser scanning. Fossils were individually sorted, identified, and boxed in the field and then transferred to the vaults of the University of the Witwatersrand where they were catalogued and stored in a manner that makes them accessible for scientific study whilst minimizing the risk of damage and loss. It took months to process all the fragments and assemble them into a minimum of 15 individuals—male and female, adult and subadult. In May 2014, an early-career workshop involving 54 local and international scientists was held and resulted in the description of all fossils recovered. On announcement of the discovery, approximately 80% of the fossils were placed on public display allowing for both public and scientific access.

POSTER PRESENTATIONS, June 21 and 22

Wednesday, June 21, 3:50pm–5:00pm

1. Disaster Preparedness

A vapor phase nitrogen cryogenic biorepository for the Division of Genomic Resources, Museum of Southwestern Biology

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The Division of Genomic Resources (DGR), Museum of Southwestern Biology (MSB) at the University of New Mexico is a natural history biorepository archiving >500,000 cryogenically-preserved samples representing 250,000 specimens and 3,000 species from the Divisions of Mammals, Birds, Reptiles and Amphibians, Fishes, and Parasites. Established in 1979, MSB DGR is the largest global collection of mammalian frozen tissues and among the ten largest collections of frozen bird tissues in the US. In 2016, the MSB received funding from the National Science Foundation (NSF # 1561342) to transition to vapor phase nitrogen storage as part of a remodel and expansion of the existing collection space by the University of New Mexico. This 3-year grant will result in 1/3 of the collection transferred from mechanical freezers to more secure vapor phase nitrogen storage at < -180C. Vapor phase nitrogen storage is ideal for genomics collections as samples are stored at colder temperatures capable of maintaining DNA and RNA quality for the long term. In case of catastrophic power failure, vapor phase nitrogen tanks are independent of the electrical supply, maintaining temperatures for up to 21 days. On-site liquid nitrogen supply is provided by a nitrogen cryogenerator and a 2,000L bulk tank on emergency backup power. Samples are searchable and trackable online via object

tracking with the Arctos database (http://arctos.database.museum/) archived at the Texas Advanced Computing Center. At full capacity, the MSB DGR collection will house and provide nitrogen supply for 11 vapor phase nitrogen tanks storing approximately 1,000,000 samples.

2. Public Access to Collections

Rediscovering collections in curation: a cache of Pleistocene locusts

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In 1952, archaeologist Phil C. Orr, Santa Barbara Museum of Natural History, collected the contents of a cache pit containing the remains of approximately 700 locusts from a dry cave in western Nevada. The cave, on public lands managed by the Bureau of Land Management, is located at Winnemucca (dry) Lake. The Nevada State Museum curates artifacts and specimens from Orr's excavations, as well as other collections removed from federally managed public lands. Orr recognized that the cache was culturally deposited and might be Pleistocene in age. However, he did not pursue further research of the cache. The locusts remained stored in the original paper bag from the excavation, largely unnoticed, except for periodic inventories. During the most recent inventory of the Orr collection, Curatorial Assistant, Evan Pellegrini, took an interest in the locust cache. After studying field notes from Orr, Pellegrini believed the cache might document Early Holocene (11,600–8,900 cal B.P.) Native American use of insects. A direct AMS date on locust chitin, however, yielded an age of 12,310+/-40 C14 yrs. B.P. (14,195 cal B.P.), representing the oldest date for human occupation of the region. After receiving the date, Pellegrini screened the collection and sorted the faunal and floral components of the cache. Hojun Song, Texas A&M Entomology Department, confirmed the species of the grasshoppers as the historically extinct Rocky Mountain locust (*Melanoplus spretus*). This locust's home range was principally east of the Rocky Mountains, but occasionally extended into Nevada and California during locust plagues.

3. Advances in Digitization Worldwide: an iDigBio Symposium

Crowdsourcing carabid collections

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Danny Shpeley, Felix Sperling
E.H. Strickland Entomological Museum, University of Alberta, Edmonton, Alberta, Canada

The University of Alberta's E.H. Strickland Entomological Museum contains over 200,000 carabid beetle specimens, of which more than three quarters (174,308) have had their collection information digitized and made publicly available. Here, we describe our efforts to digitize the remainder of our ground beetle holdings for North America as part of a continent-wide initiative with collaborators in the United States and Mexico. Our goal is to make carabid biodiversity information publicly available to researchers investigating the effects of climate change on the diversification and ecological dynamics of this widely studied insect family. Over 20,000 carabids from the University of Alberta's E.H. Strickland Entomological Museum were photographed along with their collection labels. Two part-time undergraduate students completed this work over a period of 23 weeks using standards and guidelines adapted from those used by the University of California Berkeley's Essig Museum of Entomology. Transcription of collection label data from the images is now actively being crowdsourced to an online community of volunteers using the Notes from Nature project. Upon completion of data transcription, data will be checked for quality control, re-integrated with our local database, and published to the Global Biodiversity Information Facility (GBIF), iDigBio, and Canadensys data aggregators to ensure persistent public availability for researchers.

4. Advances in Digitization Worldwide: an iDigBio Symposium

Better quality, less work: how to improve collections data with the efficient use of resources provided by aggregators and consortia

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Digitizing specimen data both improves accessibility of biodiversity collections to external audiences and highlights opportunities for improving internal data quality. Here we demonstrate the latter through the data management experience of The Chicago Academy of Sciences/Peggy Notebaert Nature Museum (CAS/PNNM) as it has collaborated with collections data consortia and with biodiversity data aggregators. Consortia provide a broad, verified (to varying degrees) base for comparing and cleaning data, including collector names, taxonomy, and localities. Consortia also facilitate discussion over data standards and methods at a level that many collection managers and curators may feel more comfortable entering, as opposed to, e.g., similar discussions happening at the level of data standards governing bodies. We present the workflows used at CAS/PNNM to take advantage of and contribute to consortia resources from Arctos and from the InvertEBase Thematic Collections Network. For published specimen data, biodiversity data aggregators provide a variety of tools—e.g., iDigBio's data quality flags, or VertNet's annotation function—that CAS/PNNM has been able to effectively use to repatriate data quality improvements. These workflows are also described. The effort we put into digital data quality improves physical collections management as well, ensuring that specimens are uniquely identified and, when applicable, united with data from disparate physical sources. This poster aims to share our experience in the form of workflows that may be relevant and reproducible for other collections.

5. Advances in Digitization Worldwide: an iDigBio Symposium

Digitizing Paleogene mammals from the Rocky Mountain Region

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Early fossil mammals are very small and generally represented in the fossil record only by the part of their bodies most resistant to decay: their teeth. Fortunately, the features of mammal molars are frequently diagnostic of genus, if not species. Accurate tooth measurements and access to comparative material expand the potential for identification based research projects. The University of Colorado Museum of Natural History (UCM) Fossil Vertebrate Collection is enacting an IMLS-funded digitization project of Paleogene mammal specimens from the Rocky Mountain Region (CO, UT, WY, NM, SD). Teeth are well represented in the UCM collection. The project will produce approximately 4,400 high resolution, focus stacked, TIFF images of 1,100 identified fossil mammals. Specimens are selected from the collection to represent the upper and lower dentition of each species. The specimens are photographed repeatedly throughout the depth of field and from multiple angles. The composite, edited images include a scale bar and UCM catalog number. All images are backed up on multiple hard drives and uploaded to the cloud (GLOBUS) as well as the university network server. The images are JPEG formatted to be shared on the UCM collection's online database (CollectiveAccess) and will be published on the iDigBio portal. The online availability of the JPEG images allows for general public access, and the TIFF images are available on request to researchers. The preservation of the specimens will be enhanced by the reduction in handling; e-loans help prevent damage and loss.

6. Advances in Digitization Worldwide: an iDigBio Symposium

Increasing data robustness for concretions using Inselect

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Due to a lack of rapid digitization protocols in the past, the paleontological community was unable to provide high resolution object data for samples with multiple specimens. In the past, we have often looked at a slab or concretion, identified and cataloged key specimens, and noted that additional objects were present. Extremely common taxa were "ignored" in favor of rare or visually appealing specimens on the sample. Now we can take high resolution images of a sample and isolate specimens from these images. Using Inselect, open source software for image cropping and metadata incorporation, has allowed us to rapidly digitize hundreds of specimens from multiple surfaces of a three-dimensional sample. Every object can then be cataloged individually and the specimens linked to each other, greatly increasing the quantity of data available to researchers as well as the completeness. Even though many of the samples are time-averaged, the data of which taxa are present and in what proportions can be extremely valuable. Expanding the context on small temporo-spatial scales by digitizing all of the objects in a multi-organism sample enhances ecological and taphonomic analyses in paleontology. In the Yale Peabody Museum, two projects, the Cretaceous World TCN and the Fossil Insect Collaborative TCN, are using Inselect to enhance digitization and provide more robust data to researchers. These improvements will increase resolution for community and ecological analyses and preserve the context of the assemblage for ecological and taphonomic analyses.

7. Innovative Uses of Collections Data an iDigBio Symposium

Update on the Fishes of Texas project

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The Fishes of Texas project (www.fishesoftexas.org), originating in 2006, remains the most reliable (quality controlled) and data rich site for acquiring occurrence data for Texas fishes, holding over 124,000 museum specimen records from 42 museums. We've examined over 6,000 specimen lots and greatly improved/amended data held by our data contributors. Among many discoveries, we've detected at least 3 freshwater species not known from Texas. We continue making improvements, but substantial updates so far have been onerous for our developers for various reasons. A recent major update reduces coding redundancies, points the website to a new restructured and more fully normalized PostgreSQL database (was MySQL), and places the code in a versioning environment. These changes have little effect on user experience, but will greatly accelerate development. PostgreSQL allows for complex spatial queries and users will be able to quickly map occurrences alongside numerous political/environmental layers. While our database/web designers have been implementing these changes and fixing bugs, we've been preparing resources for them to integrate into the website. Some highlights to expect: (1) new updates to the state Species of Greatest Concern list; (2) expert opinion-determined nativity spatial layers for all freshwater fishes displaying in our new mapping system; (3) dynamic statistical summaries; (4) new data types from the literature (>14500 records), citizen science (>4500), anglers (>32000), and agency databases (>800000); (5) new museum records, many derived from our gap sampling (17000, 4 museums); (6)

more specimen examinations (>400) and photographs (1000); and (7) document archive with smart text search tools (currently in beta testing using TPWD fisheries reports). Keep your eyes open for updates.

8. New Solutions|Conservation

Treatment of the American Ethnology Collections at DMNS

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DMNS opened the Avenir Collection Center in 2014, allowing the collections to be consolidated from over 49 separate storage areas into one purpose-built preservation facility. As the Anthropology Collection began moving, it rapidly became clear that many objects required stabilization treatment prior to storage mount fabrication. This led to a new model at DMNS for completing conservation work concurrent with rehousing. In this model, detailed condition examinations, treatment proposals, and the treatment itself are all completed for each individual object before it receives a customized storage mount. Previous DMNS detailed surveys and rehousing projects did not include a treatment component. Concurrent stabilization reduces handling and prevents the need for new mounts after a treatment has altered the shape, level of completeness, and/or consideration of fragile areas for the object. In 2016, the Museum received funds from the Institute of Museum and Library Services – Museums for America program (Collections Stewardship category) to undertake a three-year project to stabilize 375 high priority objects in the American Ethnology Collection using the new model. The grant application was posted on the IMLS website as a sample of recently funded applications that support activities in the Collections Stewardship category. The Avenir Conservation Center and some of the objects treated during the first year of the project will be available for viewing during the SPNHC tours of the Avenir Collection Center.

9. New Solutions|Collections Management

Applying best practices to data migration: a relational database for the New Mexico Museum of Natural History and Science

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The goal of this project is to create a relational database for the Bioscience Collection of the New Mexico Museum of Natural History Science (NMMNHS). Currently, the data are stored in several flat file databases separated by taxonomic group. In addition there are issues with data quality, including errors and missing data. As part of a practicum in collections data management offered at UNM's Maxwell Museum, I have developed a low-cost but viable database for collection management and research use. My objective is to produce a relational, normalized and user-friendly database in Microsoft Access for the staff and volunteers using the collection. A Memorandum of Understanding with the Museum of Southwestern Biology allows for partial use of the Arctos database, with a plan to eventually migrate all NMMNHS data to Arctos. Therefore to ease the eventual data transfer, in developing the database I consulted current standards of Darwin Core and the Arctos data structure. I am currently working on cleanup and consolidation of existing data for migration into the new Access database. Two of the major consolidations include locality and taxonomic information. Protocols for data integrity were also developed. This system will allow users to select from existing taxonomic and geographic data, which will reduce inconsistencies between records and make data entry easier. The user interface will allow a wide range of interactive options but will limit the ability for some users to edit tables. The results of this project will be available to cohorts of NMMNHS. It will also facilitate integration of data into the Arctos database in the future.

10. New Solutions|Collections Management

Building critical infrastructure for endangered species management: an event-based model

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The Museum of Southwestern Biology (MSB) has maintained a multi-decadal collaboration and repository agreement with the USFWS Endangered Species Recovery Program to accession, process, curate, and archive Mexican Grey Wolf (*Canis lupus baileyi*) specimens. MSB's database (Arctosdb.org) provides an online archive for linking associated data through multiple identifiers (e.g., catalog, studbook, and GenBank numbers) associated with complex systems including live sampling and archiving of museum specimens. Due to the endangered status of the Mexican Grey Wolf, multiple and diverse samples (e.g., serial blood samples, tissue, skin, and skeletal material) are associated with each specimen and linked to derivative data (e.g., gene sequences, isotopes, publications) that must be discoverable. In the past, each blood sample collected from live wolves and subsequent traditional specimens from deceased wolves was cataloged separately in Arctos. Samples collected from the same wolf but at different times and by different facilities were difficult to track. Over the last five years we have worked with Arctos developers to create an event-based model for specimen data, whereby all information from a single wolf, including time series samples, can be tracked under a single unified record. As new specimens from wild and captive populations enter the repository, their information is now databased using these new protocols established by MSB and USFWS personnel. This project streamlines specimen curation, discoverability, and accessibility and represents a model for how museums and federal agencies can collaborate to build powerful data management and archival infrastructure for critical wildlife management and endangered species recovery efforts.

11. New Solutions|Collections Management

Preserving natural history collections through student involvement and public interest

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Public interest in natural history collections has declined in recent years. This may stem from a lack of public exposure, especially in certain age groups. Many proponents of natural history collections likely had some exposure to collections that sparked an interest in these collections as children or young adults. Several students and faculty members at Arkansas State University (A-State) formed a club that curates and maintains natural history collections after noticing an interest in the natural history collections. These collections are now used for research, education, and public outreach, but were previously neglected. This club approach can reach members of the public and students with relatively little exposure to natural history collections. The club approach can also nurture interests in students who want to work in these collections and learn how specimens are prepared and maintained. Interested students not only gain valuable knowledge and experience, they also acquire skills that can lead to careers as collections professionals. The Natural History Collections Curation Club has also assisted in founding similar clubs at several other institutions. Multiple clubs can

catch more public interest and initiate a bottom up effect that ultimately benefits natural history collections as a whole. The two major outcomes of this approach, public exposure and creation of future professionals, are beneficial to maintaining small natural history collections as well as supporting larger collections. We believe this club approach can preserve natural history collections by fostering student involvement and engaging the public.

12. New Solutions|Collections Management

Project Macroinvert: bringing aquatic macroinvertebrate collections out of the dark at Arkansas State University

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The George L. Harp Aquatic Macroinvertebrate collection at Arkansas State University is comprised of approximately 200,000 specimens collected by Harp and his students from 1976–1987. Since his retirement, the collection has been stored and not well-curated. In fall of 2016 two undergraduate honors students undertook the task of restoring the Harp collection. Currently, we are working to digitize the over 20 individual student notebooks that represent the only known written data for the collections. Catalogs were imaged in 2014 and are now being transcribed. Once transcription is complete, we will match label information from specimens to existing catalog records. All specimens will be cleaned and transferred to new containers and fluids. In addition to steps to curate this collection, a standards of operations manual will be created to guide future students, faculty, and researchers using this collection. These specimens are likely the best representation of aquatic macroinvertebrate diversity for the state of Arkansas. We expect the digitization of these data to be greatly beneficial to research efforts in Arkansas and the eastern United States.

13. New Solutions|Collections Management

DNA collection from field to freezer: an example using fish

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Advances in genomic research have had a major impact on our scientific understanding of life on Earth, including the importance of biodiversity in ecology and evolution. Underpinning this scientific progress are dedicated tissue collections, or biorepositories, that contain the genetic materials of individual museum specimen vouchers that represent a host of the world's species. It is important to recognize the process by which the genetic materials maintained in museum biorepositories are collected and preserved, as the collaboration of multiple museum units makes the process distinct from a standard Laboratory Management System protocol. The Smithsonian's National Museum of Natural History (NMNH) has developed a methodological workflow for successfully collecting, preserving, and tracking genomic resources for current and future scientific research. Here we illustrate the specific steps, procedures, and supplies involved in the collection, extraction, and permanent storage of DNA at the NMNH. A fish DNA collection is used as a model to demonstrate the correct collection and preservation practices that are essential to ensuring that the highest quality genomic resources are available long term to the scientific community.

14. New Solutions|Collections Management

Fishes DNA collection loan processing

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The National Museum of Natural History's (NMNH) Biorepository currently houses and handles a rapidly growing collection of 30,000+ frozen genome-quality DNA samples derived from fish, amphibians, plants, mammals, birds, insects, invertebrates, and reptiles. These samples are available to both intra- and extramural researchers following proper departmental loan request procedures. Upon receiving a request the appropriate department will approve or deny the loan request after careful consideration. If approved, it is then sent to the NMNH Biorepository Manager to begin processing. Using the inventory tracking software, FreezerPro, Biorepository staff generate a pick list to locate frozen samples in freezers. Matrix boxes containing DNA samples are then manually located, removed from ultra-cold storage, and transferred to a +4° Celsius refrigerator to thaw prior to sampling. Up to nineteen boxes containing samples are loaded onto the deck of an automated tube handler. The requested samples are pinpointed using an automated pick arm that can sort five hundred (500) tubes per hour. DNA samples are located using a globally unique 2D barcode and scanned for accuracy before being transferred to a new, temporary box for sampling. Following proper Biorepository sub-sampling procedures, DNA aliquots are taken from the picked samples before being returned to the temporary box. Following sub-sampling, the boxes are returned to the platform of the automated tube handler, samples are picked and returned to original locations, and boxes are returned to the appropriate storage location within the NMNH Biorepository freezer. Next, the requesting department is notified that their loan request has been processed.

15. Public Access to Collections

Yes! you can touch these (developing a hands-on exhibit with pelts)

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For over 25 years The Museum of Fauna and Natural Science has exhibited a permanent collection showcasing the wildlife of Mexico and the world through 22 dioramas. This is the only natural history museum in Monterrey, a city located in the northeastern state of Nuevo León, México. After The Museum was approached by a Mexican government agency that had recently confiscated a number of pelts, we came up with the idea for the Sensorial Safari, an exhibit to use the pelts that would otherwise have been destroyed. Security measures were required in regards to the possible arsenic contamination of the confiscated pelts, as well as the ongoing care of the other mounted animals that are part of the exhibit. Arsenic paper tests were performed on all the pelts in the exhibit to avoid harmful contact to anyone handling them; a schedule of regular care and monitoring of all specimens was also developed. Through this exhibit, we intend to spark curiosity in visitors about nature and teach them about the local wildlife, addressing topics like camouflage, the purpose of different types of fur, food chains, what responsible hunting is, and how it relates to conservation and the environment.

16. Public Access to Collections

Natural history in Europeana

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Europeana is the European digital library. The OpenUp! infrastructure facilitates the publication of multimedia objects from natural history in Europeana. Currently (January 2017), 3.2 million such objects are accessible on the Europeana site

(Europeana.eu). In addition to the data also available via, e.g., GBIF, the OpenUp! aggregator provides metadata enhancements, e.g., the addition of common names of organisms. The poster summarises our experience with the publication of collection objects in a cross-domain portal with its main audience in the cultural domain.

17. New Solutions|Conservation

Strategy for managing an ichthyology collection with space limitations

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Like many collections we are faced with severely limited space and workers. In our collection we've been forced to conduct various space saving measures including the move of many of our specimens off-site and being held under less than ideal conditions. Despite these efforts space is still limiting. Utilizing our remaining space and workers effectively has been key to our continuing to improve and grow our collection. We are experimenting with a shelving system that efficiently uses space and dramatically improves worker effectiveness. Traditionally natural history collections are arranged taxonomically, leaving space after each taxa for growth. We are now using a much more compact shelving system with jars arranged regardless of taxonomy and instead sequentially by catalog number with no spaces. Our collection is split into these two separate shelving systems for the time being as we evaluate the new system. Here we review our experiences with both systems and recommend best practices. Besides the saved space, one of the biggest advantages is the time saved on reorganizing jars and other space saving measures. We've reallocated much of that saved time to greatly increased collections growth, more data collection from those specimens (we now measure and record specimen lengths), and specimen digitization.

18. New Solutions|Conservation

Putting the monkey back in the classroom: the conservation and restoration of a mounted guenon monkey

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As mounted taxidermy specimens in natural history collections age, original components like fingers, toes, and hair, as well as areas sculpted by the taxidermist, may become damaged, aged, or lost. The deterioration often causes the specimen to be pushed to the back of the shelf, making it unfit for display or for educational activities. Such was the case for a mounted guenon monkey held in the Education Department at the American Museum of Natural History. The mounted guenon, a DeBrazza's Monkey, had lost almost all of its characteristic white mustache and beard, several fingers had broken off, and the skin on its foot and ankle had torn in two locations. In order to conserve and restore the guenon monkey for the Education Department, tears in the skin were mended, lost facial hair was replaced, and the missing fingers were remade. This poster will describe three effective methods of restoration used to revitalize this mounted guenon monkey: flocking hair, casting pigmented wax fills for finger replacement, and techniques for mending torn skin with different adhesives.

19. New Solutions|Collections Management

Tackling the challenging process of preparation of old, fluid-preserved whale bones

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Assembling skeletal parts is pivotal to building mammal collections. Keeping bones dry and flesh-free makes them readily usable in research and

education, and not attractive as a food-source for undesirable pests. The Canadian Museum of Nature keeps an assemblage of thousands of Cetacean samples, consisting mostly of fluid-preserved anatomical parts, collected during the whaling period in the 1960s in eastern Canada. These samples include bulky pieces of bone with large amounts of oil and residual flesh that were first fixed in 10% formalin then preserved in 70–75% ethanol for decades. Completing a usual bone preparation process with these fluid-preserved bones was challenging. Alternatively, we aimed to determine a practice that provides the best results in cleaning such fluid-preserved whale bones. We attempted to rid the cured, tenacious oil and flesh while making sure to get the bones perfectly dry and undamaged. Here, we describe and evaluate these preparation methods. We used a process that included compost and ammonia solutions. Bones were first buried in a large pen filled with sheep manure and straw. A cycle of 18 days was used 4 times to raise the compost temperature to 55°C–65°C for optimal bacterial activity. The bones were then unearthed and placed in a solution of 4% ammonia for a few days. Finally, bleaching them in peroxide for a couple of hours rid the stains that resulted from the burial. This original process combined 2 methods that allowed us to successfully obtain clean and ready-to-store bones.

20. Public Access to Collections

Enhancing public access to UCMP's fossil insect collections through digitization and social media

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In 2015, the University of California Museum of Paleontology (UCMP) joined the Fossil Insect Collaborative, TCN, as a Partner to an Existing Network (PEN). The Berkeley Fossil Insect PEN (BFIP) has web-mobilized digitized data and images of nearly 6,000 specimens. Specimens include compressions from Stewart Valley, NV; 3-D whole body insects extracted from the Rancho La Brea and McKittrick asphalt seeps of southern CA, and insects in amber, mainly from Chiapas, MX. Additional smaller collections include crystalline casts of millipedes from Crystal Caverns, CA and compressed Cenozoic insects from various sites in western North America. As a result of the BFIP effort we are producing high resolution images using the latest digital photographic tools. The three-dimensional specimens necessitated use of the StackShot rail, image stacking software, and the sophisticated ZEISS Discovery V20 stereomicroscope imaging system for the amber inclusions to produce professional quality images. Concurrent with the public serving of the metadata and low resolution images to iDigBio and iDigPaleo, user access and experience has been enhanced by the serving of high resolution images via the Calphotos online database. The Calphotos images in turn are directly linked to their metadata records in the UCMP online database. Access to the UCMP fossil insect collections by the public and professionals has also been facilitated by raising awareness of the project and the work in progress through social media interfaces such as Twitter, Instagram, and Facebook, which are all linked to the BFIP website.

21. Public Access to Collections

Curating the Cretaceous seas of California at the Natural History Museum of Los Angeles County

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The Invertebrate Paleontology collection at the Natural History Museum of Los Angeles County (NHMLA)

recently received an NSF Collections in Support of Biological Research (CSBR) grant to improve the curatorial quality and digital accessibility of the museum's extensive California Cretaceous collections. Despite their immense research value, these specimens remain largely inaccessible beyond the NHMLA. There is added urgency to improve these collections while the original collectors/research associates are able to contribute their expertise to the project. Goals include rehousing and digitizing (databasing, georeferencing, imaging) approximately 25,000 specimen lots, and replacing/refurbishing cabinets in the collection. Importantly, much of this work will be accomplished by student interns from traditionally underserved local universities and community colleges. Student involvement in the NHMLA's invertebrate paleontology collections has proven extremely successful and mutually beneficial for both the museum and participants. Other outreach efforts will focus on providing resources for the local avocational paleontology community and educators (public school teachers and homeschool families). For avocational paleontologists, we will develop print and online tools to explore important California Cretaceous localities (historic and accessible) along with visual identification aides for common fossils. This will be accomplished in partnership with the Southern California Paleontological Society. For educators, we will focus on using the form and function of ammonites as a tool to explore basic STEM concepts. We will work with teacher interns from the Los Angeles United School District to ensure that the activities we design align with Next Generation Science Standards.

22. Public Access to Collections

Citizen science involvement in Oklahoma amphibian infectious disease screening

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The Herpetology Department of the Sam Noble Museum has begun a statewide sampling effort in Oklahoma to survey for the potentially fatal amphibian fungal disease, *Batrachochytrium dendrobatis* (Bd). Previous research conducted on museum specimens indicates that the Bd has been present in Oklahoma since at least 1926 but little is known about current distributions and infection rates. To broaden the sampling efforts for Bd statewide in Oklahoma we initiated a citizen science program to share for teachers and students in K–12 education programs and homeschool settings. Teachers are provided with citizen science kits containing frog sampling supplies, instructions and datasheets, background information, lesson plans, and student worksheets. In 2016, 40 citizen science kits were provided to teachers and homeschool families throughout 23 Oklahoma counties, and the laboratory screening for the samples is now in progress. Citizen science as a means of collecting data on a large scale has become an increasingly popular method amongst all fields of science. For amphibians in particular, there are several highly successful citizen science species detection programs, such as FrogWatch, Maryland Amphibian and Reptile Atlas, and Sahonagasy.org. The Buffalo Zoo and the Henry Doorly Zoo and Aquarium have also developed a citizen science project to screen local amphibians for Bd in New York and Nebraska. It is our hope that our citizen science project will become a conservation asset for monitoring the presence and spread of infectious amphibian diseases across the state, in addition to providing a much-needed hands-on STEM activity for Oklahoma students.

Thursday, June 22, 8:00am–9:20am

1. Innovative Uses of Collections Data: an iDigBio Symposium

On the front lines of discovering change: biodiversity specimen collectors as the Anthropocene's outlier detectors

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Though they are often considered sources of exclusively historical data, natural history collections can play a critical role in the rapid detection of biological change through the activity and skill of specimen collectors. As active naturalists, collectors are uniquely able to detect biological outliers (e.g., in phenology, distribution, ecology) which may indicate early stages of significant change that merit immediate attention; however, the collecting community has seldom recognized this potential. We surveyed biodiversity specimen collectors and preparators and determined that they do indeed detect biological outliers, but lack the tradition, training, cyberinfrastructure, and semantics to efficiently document and report outliers to potential stakeholders. From these results, we developed recommendations for both collectors and the broader scientific community to better empower collectors as sentinels of change.

2. New Solutions|Collections Management

Project Macroinvert: unlocking geospatial data from the Aquatic Macroinvertebrate Collection at Arkansas State University

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The George L. Harp Aquatic Macroinvertebrate collection at Arkansas State University houses approximately 200,000 specimens (1,000+ species). Most of the specimens were collected in Arkansas, but coverage includes North and Central America, and Australia. Project Macroinvert was initiated at Arkansas State University in fall of 2016, which involves restoration, digitization, and georeferencing of the Harp collection by two undergraduate honors students. Until recently, specimen data were stored in handwritten catalogs, making query and locality mapping cumbersome and time consuming. As a part of Project Macroinvert, we are digitizing and georeferencing the Harp collection data. Once completed, these geospatial data will provide a very high resolution picture of distributional patterns of aquatic macroinvertebrate taxa on smaller scales (e.g., regional, county, and/or drainage level) proximate to the institution. We expect that digitization and georeferencing of small collections, such as the Harp collection, will contribute vastly to our knowledge of species distributions and our ability to accurately characterize biodiversity at fine scales.

3. New Solutions|Conservation

Strategies for the conservation and storage of taxidermy: beaver case study

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Specimens utilized in teaching collections are handled frequently in transport and use, requiring special considerations during conservation treatment and storage to protect them from damage. This poster addresses techniques used in the conservation of a taxidermy

beaver mount from the Education collection at the American Museum of Natural History (AMNH), a specimen that is used in discussions of the species and its habitat during public programming. This object was treated during an advanced graduate course at the Conservation Center of the Institute of Fine Arts, New York University (NYU). Tears in the beaver skin were first stabilized with a combination of wet and heat-activated adhesives. Missing components on the specimen, such as ears and tail skin, were reconstructed to create a more accurate representation of the species, which is critical for a teaching specimen. Since the object will be moved in and out of storage, additional supports under the tail and hind foot were added to the base. Missing habitat elements were replaced using materials collected from the field. Thoughtful placement of the new habitat materials also provided an opportunity to draw attention to vulnerabilities in the taxidermy mount, hopefully preventing damages when retrieved from storage. This case study illustrates the ability of art conservation not only to preserve a specimen and prevent future deterioration, but also to return it to educational use.

4. New Solutions|Conservation

Conservation of two taxidermy spitting cobras: skin repair with limited access

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A recurrent challenge in the conservation of mounted taxidermy specimens is the problem of executing visible, structural skin repair when access to both sides of the skin is limited. This poster presents a case study in the treatment of two mounted spitting cobra specimens from the Department of Education at the American Museum of Natural History (AMNH). Both specimens had tears to the snakeskin in conspicuous locations where access to the flesh side (interior) of the skin was limited. Repairing from the interior of the skin is ideal because once complete, the repair materials are rendered invisible. A technique of structural skin repair using goldbeater's skin, Japanese tissue paper, and a combination of thermoplastic, acrylic adhesives was developed and successfully implemented. This poster will address the testing and mock-ups used to arrive at this technique as well as the challenges that arose and the inevitable compromises in any such treatment.

5. New Solutions|Conservation

Strategies for the conservation and storage of taxidermy: flying squirrel case study

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This poster covers the examination and treatment of a giant red flying squirrel taxidermy mount from the American Museum of Natural History's Mammalogy collection. The objective of this poster is not only to describe the treatment methodology for this particular specimen, but also to address broader issues of storage and handling of taxidermy mounts. Examination of the specimen revealed a number of condition issues including a break in the tail, a moderately large tear in the squirrel's gliding membrane, breaks and losses in the specimen's claws, and localized fur loss. While the exact cause of these damages is unknown, they illustrate the type of damages that may occur from improper storage and handling. As part of the squirrel's treatment, we have constructed a custom archival housing for it, and are exploring possible modifications to its long-term storage or display. Beyond this case study, the poster will also touch upon best practices for storage, handling, and taxidermy in general.

6. New Solutions|Collections Management

Storage improvements for paper records and documents at the Michigan State University Museum

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Established in 1857, the Michigan State University (MSU) Museum houses over 111,000 vertebrate specimens dating from 1844. Over the past 25 years, the Museum has received funding from the Institute of Museum and Library Services for a series of collections stewardship and data quality enhancement projects for vertebrate specimens. In 1993, a general conservation survey assessment was completed for the vertebrate collections as part of a general survey of the Museum's entire holdings. Report recommendations provided the foundation for a series of successful rehousing projects for both wet and dry vertebrate collections. The 1993 assessment did not include a survey of the natural science paper materials and documents. In October 2016, the Museum received Institute of Museum and Library Services funding for an updated conservation assessment of the collections and paper records. A professional natural history collections consultant and a paper conservator were hired to conduct surveys of the vertebrate collections and associated paper materials. Paper records included field notes, egg slips, necropsy reports, data sheets, manuscripts, observation records, correspondence, and other key documents associated with the Museum's vertebrate collections. The paper items had been previously stored without attention to modern stewardship standards and best practices for these types of materials. MSU undergraduate students are assisting Museum staff with addressing prioritized stewardship activities for the paper materials and for specimens. The updated surveys and resulting reports will provide the foundation for future collection improvements.

7. New Solutions|Conservation

Challenges, successes, and lessons learned in integrated pest management at the Illinois State Museum

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Integrated pest management (IPM) is a continuous process and institutional changes can potentially disrupt pest monitoring and control procedures. Following staff reductions and site closures, Illinois State Museum staff re-visited procedures for pest monitoring and control in collections and facilities. After a round of pest trap surveys, two issues of concern were identified. First, Oriental cockroaches (*Blatta orientalis*) were recorded on several traps in a boiler room area. Second, an infestation of carpet beetles was detected in the library. Three species of *Anthrenus* (Dermestidae) were identified and some interesting behaviors were noted. Strategies and resolution for both issues required coordinating the response among museum staff, facilities engineers from a separate state agency, and outside contractors. Procedures implemented as part of IPM review include development of pest trap report forms and quarterly inspections of most areas in the collections center. Challenges include involving more staff in regular trap monitoring and budgeting for IPM materials.

8. New Solutions|Conservation

Bringing curation to a university prep lab: bridging conservation and preparation

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Historical methods in fossil preparation did not always emphasize curation as a key consideration when working with specimens. In the University of Wisconsin Geology Museum (UWGM) Fossil Preparation Lab, curators,

preparators, and student collections assistants are working to fix the misguided preparation techniques of the past through remedial conservation and at the same time actively striving to conduct preventive conservation. The new standards for the UWGM preparation lab include the use of the proper archival materials for specimen mounting and storage and preservation techniques including an emphasis on reversibility and environmental conditional monitoring. Improving the quality of specimen preparation documentation and increased scientific communication between museum staff roles, particularly as fossil preparation becomes more formalized, will reveal the hidden secrets of the trade, broaden the scope of techniques and methods, and standardize best practices. Lastly, the use of student curatorial liaisons in the UWGM preparation lab has been critical for mediating and facilitating curation and conservation practices both in and out of the preparation lab. In summary, these new standards represent one way to dovetail preparation and conservation in a small lab setting. These techniques will help to ensure the long-term preservation of historical and scientifically significant specimens in the UWGM collections.

9. New Solutions|Conservation

Long term conservation challenges in the Carnegie Quarry, Dinosaur National Monument, Utah, USA

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Dinosaur National Monument was created in 1915 to preserve the Carnegie Quarry, a sandstone layer containing thousands of dinosaur bones. A building protects the quarry from the elements, however there are many other problems threatening the site. The most persistent problem is an extensive natural system of cracks with unknown depth and rate of expansion. In one area bedding planes may be a weak point that could allow the upper layer to catastrophically slough off. The expanding cracks also cut across bones, causing damage. Another problem is historic adhesives. The substances used, including asbestos filler, were not clearly documented, have unknown aging properties, and are potentially hazardous. Other bones were never stabilized and thus are becoming friable. Health and safety challenges include accumulated dust, rodent feces, and the 70° dip of the rock. In 2016, condition reports were completed for 975 (~2/3) of the bones in the quarry. A standard assessment form was created and each bone scored based on a list of 13 conditions ranked by severity, resulting in a score on a scale from 0 to 22. Based on this score and observation notes, the bones were placed into one of three categories: Needs Immediate Repair, Needs Preventative Conservation, and Does Not Need Conservation. The reports also recorded all visible adhesives. 57 bones need immediate repair. Another 141 need preventive conservation. Common issues are expanding cracks, friable bone, separation from matrix, and failure of unknown/hazardous old adhesives. Moving forward, first steps include, at a minimum 1) a plan for asbestos mitigation 2) repairs on damaged bones 3) testing of historic adhesives 4) cyclic cleaning and monitoring of the bones and rock 5) monitoring crack systems, and 6) an assessment of the structural stability of the quarry. These problems are typical of those faced by in situ fossil vertebrate exhibits, and are an emerging area of study within fossil conservation.

10. Public Access to Collections

The Southeastern Louisiana University vertebrate collections: a small collection with a big agenda

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Southeastern Louisiana University possesses substantial holdings of vertebrate specimens that have been used in

teaching and research since the 1950s. Despite limited university support, the vertebrate collections have grown substantially over the past decade. The purpose of this presentation is to highlight our collections and showcase the recent modifications to the physical space and equipment additions. The vertebrate collection houses more than 100,000 vertebrate specimens, with the ichthyology collection comprising nearly 80% of the specimens, followed by the herpetology collection, which contains approximately 15,000 specimens. Most specimens housed in the collection are from the southeastern United States, but there is substantial representation from Mexico, Guatemala, and Belize based on recent collecting effort by the curator since 2003. Recent equipment additions include compactor shelves for both the ichthyology and herpetology collections and a Zeiss V20 Discovery Z-stacking microscope. With the help of over 200 hours of volunteer time each year, and the university's two dedicated graduate student collection managers, we have made substantial progress in re-curating and digitizing a portion of the former herpetology collection from the Tulane University Museum of Natural History, for eventual addition to online databases. Finally, we are increasing our internet presence via an updated website, blog, and social media outlets, and we are beginning to utilize web-based citizen science projects to assist with digitization.

11. New Solutions|Conservation

Novel method of bioremediation and characterization of bacterial communities on arsenic-impacted museum collections

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Metal-based pesticides, including toxic arsenic salts, were widely used prior to the 1970s for the prevention of rodent and insect damage to museum collections. An estimated 80% of collections housed in U.S. and Canadian museums have exogenous metals present, and the use of bacteria in the removal of these metals is of interest. Research shows that *Rhodopseudomonas palustris*, a metabolically versatile proteobacterium, is able to volatilize arsenic via methylation resulting in the conversion of the metal into a gas which can be collected and removed. In this study, *R. palustris* tolerated concentrations of arsenic up to 250 ppm and showed the ability to remove up to 78% of arsenic from a starting concentration of 10 ppm soluble arsenic within 19 days. In order to optimize the potential application of bacterial volatilization of arsenic as a remediation technology for arsenic-treated museum specimens, the presence of in situ bacteria on the surface of museum collections needs to be addressed. High throughput sequencing revealed diverse bacterial communities associated with the museum specimens examined at the Denver Museum of Nature & Science. Bacterial community composition seemed strongly influenced by several factors, including type of materials comprising the specimen, the presence of arsenic, and in which museum collection the specimen was housed. Organisms of high abundance across the items sampled included the genera *Ralstonia*, *Sediminbacterium*, *Acinetobacter*, and the family Enterobacteriaceae. Additionally, testing of surface-associated arsenic revealed a wide range of concentrations on arsenic-impacted items at the Denver Museum of Nature & Science.

13. New Solutions|Collections Management

Incorporation of the orphaned UCLA fish collection into the Marine Vertebrate Collection, Scripps Institution of Oceanography

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Recently, the UCLA Department of Ecology and Evolutionary Biology fish collection was transferred to the Scripps Institution of Oceanography Marine Vertebrate Collection

(MVC). The UCLA collection includes a variety of marine fishes dating to the 1940s and 1950s representing extensive collections of coastal fishes from California, the tropical eastern Pacific, and its oceanic islands by Drs. Boyd Walker and Don Buth. The relocation entailed over 20 trips between the two collections to transport more than 9,000 lots to be incorporated at Scripps. This material significantly improves the MVC's holdings of eastern Pacific fishes, adding over 100 species new to the MVC and specimens of nearly 500 poorly represented species from rarely sampled localities. Through this process we have cataloged significant specimens such as some dating to the late nineteenth century that originated with the famed Indiana University Collection of David Starr Jordan. Further, the UCLA collection was never recorded digitally and was significantly underutilized in recent years. We are in the process of digitizing and integrating this extensive collection into the MVC and subsequent data repositories for better access by the scientific public. In addition to digitization, we replaced lids and gaskets, created printed plastic labels, and replenished or changed old isopropanol. We have trained numerous undergraduates in systematics and collection management via continued digitization and curation efforts. Integration of the UCLA material makes the MVC one of the most extensive collections of eastern Pacific fishes in the world and ensures a stable home for these important specimens.

14. New Solutions|Collections Management

Restoration of the Oregon State Aquatic Invertebrate Collection

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Since its inception in 1960, the Oregon State Aquatic Invertebrate Collection (OSAIC) has been compiling diverse specimens through class field trips and donations from around the world. Unfortunately, no one had held official charge of the collection, resulting in severe neglect of the specimens. The OSAIC was eventually forgotten and hidden amongst the Oregon State Ichthyology Collection, where the state of the OSAIC continued to decay. Many invertebrates were housed in ill-sealing containers subject to evaporation, which led to massive amounts of desiccated specimens. In an attempt to rehabilitate what was left of this extraordinary collection, as an undergraduate I co-authored and was awarded a grant which funded the restoration process. I began by replenishing storage fluids and containers while simultaneously creating and implementing an organizational system. This new structure granted accessibility to the cataloged specimens, allowed me to verify and update specimen identifications, as well as create a backlog of specimens to be identified and cataloged in the future. Approximately 1/3 of the OSAIC had been completely desiccated. The most unique specimens to the collection were chosen to go through the rehydration process using the recently published protocol by Singer (2014). The only copy of the OSAIC catalog was a handwritten ledger, which I transcribed and digitized to be uploaded to iDigBio and other biodiversity clearinghouses to increase its accessibility for research and education throughout the scientific community.

15. Public Access to Collections

Supporting genomics, research, and public access through the digitization of national collections

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Agriculture and Agri-Food Canada (AAFC) houses over 19 million specimens of insects, plants, fungi, bacteria, and nematodes that are among the most comprehensive in the world and support Canada as the major contributor to biosystematics and nomenclature. The collections are supported by a critical mass of scientists working with them. In 2016, the Treasury Board of Canada awarded 30 million dollars to support research in agricultural genomics, accelerate the digitization of specimens, and improve public access to AAFC collections. As a result, three projects

were funded. 1) Data Capture and Imaging: creating a digital inventory of each collection, virtual collections for public access, and enhanced digital resources for specimens, including images, data capture, and georeferencing. 2) Molecular Characterization: producing DNA barcodes and partial or complete genome sequences as appropriate for agriculturally relevant species using protocols developed for high throughput sequencing and data analysis. 3) Data Integration and Sharing: implementation of a centralized collection management system for AAFC collections and a biodiversity portal for sharing specimen and molecular data within AAFC, other government agencies and the public. Efforts are on-going to determine the most effective protocols, technologies, and best practices to achieve the goals outlined in each project.

16. New Solutions|Collections Management

RHS Herbarium: creating beautiful specimens fit for purpose

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The Royal Horticultural Society's Herbarium at RHS, Wisley (WYS) holds a unique and special collection of plant specimens of horticultural significance. Collections are incorporated from a number of sources: RHS Shows, meetings, linked gardens, historical donations, etc., but most of the new additions come from the Trials Section and new accessions at the RHS Garden, Wisley. Unlike field collections which are often made in bulk and haste, the accumulation is a careful, methodical process. This poster outlines refinements and innovations to the process, from collection to mounted specimen, which enhance the end product. The poster will show the use of an equipment drier (unmodified) which enables rapid drying and allows the use of dampened blotting paper and foam in the method. Dampened blotting paper and foam moulded over/around the specimen enable the flatter parts as well as the lumps and bumps to receive firm pressure. This innovative combination improves the pressing and drying. Tension rods used in the pressing also help to produce a more evenly pressed plant. The herbarium is accessed by a range of users, particularly the specialist plant growers/horticulturalists and the taxonomic community. To this end great care is taken to describe all the horticultural characters, such as colour, size, and habit as well as the standard taxonomic details and includes the use of the RHS Colour Chart. The poster outlines the method and materials used to mount specimens rendering the product of true archival quality, a resource to last for future generations.

17. New Solutions|Collections Management

Moving 20,000 specimens: curating the former North American '*Aster* L.'

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The Steere Herbarium of the New York Botanical Garden contains one of the finest collections of Asteraceae, largely due to the work of Arthur Cronquist and his students and colleagues. However, the size of this massive collection presents a challenge to updating the collection to reflect advances in systematic understanding and taxonomy. Using the former members of North American '*Aster*' as an example, this poster will discuss approaches that can be used to help maximize efficiency and time-management when curating and moving large natural history collections.

18. New Solutions|Collections Management

Developments on rehousing the ethanol collections at the Academy of Natural Sciences of Drexel University

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Founded in 1812, the Academy has the oldest mollusk collection in North America. In 2014, the Academy's Malacology Department secured National Science Foundation funding to rehouse its molluscan fluid-preserved collection. This collection consists of 41,000 cataloged lots, which contain 1.5 million specimens from about 140 countries. Many samples had not been rehoused since first cataloged, and an increasing number of lids were failing, which threatened the integrity of the collection. We redesigned a database that had been used for recording maintenance activity for our alcohol collection to link to our main collection database by catalog number and show potentially matching records from the current and prior number fields. More than 30,600 lots have been processed to date. Most lots have had the lids replaced and almost 16,000 have had the container replaced, many moving from 2 ounce jars to 6 dram vials to save space. 3,400 lots had fluid levels under 50% and 1,021 were desiccated. So far, 698 lots (2.3%) have not had matching database records. These were effectively lots lost in the collection since without a database record we did not know we had them and there was no way to find them short of the full inventory funded by the project. Jars and vials are placed in modular trays which can be easily removed from the shelf to check fluid levels. Shelving units are rebuilt to decrease the space between shelves, since headroom for removing individual jars is no longer needed with the modular tray design. This has resulted in 20% expansion space for the collection, even though we no longer use the top shelves of the units, to avoid the need to use ladders, and the bottom shelves are only partially filled, now being reserved for over-sized jars.

19. Disaster Preparedness

Responding to a potential disaster: moths in the Ethnographic Collections at the American Museum of Natural History

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On the evening of December 23, 2015, while securing storage for the holidays, Collections Management staff noticed two webbing clothes moths, *Tineola bisselliella*, fluttering down the main aisle of one of the Division of Anthropology's largest ethnographic storage rooms. Despite a robust preexisting integrated pest management strategy, it was obvious that the collections had been compromised. 2016 would have to be largely devoted to mounting an emergency response. Beginning in January, the Collections Management team launched a massive undertaking to discover the source of the infestation, isolate the room, treat affected objects, and prophylactically secure the some 63,880 as yet unaffected objects stored in the 9,577 square foot space. The presentation will highlight the IPM challenges of caring for a highly vulnerable collection in a historic structure where legacy storage facilities exist beside staff offices. The experience demonstrates the efficacy of acting quickly, redirecting resources, and following a plan while remaining flexible, to neutralize a potentially devastating emergency.

20. New Solutions|Collections Management

Precision sampling of herbarium specimens of plant pathogenic fungi to minimize damage and maximize extraction of target DNA

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The Canadian National Mycological Herbarium (DAOM) in Ottawa, Canada, houses ~350,000 specimens spanning a hundred years from around the world. The collection ranges from moulds to mushrooms emphasizing Canadian fungi and pathogens. Sequencing of agarics began 20 years ago and that of obligate plant pathogens (*Synchytrium*) from the herbarium began 16 years ago. Since October 2013 the method of sampling foliar pathogens changed to minimize physical damage to specimens and to maximize throughput. The focus was on rust fungi, downy mildews, and powdery mildews. These groups were

selected for sampling because they are difficult to maintain in living cultures and pose risks to food production and distribution. DNA barcoding is increasingly being used to identify unknown pathogens in farmers' fields and in the environment, as well as for screening imports and exports for invasive species. However, for DNA barcoding to be successful there needs to be a robust reference database in which the sequences can be compared. DNA barcoding allows for species level identification of organisms by using the sequence of a short section of DNA from a standardized region of the genome. Most herbarium vouchers were identified by expert mycologists but often the host was not as accurately identified as often they were not flowering or were deformed. Both healthy and diseased host tissue were sampled in tandem. The tool selected for sampling is a disposable biopsy punch. It is useful because its sharp circular blade provides clean cuts of a small targetable sample size. Different diameter punches were tested and the 2mm diameter size was determined suitable for providing sufficient material for sequencing while minimizing the impact of "destructive sampling". Careful handling and limiting the sampled areas is important for maintaining the quantity and integrity of herbarium specimens. Once verified sequences are produced they will be uploaded to BOLD (Barcode of Life Database) for reference.

21. New Solutions|Collections Management

Managing microscope slides: physical and digital issues

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Microscope slides present interesting and unique challenges in collections whose practices are oriented around macroscopic animal and plant specimens. Their small size, the density of information they may contain, and their out-of-sight and inflexible physical storage requirements often make them somewhat unsuited to current ideals for standardized cataloging, data management, and imaging workflows. Our poster illustrates the exceptional nature of slide collections by focusing on two test cases, one from the Harvard University Herbaria, and one from the Harvard Museum of Comparative Zoology. From the botanical and mycological world, we explore the many-to-one relationship of organisms to slide, while from the zoological world we highlight the concept of how one organism is frequently sliced out over many slides. We discuss the "best possible" (and/or "best reasonable") ways in which the realities of these collections might be represented digitally.

22. New Solutions|Collections Management

International collections moves: the return of the Machu Picchu artifacts to the people of Peru

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Between 2011 and 2012 the Yale Peabody Museum of Natural History returned the Machu Picchu archaeological collections to the People of Peru. The collection of more than 5,000 catalogue entries represents almost 45,000 individual artifacts excavated by Hiram Bingham III in 1912. This poster will illustrate some of the logistical challenges in returning a large collection of historically and politically significant material to its place of origin. In the process of defining the return of this collection many logistical challenges surfaced that required the support of numerous groups, both at Yale and from Peru. The biggest challenge for the museum staff, outside of negotiations internally and externally, was the inventory, packing, and delivery of the collection. Each phase took careful planning and execution. Like any acquisition, loan, or use of a collection, the intellectual control of the material and chain of custody had to be carefully documented and verified multiple times. Packing and

stabilizing material from ceramic vessels, metal artifacts, and stone tools to human remains and animal skeletons were a primary concern. The delivery was accomplished in three shipments over two years and consisted of 170 crates, requiring commercial flights, military flights, and a chartered FedEx delivery. To ensure success, coordination and good communication between multiple Peruvian government offices and university officials was key.

23. New Solutions|Conservation

Once in a lifetime: examination and treatment of a museum icon

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Sometimes everything just falls into place. The Carnegie Museum of Natural History is going through a period of re-envisioning and re-interpreting its older exhibits. The scientific staff, Conservation, and Exhibits are working together to clean older dioramas and make them more relevant. In the fall of 2015, ten dioramas were cleaned, the exteriors painted, and reinstalled in a new exhibit, "The art of the diorama." This exhibit includes two rare Victorian "bubble glass" dioramas. In 2016, Botany Hall has been renovated and cleaned. Work included improving lighting with LED lights. Three dioramas (a snow leopard, a giant panda, and an Alaskan wolf) have been retrieved from our offsite warehouse, conserved, and the shells re-clad, and installed as part of a new museum store, to the delight of many.

SPECIAL INTEREST GROUPS, June 23

Storage Techniques for Art, Science, and History Collections (STASH) preventive conservation and storage: STASH Flash I

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The conference theme addresses the next generation of best practices that are designed to prolong the lifetime of natural science collections. This session will focus on best practices in storage as a primary factor that affects the preservation potential of collections.

The session will begin with an introduction to Preventive Conservation: Collection Storage, a new volume (expected publication date of summer 2017) that is a joint venture between SPNHC, the American Institute for Conservation (AIC), Smithsonian Institution, and The George Washington University. This new volume provides updated information for the foundational two-volume set—Storage of Natural History Collections: Ideas and Practical Solutions and Storage of Natural History Collections: A Preventive Conservation Approach—both originally published by SPNHC (1992 and 1995, respectively). The session will then focus on best practices for collections housing, using the STASH (Storage Techniques for Art, Science and History Collections) website (www.stashc.com) to illustrate the connection between foundational concepts covered in the book and examples of best practice.

STASH was created by the Foundation of the AIC (with funding from the Samuel H. Kress Foundation) to share well-designed storage solutions and has grown annually to include innovative and creative storage solutions from a wide range of allied professionals concentrating on collections care. STASH is interdisciplinary and the editorial board is composed of representatives from a range of allied organizations, including SPNHC.

The STASH Flash session will utilize a lightning round or "tips" session format with short, five minute presentations detailing a particular storage design or technique. If time allows, presentations will be followed by group discussion, where participants can talk about modifications, materials choice as well as other creative ways to carry out similar projects. Flash submissions will be grouped according the following themes:

In keeping with the conference theme, presentations will be solicited on storage mounts or support systems that demonstrate ingenuity and utility. These can be scenarios related to disaster preparedness, impacts of changing regulations, moving collections, new solutions to old problems, public access to collections, sustainability, and use of new materials or digitization of collections.

The second proposed theme focuses on multi-function supports serving more than one purpose, such as storage, examination, travel and/or exhibition purposes.

Innovative storage solutions for individual or collection groups that do not conform to either theme will be accepted if space allows.

Uncover the invisible—what do we know about deterioration processes in mammal skins and hides?

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In many mammal collections the deterioration of skins and hides is a well-known conservation problem. In the Museum für Naturkunde Berlin, Germany, substantial parts of bigger study skins are brittle and easy to damage. The tear strength decreases over time until the skins fall apart and are lost forever. Hitherto, our finds show that a high acidity in the skins is the main reason for the degradation. However, factors like air pollution and bad storage conditions can cause acceleration of their deterioration.

In this informal session we want to share and exchange our experiences and knowledge amongst colleagues working with skins and hides around the world and across disciplines. Points to consider include: What is the status of mammal skins in your collection? Are you facing the same problems? How do you measure and assess damage and risk? Are there any parameters that can help us to describe a hardly visible problem without causing even more damage? What are you doing with threatened and damaged skins? What are the pros and cons of different storage conditions? Is there a best practice in the storage of bigger study skins? How do you prepare bigger study skins to ensure their long-term preservation and availability for a whole range of potential uses in the future?

We invite you to share your expertise with other interested people in order to bring together our knowledge, to develop a better understanding of underlying processes, approaches to handling the problem, and best practices of storage and treatment of historic and new skins and hides.

IMLS grant chat

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Bring your ideas for an IMLS grant application to vet them with your peers and with a senior program officer from IMLS. This informal session will give you the opportunity to share your ideas, elicit opinions from others, hear what others are thinking about, and ask questions about the IMLS application process as it applies to your organization and your needs for collections support. IMLS welcomes applications addressing collections planning, management, conservation, access and use, digitization, website development, and professional development/training. Why not make your project the next one funded?

Collection fact sheets as useful collection management tool

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At the Museum für Naturkunde Berlin we are in the process of establishing an internal (and later on partly external) Collection Management Wiki. To develop it from a somewhat theoretical information source to a more practical tool to manage collections one approach is to develop collection fact sheets, which are meant to act as centralized and standardized repository.

This informal session is meant to exchange ideas and concepts and systems used at different institutions. We want to explore ways how fact sheets or a wiki in general can help to develop a sustainable, standardized and transparent central repository for collection documents and key data, which can be easily updated and be used in every day work life and facilitate it in the long term. May it be for data retrievals, storing and sharing documents concerning work flows, processes or best practices. Be it as a fundament to establish assessment data, emergency planning or show case the collections or the work done in them for internal or external reasons. We'd be happy to share our experience and learn and exchange how other institutions and natural history collections cope with

an ever growing number of information and the need for documentation and establishing an easy to use repository of the different aspects collection management requires.

Herbarium curation

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Now more than ever, collections are used to answer a broader range of ecology and evolutionary questions, strengthening their importance for scientific research. As herbarium curators, collections managers, and researchers, the importance of these collections seems undisputable. So, we may forget that not everyone at our institutions appreciates the value of these irreplaceable resources. With shrinking budgets and less available space, administrators may view dissolving herbaria as an easy way to solve budget and space problems, as is happening at NLU. This Special Interest Group Session will facilitate conversations on how to create long-term sustainability and communicate your herbarium's value to administrators, the public, and policy makers.

SPNHC wiki hack-a-thon

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The SPNHC wiki (http://spnhc.biowikifarm.net/wiki/) was created to foster SPNHC's mission to improve the preservation, conservation, and management of natural history collections in order to ensure their continuing value to society. It allows an open forum for museum professionals to access, add and comment on documents, procedures, and practices related to natural history collections care. This informal session will allow SPNHC members to work collaboratively in small groups to review draft pages by editing existing content and incorporating new information and resources. A list of desired best practice topics is available on the wiki (http://spnhc.biowikifarm.net/wiki/Category:Desired_BP_Content). These are topics that have been highlighted for development by the Best Practice Committee. They may contain some preliminary content, but are awaiting member contribution and discussion. This session will also allow those interested in working on new topics to share ideas and draft outlines for new wiki pages. Lastly, we welcome those that are not familiar with the wiki to receive hands-on training by members of the Best Practice Committee so they can contribute to this valuable resource when they return to their home institution.

AVENIR COLLECTIONS CENTER
Denver Museum of Nature & Science
FUN FACTS

The Avenir Collections Center (ACC) opened at the Denver Museum of Nature & Science in February 2014. The facility was designed to fulfill the Museum's public trust obligation to preserve 4.1 million objects while balancing public access and incorporating the highest standards in human health and safety.

Before the facility was constructed, the research collections were housed in 49 different locations around the building.

In preparation for the ACC, the Museum developed a Long-Term Collection and Research Plan to prioritize and improve collections content, conducted a comprehensive Collection Risk Assessment and space analysis, and developed specifications for equipment to maximize storage efficiency and preservation.

The ACC and adjacent Morgridge Family Exploration Center received LEED Platinum certification by the U.S. Green Building Council, the highest rating for new construction. It is designed to reduce energy costs by 50% and energy use by 60%. The project also received the Buildy Award from the Mid-Atlantic Association of Museums. The purpose of the Buildy Award is to increase awareness of the value of museums and the need for their ongoing rehabilitation and expansion to serve future generations.

Key design features:

- Separate dirty activities located on Level 1 away from clean activities on B1 and B2
- Separate workspaces from the collection storage rooms
- Controlled temperature and relative humidity with set points that are more easily achievable in the Denver climate
- Heating and cooling plant using heat pump technology and recycled water from Denver Water
- High-efficiency LED and lighting, Energy Star appliances, and occupancy sensors on lights
- Main water pipes run through mechanical rooms
- State-of-the-art fire detection and water-based fire suppression
- Under-slab drainage systems to minimize ground water

- Collections uncrowded in customized storage equipment
- Capacity for 20 years of future growth
- Separate space for culturally sensitive items, as identified by tribal consultants

By the numbers:

- Together, B1 and B2 total 63,000 square feet (a National Football League football field is 48,000 square feet).
- The cabinets ride on nearly one mile of rail (4,756 feet).
- There are 16 different styles of customized cabinets to achieve efficient storage.
- We have secured 14 federal grants for a total of $4.3 million to support the ACC.
- Since opening, we have increased behind-the-scenes visitation by more than 500%.

EDUCATION COLLECTIONS, LEVEL 3

The Museum is proud to have had a professionally managed Education Collection for the last 27 years. These 35,000 authentic artifacts and specimens are dedicated for community interaction in nearly 4,000 classes and workshops, gallery programs, temporary exhibitions, and exploration stations around the Museum every year. People of all ages are encouraged to explore and discover the natural sciences through these tangible experiences.

SPNHC 2017 Denver | Field Trips, Saturday June 24

There are four Field Trips

- *People, rocks, fossils, oh my!* 8:00am–2:30 pm ($50)
- *Wild to Captive* 8:30am–2:30pm ($50)
- *Nature to Nurture* 7:00am–2:30pm ($50)
- *Florissant Fossil Beds* 7:00am–5:30pm ($75)

Additional Options

- For tours ending at 2:30pm, there is an Afternoon Add-On starting at 3:30pm: *Microbrews in RiNo* ($30, includes tastings, 1 full glass and a snack pack)
- Additionally, *Denver Botanic Gardens* ($0 for SPNHC attendees) is open from 9:00am–9:00pm in the summer with a tour for SPNHC attendees on Saturday, June 24 at 11am. Meet in front of the Gardens visitor center at 10:45 to join the tour.

Even if you choose not to participate in the field trips but will be in town Saturday evening, we hope you will join us at the final microbrewery. Catch up with people who were on other field trips, try some of the many microbrews that have dubbed Denver "the Napa Valley of beer," and get a final chance to chat before parting ways!

Considerations

Please note that all the field trips will include walking at >2,000 meters elevation, so be prepared for moderate exertion at elevation. As the fifth sunniest state in the nation plus elevation, it is very easy to become sunburned. Before registering, please ensure that you are medically able to participate on the field trip.

Please have appropriate footwear to walk over uneven surfaces, sunscreen, plenty of water, snacks, insect repellent and layers as the weather can change quickly. The buses will have small supplies of sunscreen, water, insect repellent, and Gatorade, should anyone be affected by the elevation.

Details of the field trips may change slightly from what is currently posted. Lack of sufficient registration may necessitate cancellation of a field trip and will be fully refunded.

If you have any questions, please contact the Registration Desk.

Field Trip | People, rocks, fossils, oh my!

- Leave the Curtis Hotel at 8:00am and return to the Curtis Hotel at 2:30pm, with the option to join the microbrewery tour at 3:30pm
- Cost: $50, includes a box lunch
- Total estimated driving time is 1.5 hours; each stop will be at least an hour
- Difficulty: Easy to moderate

The day will start at **Apex Park** where we will take a short walk and learn about the Magic Mountain site, "one of the most important archaeological sites on Colorado's Front Range," which was occupied from

roughly 5000 BC to 1000 AD. From there, the bus will drop us off at **Red Rocks Amphitheater**, nestled in the Fountain Formation, an iconic natural amphitheater where many of the greats have played, from Neil Young to Norah Jones. On a 1.2 mile guided walk, we will see the Fountain Formation up close, view the Rocky Mountains meeting the Great Plains, and learn how earth's geologic processes created such a beautiful and revered location.

Lunch will be at the amphitheater with enough time to walk around the theater, soak in the vibes and check out the mini-museum. If you're feeling energized, there is a native plant garden you can walk to. After lunch, we will explore dinosaur bones and footprints—close enough to touch (it's really, really cool!) at **Dinosaur Ridge**. The guided walk is 1.4 miles. The day will end at the Dinosaur Ridge Visitor Center before being whisked back to the Curtis Hotel.

Field Trip | Wild to Captive

- Leave the Curtis Hotel at 8:00am and return to the Curtis Hotel at 2:30pm, with the option to join the microbrewery tour at 3:30pm
- Cost: $50, includes a box lunch
- Total estimated time on the bus is 3 hours
- Difficulty: Easy

Located just northeast of Denver, the **Rocky Mountain Arsenal National Wildlife Refuge** is a 15,000-acre expanse of prairie. The land has a unique story: It has survived the test of time and transitioned from farmland, to war-time manufacturing site, to wildlife sanctuary. It may be one of the finest conservation success stories in history and is a place where wildlife thrives. To see the Refuge, we will take a 1.5 hour bus tour. Expect to see buffalo, prairie dogs, and various species of birds, including burrowing owls. Lunch will be by Lake Mary with a chance to stretch your legs and observe some of the wildlife up close.

After lunch, we will step inside the **National Wildlife Property Repository** for a tour of this unusual collection. The National Wildlife Property Repository is a 22,000 square foot warehouse that is responsible for receiving wildlife items that have been forfeited or abandoned to the U.S. Fish and Wildlife Service (think: illegal furs, rhino horns, fancy leather purses). The Repository holds roughly 1.3 million items in its inventory. A completely unique collection and not usually open to the public, our behind-the-scenes tour is a singular opportunity.

Please Note: Only those at least 12 years in age may participate on this field trip.

Field Trip | Nature to Nuture

- Leave the Curtis Hotel at 7:00am and return to the Curtis Hotel at 2:30pm, with the option to join the microbrewery tour at 3:30pm
- Cost: $50, includes a box lunch
- Total estimated time on the bus is 3 hours
- Difficulty: Moderately difficult

While Denver and the conference isn't situated in the mountains, you can get your mountain fix by hiking at **Mount Goliath**, 3,500 meters in elevation, with awesome (truly awe-inspiring) vistas of the Continental Divide peaks.

On the bus ride there, we will get a narration of the surrounding geology to prepare us for what we will see while hiking. Our guided, downhill hike, will be along the **M. Walter Pesman Trail** for 1.5 miles. This is a trail of contrasts—delicate floral treasures; wind-sculpted, ancient bristlecone pines; cold summit winds; and gentle summer breezes. Located at a transition zone between sub-alpine and tundra, the place has an almost magical beauty. Wildlife abounds, and we may spot the native pika or the introduced mountain goats.

In small groups, the trail will take us down to the Mount Goliath Natural Area, a site managed by Denver Botanic Gardens, where we will enjoy a well-earned lunch.

IMPORTANT: This is a downhill trek on a moderately difficult trail that starts at 3650 meters. Before selecting this field trip, please ensure you are physically fit and medically able to participate in physical activity at high-altitude conditions.

Field Trip | Florissant Fossil Beds

- Leave the Curtis Hotel at 7:00am and dropped-off at the microbrewery at 5:30pm before continuing to the Curtis Hotel
- Cost: $50, includes a box lunch
- Total estimated time on the bus is 5 hours
- Difficulty: Easy to moderate

Just 2.5 hours from Denver is the **Florissant Fossil Beds National Monument**, which is one of the richest and most diverse fossil deposits in the world with petrified redwood stumps up to 4m wide and thousands of detailed fossils of insects and plants that reveal the story of a very different, prehistoric Colorado. Guided by the park's paleontologist, we will explore this rich fossil deposit and learn about a new project that will explore techniques to stabilize the in situ petrified tree stumps.

In the afternoon, we will be taken on a **behind-the-scenes tour** to see the lab and collections spaces, with plenty of time to ask questions of the park's paleontologist. The afternoon will be complemented with a short botanical walk for anyone interested in learning more about the montane flora. At the end of the trip, the bus will drop us off at the last microbrewery on the microbrewery tour where we can meet up with other SPNHC attendees, try some microbrews, and relax. The bus will then continue on to the Curtis Hotel (about 1.5 miles from the microbrewery) for anyone who would like to head back to the hotel.

Please note that most of the day will be walking at 2500 meters so be prepared for moderate exertion at high elevation.

Afternoon Add-on | Microbrews in RiNo

- Activities will start at 3:30pm. Participants are responsible for making their own way to the first brewery, which is 1.5 miles from the Curtis Hotel.
- Cost: $30, includes tastings, additional beer after the education session and a snack pack!
- Difficulty: Easy

Learn about Denver microbrews in the trendy & up-and-coming RiNo district, **River North Arts District**, a unique area to Denver where historic warehouses and factories now house jazz bars, restaurants, brewpubs, art galleries, and studios. We will have a brewery tour led by a certified Cicerone® and participate in **Flight School**: 4–5 different tastings while learning about the unique ingredients and processes microbreweries use to make their beer original.

After graduating Flight School, the group will be split into teams and will have one hour to complete a **scavenger hunt** in RiNo. Everyone will meet at the final brewery to share their answers with prizes for first and second place teams.

Please note: You may select this Microbrewery Tour in conjunction with another field trip or on its own. You will not be able to attend the Microbrewery Tour if you select the Florissant Fossil Beds field trip. (The Florissant Fossil Beds trip will be dropped off at the final microbrewery at 5:30pm.)

Denver Botanic Gardens

- Denver Botanic Gardens is open from 9:00am–9:00pm during the summer. A behind-the-scenes tour will be offered at 11:00am on Saturday, June 24.
- Cost: Free for SPNHC attendee with badge
- The Gardens can be reached by public transportation and is 2.7 miles from the Curtis Hotel
- Difficulty: Easy

Wishing for some relaxation or a last chance to learn? At Denver Botanic Gardens you can do both. Often called a "sanctuary" by regular visitors, bring a book and sit in the shade by the Monet Pond, or let your mind wander while strolling the 24 acres of cultivated gardens. If you are looking for a last bit of learning at the end of the conference, staff will be giving a tour of the herbarium and discussing the natural history collections housed at the Gardens.

Collections and Data in an Uncertain World

25 August – 2 September, 2018

The local organising committee – the Otago Museum and the University of Otago – is honoured to host the annual meeting of the Society for the Preservation of Natural History Collections and the Taxonomic Database Working Group. This will be the first time that the two bodies will be holding the meeting together, and the first time that SPNHC will be in the Southern Hemisphere.

The theme for the meeting is 'Collections and Data in an Uncertain World'. How do we manage collections and data in earthquake-prone regions? What data uncertainty is there between the specimen, the record, the web? What role will natural history collections have in an increasingly challenging world? Keep an eye out for our website, launching soon.

New Zealand is only a ten hour flight from most places in the Pacific Rim; three from neighbouring Pacific islands and the eastern seaboard of Australia. A further two-hour flight from Auckland brings you to Dunedin where world-class events are housed in unique heritage buildings – high tech meets Edwardian and Victorian architectural charm. These sit alongside stunning coastal scenery and remarkable wildlife experiences.To learn more about Dunedin please visit www.dunedinnz.com

Website:
spnhc-tdwg2018.nz

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Logo of the 32nd Annual Meeting of the Society for the Preservation of Natural History Collections, June 18–24, 2017, Denver, Colorado

Frank Krell, PhD, Editor and Production

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