

**CENTER FOR BIOLOGICAL RESEARCH COLLECTIONS**  
**ANNUAL REPORT**  
**Submitted March 1, 2024**

**I. Basic information on the Center for Biological Research Collections (CBRC)**

This report covers the period of February 28, 2023, to March 1, 2024

CBRC had its first external review in April 2023. External reviewers' documents were submitted to the Dean's office shortly thereafter. CBRC's reply to the external review committee's evaluation was submitted to the College in December 2023.

Director, Claudia C. Johnson, Department of Earth and Atmospheric Sciences  
Executive Committee Members, P. David Polly, Department of Earth and Atmospheric Sciences  
Ryan Kennedy, Department of Anthropology  
Collections Manager until December 30, 2023, Paleontology and Zooarchaeology, Jess Miller-Camp,  
Department of Earth and Atmospheric Sciences  
Laboratory Manager, William R. Adams Zooarchaeology Laboratory, Samantha Couch, Department of  
Anthropology  
Affiliate Member, Gary Motz, Information Technology Manager, University Collections, University  
Information Technology Services  
Head of Computer Systems, Information Science, Yale Peabody Museum

*Governance*

CBRC is run by a Director, Executive Committee, and Collections Manager consisting of faculty and research scientists who oversee IU's formal paleontological and zooarchaeological natural history collections.

*Operating Budget*

CBRC is funded by the College of Arts and Sciences, Office of the Vice Provost for Research, Department of Anthropology, and Department of Geological Sciences.

External sources of funding include the National Science Foundation's Advanced Digitization of Biological Collections, and the Institute of Museum and Library Services, alumni donors, and private contributors.

The operating budget for 2023-2024 was allocated for staff, graduate and undergraduate student salaries, travel for research presentations, hospitality for external review committee members meetings with faculty, students and staff, equipment purchases, equipment repair, contractual services for equipment maintenance, consortium dues, institutional membership dues, and warranties for technical equipment for digitization of specimens.

**2. Description of CBRC**

*Executive Summary*

CBRC holds core strengths in the current technological fields of 3D imaging and digital infrastructure development for Indiana University's integrated natural history collections. CBRC procures external funding from NSF and IMLS, and from OVPR and the College to support its growing digital expertise. CBRC invests in training STEM and non-STEM graduate and undergraduate students in 3D technology for enhancement of academic and professional careers. Top priorities for scientific outreach are national and international academic research communities, and residents of the State of Indiana through elementary school corporations and local university-Bloomington engagement events and activities.

The Center for Biological Research Collections (CBRC) includes two natural history collections:

- The IU Paleontology Collections (IUPC), housed within the Department of Earth and Atmospheric Sciences, holds > 1.5 million fossil specimens, including more than 1,000 unique type specimens, representing more than 400 million years of Earth's history. The IUPC holdings are global in their geographic scope, but most are representative of the Paleozoic of North America, with many specimens from the State of Indiana.
- The William R. Adams Zooarchaeology Laboratory (WRAZL), located in the Department of Anthropology, houses over 10,000 modern comparative faunal specimens inclusive of mammals, reptiles, amphibians and fish. WRAZL holdings include species from across the globe, with the most depth being found in Midwestern fauna. Ongoing zooarchaeological research in WRAZL leverages the collection's breadth and includes projects in the American West, Gulf of Mexico, Chesapeake Bay, and Midwest.

The IU Paleontology Collection and William R. Adams Zooarchaeology Laboratory hold natural history specimens in formal research repositories. The specimens form the basis for research in paleontology, zooarchaeology, functional morphology, ecology and paleoecology, evolutionary biology, and related disciplines. The specimens are the primary sources of data on the structure and composition of organisms of the present and past, and they serve as tangible evidence that those organisms lived in particular places and times. Like archival research libraries, the materials in these collections are used by researchers at IU and around the world. CBRC and the faculty and staff associated with the two collections thus carry out independent research on the collections, but they also maintain the integrity and accessibility of the collections for broader research communities. This arrangement works in kind; faculty and staff at other universities and museums provide IU researchers with equivalent access to collections around the world.

#### *Vision*

Indiana University's Center for Biological Research Collections supports the College of Arts and Sciences' vision of creating leaders and thinkers by developing digital infrastructure to advance a collaborative biodiversity platform, facilitate research on IU's natural history specimen collections, and promote educational enhancement to create citizen science leaders for the State of Indiana.

#### *Mission*

The mission of the Center for Biological Research Collections is to enhance collection-based research and education in biodiversity, zooarchaeology, paleontology, and related disciplines by providing shared infrastructure and data management support of IU's natural history collections. The Center's research focus is on 2- and 3D imaging of specimens, including biological, fossil, and archaeological remains, that have associated taxonomic, geographic, and temporal metadata. CBRC thereby provides stewardship for IU's formal paleontological and zooarchaeological repositories.

#### *Principal Goals*

CBRC supports data management platforms and digitization for research grants that use IU's natural history collections, coordinates policy, and develops external funding streams for upkeep and development of collection infrastructure.

CBRC actively promotes training in 3D imaging for STEM and non-STEM undergraduate and graduate students.

#### *Primary Role in the College*

CBRC is a pooled resource to support the natural history collections and the faculty who are responsible for them. CBRC serves as a vehicle for collaborative grants to enhance the collections and to support research; it maintains digital infrastructure such as collection management databases and digitization facilities; it provides training to faculty, graduate students, and undergraduates in collection-based

research methods and in collection care; and it facilitates access and use by researchers by providing support in locating specimens, processing loans, and linking specimens with associated data.

#### *Primary Role on Campus*

CBRC collaborates with other collections and units to develop shared infrastructure and best practices. Partners include University Collections, Digital Library Project, Institute for Advanced Study, University Information Technology Services, Indiana Geological & Water Survey, IU Museum of Archaeology and Anthropology, Advanced Visualization Laboratory, the Data to Insight Center of the IU Pervasive Technology Institute, and the IU School of Education.

### **3. Overview of CBRC's contributions and activities**

*CBRC is not a degree-granting program or department yet its benefits to the College, Campus, and Bloomington community are significant, highlighted here.*

#### ***CBRC Educates Students in Underrepresented Groups in STEM, thereby contributing to diversity, equity and inclusion goals of the College of Arts and Sciences and Indiana University.***

CBRC enhances the teaching and research mission of Indiana University by training undergraduate students in digitization of zooarchaeology and fossil specimens and their associated metadata, and graduate students in enhanced specimen research and in training undergraduates on specimen-related, technological research, managerial and curatorial procedures.

#### ***CBRC Trains Students in 3-D Scanning Techniques, Workflows and Workshops***

CBRC prioritizes purchase of 3D scanning equipment and provides training for graduate students to develop workflow documents and videos on procedures for scanning objects of varying sizes and densities. Students develop training documents as test runs prior to presenting formal workshops to the university community of engaged students and faculty researchers.

#### ***CBRC Prepares Students for Professional Careers***

CBRC funds RA positions for graduate students to learn management and curatorial skills with physical specimens and 3D and digital data methods. Graduate student RAs, in turn, instruct undergraduate hourly workers, who then teach techniques and technologies to their peers. More than 50 students expressed interest in the 12 hourly positions available. For many of our undergraduates, this work represents their first exposure to scientific research. Thus, their assignments have been designed to serve a dual purpose: to push the goals of CBRC, WRAZL, and IUPC forward, while simultaneously acting as an introduction to various aspects of the scientific process and the organization of contemporary research collections. CBRC-supported students consistently receive offers of admission to graduate programs, present research findings at conferences, and win scholarships and other awards, all serving as evidence that the training provided by CBRC is critical in students' professional development. In addition, all WRAZL and IUPC undergraduate workers have contributed to, and are responsible for, general collections upkeep, including maintaining equipment, supplies, and work areas within the two collections.

#### ***CBRC Provides Stewardship to the IU Paleontology and the W.R. Adams Zooarchaeology Collections***

CBRC faculty, graduate students, and undergraduate hourly workers are trained in specimen management and collection practices, principles, and policy. The IUPC and WRAZL collections' specimens are formally curated in climate-controlled conditions supervised by building management personnel.

#### ***CBRC Coordinates Specimen and 3D-imaged Loans to the Academic Research Community***

Formalized repository policies allow for exchange of specimens among members of the academic research community. When IU faculty request loans from other institutions for themselves or their

students, official institutional loan papers and borrowed specimens are under the supervision of IU's curators and collection manager.

The Institute for Advanced Study provides competitive funding for external researchers to visit the IUPC and examine specimens for their research. In early 2023 two awards were made to non-IU researchers to pursue their paleontologic goals using specimens curated and housed in the IUPC. In early 2024 two more awards were made to non-IU researchers using WRAZL specimens to create a comprehensive reptile/amphibian osteology guide and produce 3D models of turtle shells to use in morphological analyses.

### ***CBRC Arranges Specimens and Training for Educational Use Across Disciplines***

Specimen loans for classroom use, research projects, tours to public visitors, and outreach and collaboration with educational and research entities occur frequently throughout the academic year.

*\*Educational Offerings from CBRC Collections* are listed in *Appendix 1*.

Of special note is WRAZL's new Director Ryan Kennedy who has increased the use of specimens in educational activities. WRAZL's comparative faunal collection provides opportunities for undergraduate and graduate students to participate in specimen processing and curation each semester.

### ***Major activities in 2023–2024***

#### ***Highlights of CBRC's accomplishments***

Significant accomplishments of 2023-2024:

- Completed CBRC's Strategic Plan inclusive of mission, vision and goals
- Prepared for and conducted CBRC external review committee's on-site visit Spring 2023
- Advanced a plan of action to address the most urgent recommendations of the external review committee
- Digitized specimens and processed images associated with metadata identifiers for research and teaching purposes
- Managed and curated natural history specimens across WRAZL and IUPC
- Taught, trained, and encouraged research activities with graduate and undergraduate students

Highlighted here are major activities unique to WRAZL and IUPC repositories that were undertaken to keep repositories functional, relevant, and in accordance with formal policy.

#### ***W.R. Adams Zooarchaeology Laboratory (WRAZL)***

Dr. Ryan Kennedy, Assistant Professor in the Department of Anthropology, is Director of the W. R. Adams Zooarchaeology Laboratory.

Collaborations with outside researchers interested in analyzing the Laboratory's specimens using a range of methods including: zooarchaeology by mass spectrometry; stable isotope analysis; genetic analysis; and various modes of digitization, including photogrammetry. Together, these analyses help refine taxonomic identifications within WRAZL's collections and contribute to publications focused on zooarchaeological methods. These initiatives are part of a larger effort to dramatically increase the use of WRAZL specimens as the target of research rather than simply as tools for identifying animal remains from archaeological sites.

WRAZL staff have made great progress on multiple zooarchaeological analysis projects. This work relies on the extensive comparative skeletal collection in WRAZL, and it includes four 19<sup>th</sup>-century Chinese sites in the American West, a Revolutionary War fort in coastal Georgia, a sea turtle cannery in Florida, and numerous archaeological sites in the Chesapeake Bay area and in New Orleans. The Chesapeake Bay

work focuses on past human impacts to turtles; this work is funded by IU's Social Sciences Research Funding Program, and Dr. Kennedy received Maryland Archaeological Conservation Laboratory's Gloria S. King Research Fellowship in Archaeology in further support of the project.

Continued improvements were made to WRAZL's specimen database, with the ultimate goal of making a fully updated version of the database accessible via the internet. Much of this work is being done through Dr. Kennedy's participation in the National Endowment for the Humanities-funded "Networking Archaeological Data and Communities" two-year training program. The WRAZL team for this training also includes Mr. Jeremy Floyd (University Archives) and (in 2023) former Collections Manager Dr. Jess Miller-Camp.

CBRC-funded personnel increased specimen processing, with a focus on a unique collection of sea turtle carcasses from Florida. ~50 animal carcasses were processed into cleaned and inventoried skeletal specimens, which are critical for zooarchaeological analysis. Additional student training includes participation in various aspects of ZooMS and stable isotope research.

Dr. Miller-Camp refined a previously developed dual turtle osteology guide and element inventory workflow and beta tested the refined version with CBRC-funded WRAZL staff. This work was presented at the 2023 Association of Materials & Methods in Paleontology. The guide also proved invaluable for training WRAZL staff involved in several of Dr. Kennedy's ongoing turtle-focused research projects.

WRAZL continued efforts to procure animal carcasses to address gaps and add depth to the laboratory's comparative collection. Throughout the year, Dr. Kennedy purchased fish that are necessary for his ongoing research projects. Most notably, he brought 30 fish carcasses back from Australia that fill taxonomic gaps relevant to his work on Chinese diaspora fish trade. WRAZL also continues to accept specimens donated by current and past affiliated students and researchers, with recent donations including a deer and ~15 smaller animals like birds and rodents.

CBRC affiliates and students continue to use WRAZL specimens for digitization and photogrammetry projects. Fall 2023 saw a notable increase in this work driven by a CBRC-funded RA and a CBRC funded undergraduate student worker. In Fall 2023, the RA and undergraduate worker digitized many skeletal elements from many of WRAZL's carnivore specimens, and in Spring 2024 they are working on a wider range of taxa. The workflows that they developed have, in turn, allowed WRAZL to host an Institute for Advanced Study Repository Research Fellow, who is relying on one of CBRC's photogrammetry stations to digitize turtle shells during his research trip to WRAZL.

WRAZL staff continues to make progress on identifying "problem" specimens that need to be deaccessioned or returned to other facilities. Numerous archaeological animals remains from Angel Mounds archaeological site were returned to the IU Museum of Archaeology and Anthropology, and WRAZL staff are working to identify any other repositories that specimens need to be returned to.

The challenge to inventory and reorganize specimens to reflect current taxonomy is continuous. Many of WRAZL's specimens retain outdated taxonomic identifications that reflect the time when the specimens were first processed (e.g., in the 1980s). Dr. Miller-Camp led this work in 2023, and Dr. Kennedy has been overseeing it in 2024. Recent efforts include continued corrections of misidentified rabbit specimens and a review of all common and taxonomic names assigned to the lab's parrots.

- Workspaces for CBRC, IUPC, and WRAZL were established in Microsoft Teams, including project and task boards to track activities, and training workers to use these central spaces.
- External loans from and visits to CBRC Collections were arranged and more for 2024 summer and fall are being processed.
- WRAZL's annual IU IBC protocol and permit paperwork have been filed.
- The Lab Manager and CBRC-funded student workers created a plan to increase WRAZL's social media presence that includes researching current media trends and creating a backlog of content. This will be implemented in 2024.

### ***IU Paleontology Collections***

#### Photogrammetry

- inventoried stock and developed equipment list for IUPC and WRAZL
- developed and produced photogrammetry workflow chart for online and in-lab workers
- presented two photogrammetry workshops for faculty, graduate students, undergraduates from Earth Sciences, Anthropology, Center for Underwater Science
- established supercomputer project accounts with Quartz for graduate and undergraduate workers

Trained three undergraduate interns on specific photogrammetry projects

#### **A). Invertebrate group - conularids – an invertebrate fossil group from State of Indiana**

- created photographic databases of specimens
- conducted comprehensive literature review
- generated 3D models of selected specimens
- created a database using Excel for recording quantitative and qualitative traits of the fossil group
- outlined further research to be conducted on this group

#### **B). Vertebrate groups – fossil and modern – for developing photogrammetric expertise**

- used photogrammetry to expand digitization of WRAZL's collections
- digitized carnivore jaws, bird skull, rabbit skull and identified troublesome scans/models that required more expertise because of porous skeletons, thin, small bones, and other density issues
- investigated additional workflows/photogrammetric techniques for these specimens

#### **C). Paleoanthropological specimens and casts**

- used photogrammetric techniques to digitize specimens and casts from Olduvai Gorge, Tanzania in the lab of Dr. Jackson Njau

Integrated pedagogy into development of hallway exhibits for 5<sup>th</sup> floor display cases in Geology Building.

Trained graduate students who, in turn, trained undergraduates in development of display theme, selection of fossil specimens, writing of text to accompany specimens in display, develop aesthetics of display.

Database management system research and resolution as per recommendation of external review committee

Filled external request submitted by Dr. A. Kort, University of Michigan, for scans from WRAZL's mammal collection, specifically carnivorous mammals' femurs, pelvises, and sacra. CBRC RA guided undergraduate interns in the techniques of scanning these selected specimens.

Mazon Creek and Stanley Cemetery specimens were sorted for provenance, identified by undergraduate student hourly interns, overseen by the collections manager. Specimens were placed in drawers and cabinets in the IUPC room.

Vertebrate specimens, Big Horn Basin, WY, Paleogene were sorted and identified by undergraduate student hourly interns, overseen by the collections manager.

Paleobotany donations were sorted but await evaluation for possible accession.

Microfossil slides were catalogued and rehoused for condensed storage with archival-quality materials.

The Stotter Exhibit was part of University Collections' inaugural opening and was highly regarded by visitors. Undergraduate workers helped catalog, pack, and transport Stotter Collection specimens for return from the exhibition. Specimen arrangement remains to be finalized.

Teaching reserves. The IUPC holds a large reserve of specimens for use in Earth and Atmospheric Science courses, including research-quality specimens and casts of vertebrate and invertebrate taxa that represent a broad swathe of phylogenetic and taxonomic diversity. Undergraduate workers spearheaded a reorganization of the teaching reserves by taxonomic designations (Order and Family). Specimens were further rehoused with archival-quality materials to ensure continued preservation.

Loans were organized and inventoried for IUPC's long-term specimen loans to other institutions. Specimens from loan returns were integrated into the IUPC; associated records were updated and stored in IUPC archives.

Reorganization and unpacking. Specimens were rehoused and integrated into appropriate collections cabinets and spaces. Online collections inventory was updated to reflect the new location of items in the collections space.

IUPC Basement Storage reorganization. IUPC retains a large space for specimen storage in the basement of the Department of Earth and Atmospheric Sciences. Collections are largely representative of field collections by current and former IUPC personnel, as well as a large reserve of teaching specimens for geology courses. Field collections were organized by principal investigator, project, and locality of origin. Teaching specimens were organized by relevant course, formation, and rock type.

#### **4. Plans for CBRC's future**

##### ***CBRC is initiating new activities***

- Faculty within CBRC are developing a NSF grant proposal to advance AI and geosciences, submission date is March 15, 2024, request is ~\$1.5 million.
- Working toward filling the external review committee's two primary recommendations: placing catalog specimen data in an electronic database to serve the collections data to the public, and digitizing specimens for individual research projects and in support of teaching
- Advancing stronger relationships with University Collections to optimize technological innovations in 3D digitization and imaging techniques
- Integrating more fully into the academic digitization community to learn and share new techniques and their applications
- Cultivating educational opportunities with University Collections for McCalla exhibits for CBRC, IUPC, and WRAZL materials

- Posting our Center’s mission, vision, and goals to the IUPC and WRAZL spaces so our goals are known more fully by all who work within and visit the collections

***CBRC is establishing new goals***

CBRC developed recently Strategic Planning documents. Priority goals of these strategic plans integrated with the external committee’s recommendations include:

- utilizing more fully the *Specify* framework for collections metadata
- Serving the images and records on *Specify* to the public by advertising availability of imaged specimens to research and non-academic communities
- developing plans to invest in a data management staff
- digitizing physical specimens in the IUPC and WRAZL with priority to research and teaching activities
- prioritizing and purchasing equipment for digitization efforts
- continuing to train the next generation of STEM and graduate and undergraduate students in 3D imaging techniques and in managing associated metadata

***CBRC is anticipating changes in operation improvements***

CBRC’s budget request included a postdoctoral research position. CBRC's external review committee recommended that digitization support in the forms of investment in a collections data management system, and in data management staff with experience relevant to the zooarchaeology and paleontology disciplines be CBRC's top priorities - for the unified goal of serving WRAZL and IUPC specimen data to the public. To achieve this goal, CBRC is requesting a postdoctoral researcher with Ph.D.-level specialty in zooarchaeology to work with database management under the direction of Dr. Ryan Kennedy (Anthropology). The DEAS IUPC Collections Manager Research Faculty hire would be expected to have experience in and provide mentoring/training in collection management skills, including introduction to our collection management database system, to the new postdoctoral hire.

Job duties for this postdoctoral researcher would include database management using the *Specify* management system for both WRAZL and IUPC. The person would implement and maintain electronic databases, provide appropriate data security, and facilitate web access.

Qualifications for the Postdoctoral researcher would include verification for understanding relational databases, familiarity with international biodiversity data standards, and experience with database programming.

The post-doctoral researcher would be centered in WRAZL’s Department of Anthropology directed by Dr. Kennedy.

***CBRC has special issues and challenges***

1. Preserving individual digitized images and their associated metadata is a technology storage challenge that remains unresolved at IU regarding cost and storage availability. Transfer of digital data from Box to Google to OneDrive and Teams, with no permanent storage solution in sight, risks loss of valuable 3D data and slows progress in developing technological innovations.

2. CBRC is acting on the external review committee’s recommendations. Listed here are the major recommendations, and in Appendix II is an extraction, taken from the “Response to the External REview Committee Report” submitted to the Dean’s office December 6, 2023 and included in this document for ease of reference.

*Digital Support #1 -*

*Recommendations:* Place catalog specimen data in an electronic database and serve these collections data to the public. Invest in data management staff.

*Digital Support #2 -*



*Recommendations:* Digitize and associate related archival records with the specimen record. Continue to digitize specimens for individual research projects and in support of teaching. Serve the images and records on a searchable electronic database for both collections.

Facilitate and fund development of local archives that can handle the more complex 3D data and related metadata describing how it is made, or partner with existing federally funded domain-specific repositories (e.g., MorphoSource) to provide hosting of these types of data.

*Support for Collections Management -*

*Recommendations:* Continue to fund collections manager and lab manager positions for the Center. The Center Director may want to evaluate job duties for these positions and consider whether database management and grant writing should be part of these positions.

*Infrastructure Support -*

*Recommendations:* Plan for infrastructure needs. Consult with University Collections to strategically place some specimens off-site, once stable, climate-controlled storage can be secured. Prioritize infrastructure needs for WRAZL, including freezer updates, specimen preparation space, and additional workspace. Secure additional funds to support these needs once the one-time funding associated with Kennedy's hire runs out.

3. Additional challenges are centered on:

- Maintaining stability of digitization expertise in academia as students rotate with semesters
- Communicating the Center's goals effectively from many voices – researchers, graduate students, undergraduates, and departmental chairs – in personal interviews and written documents. This is essential in securing a productive future for CBRC.

### ***Summary***

CBRC is initiating new activities, establishing new goals, and has special issues and challenges to be addressed from the external review committee's recommendations. CBRC has faculty and student researchers with deep knowledge of the unique value of natural history collections, but with no formalization of duties in the tenure track promotion line. Nonetheless, CBRC personnel are dedicated to caring for the natural history specimens in their physical and digital forms with managerial and curatorial skills advocated by policy. With innovations in digital technology CBRC preserves the specimens, protects the history of the Earth embedded in these collections, and uses and shares these resources with researchers within and outside of the State of Indiana to introduce natural history and biological evolution of the Earth to the general public. We value our opportunities to teach, train, and support the research and creative activities of all people interested in the natural history collections housed and under the care of Indiana University.

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### **ADDENDUM**

Included here are statements written by CBRC undergraduate interns, December 2023, documenting their experiences with CBRC internships. Interns were directly overseen by CBRC RA, Anthropology and DEAS faculty, and IUPC and WRAZL Collections Manager.

What I learned in the internship this semester. Thank you to CJ and Professor Njau for being great mentors and helping me through this process!

- How to use the IU research desktop and properly use Metashape.
- How to use professional cameras, set up the light box, and use Digicam and Globus.
- How to properly put specimens in frame and tweak the settings in Digicam to get good-quality photos for proper alignment.

- How to properly catalogue specimens and keep track of which specimens I have finished and which ones I have not.
- How to properly handle specimens so that they are safe from damage.
- How to properly communicate my issues with alignment with CJ and Professor Njau.
- How to work through and solve problems when dealing with misalignment.
- How to make sparse clouds, dense clouds, add texture, and form a mesh in Metashape.
- How to “clean” the sparse clouds once they are generated properly.

In the Semester of Fall 2023, working in the W.R. Adams Zooarchaeology Laboratory:

I continued various tasks from previous semesters of work, including processing and macerations. However, the majority of this semester has been dedicated to learning the process of photogrammetry, from taking photos to developing models. My personal interest in photogrammetry aligned with the long-term vision of digitizing the entirety of WRAZL's collections. That vision requires a vast undertaking, especially for an undergraduate who was untrained in photogrammetry. Luckily, with the help of Charles Salcido, who has acted as a mentor and teacher in photogrammetry through workshops and one-on-one assistance; this semester alone, I have been able to make leaps in my understanding of photogrammetry throughout the course of the semester. Not only has the development of my knowledge expanded, but I have gained greater confidence in my skills involving photogrammetry, which has become the first step into fulfilling the vision of WRAZL's collections' digitalization. Student training and skill development inside the laboratory have been essential to my experience working and learning as an undergraduate. Not only has this contributed to personal skill and knowledge development, but this contributes back to Indiana University Bloomington research, collections, and the zooarchaeology laboratory. None of this could have been possible without the assistance and guidance of all the laboratory faculty who have shaped my development and experience at Indiana University Bloomington. Every semester, I look forward to each new project being launched, matters to be learned, and contributions I can make in the W. R. Adams Laboratory. Dr. Kennedy, S. Couch, J. Miller-Camp, and C. Salcido have all been key figures in my educational development as an undergraduate student.

For the Fall 2023 semester, I conducted basic research on the conulariids housed in the

IU Paleontology Collections. Key tasks involved in this investigation included:

- Creating a photographic database of the conulariid specimens
- Conducting a comprehensive literature review on conulariids
- Employing photogrammetry techniques to generate 3D models using Metashape
- Creating a database on the conulariids using Excel, recording quantitative and qualitative traits of the specimens

After collecting data on conulariids, I decided to investigate the impact of ocean tides on conulariid species' distribution on Earth for next semester. I plan to do this by utilizing Excel and ArcGIS for the calculation and mapping of the frequency and distribution of conulariid species and their characteristics around the world. I then plan to overlay a map of Paleozoic ocean currents onto the mapped species to see if any patterns emerge between them. Doing this will contribute to a deeper understanding of the reproductive systems of conulariids within their ancient marine environment.

## Appendix I

### *Highlights of Accomplishments of CBRC Members, inclusive of IUPC and WRAZL*

#### *\*Educational Offerings from CBRC Collections*

##### *IU Courses PLEASE UPDATE FOR ZOOARCH*

- Dinosaurs and Their Relatives (EAS G114). Introduction to paleontology and geology from the perspective of the clade Dinosauria. Introduction to the scientific process, morphology, phylogenetics, stratigraphy and geochronology, and Earth history.
- Natural History of Coral Reefs (EAS E341/E700). This course addresses the evolutionary history of reef ecosystems through geologic time, inclusive of reef composition, global distribution, modern reef development, conservation and management practices, and the persistence of the reef ecosystem through climate change scenarios. Topics include biologic, ecologic and geologic principles and processes as they pertain to coral reef ecosystems.
- Invertebrate Paleontology (EAS E411). This course introduces the structure, classification, habitats, geologic history and significance of the invertebrate phyla. Students learn the application of biologic principles and the use of invertebrate fossils in the study of Earth's history, the origin of life and the early fossil record, approaches of taxonomy, chemistry of fossils, ecology of ancient life, and the use of fossils to measure geologic time.
- Vertebrate Paleontology (EAS E412 / E512). This course introduces the biological and geological principles of studying vertebrate evolution in the context of Earth history, including morphology, phylogeny, taxonomy, evolution, biomechanics, biogeography, paleoenvironments, and stratigraphic history.
- Geometric Morphometrics (EAS E562). This course is a practical, applied introduction to geometric morphometrics. Students learn to collect, analyze, and interpret geometric morphometric data. Shape theory and methods are covered, including Procrustes superimposition and its statistical implications, analysis of curves and outlines, and Monte Carlo modeling of shape.
- Faunal Osteology (ANTH P426). This course introduces students to zooarchaeological analysis and makes heavy use of WRAZL specimens. Students learn basic skeletal anatomy of a wide range of animal groups (mammals, birds, fish, etc.), take part in an animal carcass processing workshop, and conduct a semester-long research project using archaeological animal remains.
- People and Animals (COLL C104). This course is a general survey of topics related to human-animal interactions. Discussion sections make frequent use of WRAZL collections to introduce students to animal bones and functional morphology.
- Introduction to Archaeology (ANTH P200). The instructor and 60 undergraduate students visited the WRAZL to examine specimens and learn about zooarchaeology.
- Human Geography in a Changing World (GEOG G110). Dr. Kennedy visited 50 students in this course and used WRAZL collections to talk about the trade of animal products.

#### *Exhibits*

WRAZL provided numerous specimens for use in the *Taking a Bite Out of Science* (TABOOS) exhibit created by IU Collections at McCalla.

CBRC-funded student employees created materials for two displays which will be installed in the cases outside of WRAZL in 2024.

WRAZL provided a dolphin skull, hawksbill sea turtle scutes, and a lionfish skeleton to WonderLab Museum for a display that supplements the educational messages of their "Wonder Under the Waves" coral reef exhibit.

***External Grants  
Completed***

- Geological Society of America 2023, On to the Future Fellowship (Anupama Chandroth)
- Paleosynthesis project at University of Erlangen, Germany, Analytical Paleobiology Summer School, Invited participant, Funded by the Volkswagen Foundation (Anupama Chandroth)
- The Paleontological Research Institution John W. Wells Grant-in-Aid of Research (Samantha Hartzell)
- Geological Society of America Graduate Student Research Grant (Samantha Hartzell)
- Clay Minerals Society, Student Research Grant, (Kirsten Hawley)
- International Association of GeoChemistry, PhD Student Research Grant (Thomas W. LaBarge)
- The Geological Society of America, Charles A. & June R.P. Ross Research Grant (Thomas W. LaBarge)
- Society of Vertebrate Paleontology, Jackson School of Geosciences Student Travel Grant (Charles J. Salcido)

***In Progress***

- Zimmerman, Alex N, Johnson, Claudia C., NOAA Ocean Acidification Program award #NA22OAR017021 "Ocean Protector: A game-based curriculum to teach the impacts of ocean acidification and positive actions to help"
- Njau, J.K. NASA Solar System Workings. An East African Rift fluvio-lacustrine analog for Jezero crater, Mars. Sub-award \$71962

***In Review***

- Johnson, C. C. (PI), Chakraborty, Sunandan (Co-PI), Njau, J.K. (Co-PI), Simms, J., (Co-PI), Zimmerman, A. (Co-PI), P.D. Polly (Senior Personnel) 2024. CAIG: Addressing the urgent demand for taxonomic expertise and education in geosciences through innovative AI approaches. NSF, ~\$1,500,000.
- Njau, J.K., Wenner-Gren Foundation, The Eastern African Association of Paleoanthropology & Paleontology Conference, Addis Ababa, 7/28-8/1/2024, \$20,000.
- Njau, J. K., Palaeontological Scientific Trust (PAST), The Eastern African Association of Paleoanthropology & Paleontology Conference, Addis Ababa, 7/28-8/1/2024, \$8300.
- Geological Society of America Graduate Student Research Grants (Bristol Brabson)
- Paleontological Society Student Research Grants (Bristol Brabson)
- Supporting Tomorrow's Researchers and Today's Advocates (STRATA) mentorship program (For NAPC 2024) (Anupama Chandroth)
- The Exploration Fund Grant from The Explorers Club (Thomas W. LaBarge)

***Grants Applied for and Not Received***

- Gomez-Robles, A. (Co-PD/PI), Polly, P. David (Co-PD/PI), Grant, Research/Creative Activity, "Preproposal: How did humans evolve? Using modelling to test the drivers of cranial evolution?", Leverhulme Trust, Competitive, Foundation, United Kingdom, \$488,942.00. % Effort: 10, Not Awarded.
- Johnson, C., (Co-PI), Polly, P.D. (Co-PI), Beeker, C.D. (Co-PI), Motz, G. (Co-PI), Grant, Research/Creative Activity, NSF's GEO OSE Track 1: Promoting an accessible ecosystem of digitized natural history data. NSF, \$399,999. Not Awarded.

***Internal Grants  
Completed***

- Foreign Language Support Fellowship through the College of Arts and Sciences (Danielle M. Peltier)
- Summer Grant-in-Aid through the Department of Earth and Atmospheric Sciences (Danielle M. Peltier)
- International Travel Grant, Department of Earth and Atmospheric Sciences (Anupama Chandroth)
- Dean's Women in Science Travel Grant through College of Arts and Sciences, IU (Anupama Chandroth)
- Don & Margie Hattin Field Course Fund (Matthew J Koelbel)

- Peter and Susan Dahl Fund through the Department of Earth and Atmospheric Sciences (Thomas W. LaBarge)
- The Executive Dean's Travel Award for Women in Science, IU (Sierra Lopezalles)
- Travel Grant, Department of Earth and Atmospheric Sciences (Sierra Lopezalles)
- William Thornbury Fellowship (Samantha Hartzell)
- Galloway/Perry/Horowitz Memorial Fund Summer funding (Samantha Hartzell)
- Galloway/Perry/Horowitz Memorial Fund Spring Semester funding (Samantha Hartzell)

### ***In Progress***

- J.R. Kennedy, E.J. Guiry, P. Sauer. 5/2023-5/2024. *Developing New Archaeological Approaches to Human-Turtle Relationships*. Indiana University Social Sciences Research Funding Program. \$35,000.
- College of Arts and Science Travel funding (Anupama Chandorth)
- John and Meta Dennis Fellowship for Foreign Language Support through the College of Arts and Sciences (Thomas W. LaBarge)
- Foreign Language Support Fellowship through the Office of International Affairs, College of Arts and Sciences (Thomas W. LaBarge)

### ***In Review***

- McCormick Science Grant through the College of Arts and Sciences (Thomas W. LaBarge)  
*Grants Applied for and Not Received*

### ***Peer-Reviewed Publications***

#### ***Published***

- Drumheller, S., D'Amore, D., Njau, J.K. Taphonomic Approaches to Bite Mark Analyses in the Fossil Record and Applications to Crocodyliform and Broader Archosaurian Paleobiology. In: *Ruling Reptiles: Crocodylian Biology and Archosaur Paleobiology*. (Eds. Holly N. Woodward & James O. Farlow), Indiana University Press. Bloomington, IN. Pg. 161-185.
- Gündüz, I., S. Demirtaş, M. Silsüpür, M. Özmen, P. D. Polly, D. T. Bilton. 2023. Notes from the Anatolian underground: two new mole taxa from eastern Turkey, together with a revised phylogeny of the genus *Talpa* (Mammalia: Talpidae). *Zoological Journal of the Linnean Society*, 199: 567-593 (doi: 10.1093/zoolinnean/zlad049).
- Kort, A. E. and P. D. Polly. 2023. Allometry then locomotor diversification shaped lumbar morphology in early placental mammals. *Evolutionary Journal of the Linnean Society*, 2: kzad004, 1-11 (doi: 10.1093/evolinnean/kzad004).
- McHenry, L.J., Stanistreet, I.G., Njau, J.K., Mwankunda, J. The Geoheritage of Olduvai Gorge, Tanzania: providing geological answers to human origins questions. *Geological Society, London, Special Publications*, 543. DOI.
- Pearson, A. and P. D. Polly. 2023. Temporal lobe evolution in extant and fossil Cercopithecoidea. *Journal of Mammalian Evolution*, 30: 683-694. (doi: 10.1007/s10914-023-09664-6)
- Pearson, A., P. D. Polly, E. Brunner. 2023. Updated imaging and phylogenetic comparative methods reassess relative temporal lobe size in anthropoids and modern humans. *American Journal of Physical Anthropology*, 180: 768-776 (doi: 10.1002/ajpa.24712)
- Polly, P. D. 2023. Extinction and morphospace occupation: a critical review. *Cambridge Prisms: Extinctions*, 1 e17: 1-19. (doi: 10.1017/ext.2023.16)
- Salcido, C.J, Tweet, J.S., and Santucci, V.L. (2024). Research Put Into Action: How a Fossil Inventory Informed Paleontological Resource Monitoring Efforts Preceding Road Construction at Theodore Roosevelt National Park. *Park Stewardship Forum*.
- Short, R. A., J. L. McGuire, P. D. Polly, and A. M. Lawing. 2023. Trophically integrated ecometric models as tools for demonstrating spatial and temporal functional changes in mammalian communities.

Proceedings of the National Academy of Sciences, USA, 120(7): e2201947120 (doi: 10.1073/pnas.2201947120).

- Zimmerman, A. N., Johnson, C. C., Phillips, G. E., and Ehret, D. J. ,2023. Taxonomy and paleobiogeography of rudist bivalves from upper Cretaceous strata, Gulf Coastal Plain and Puerto Rico, USA. *Journal of Paleontology* 97(2):318-340. [doi.org/10.1017/jpa.2022.104](https://doi.org/10.1017/jpa.2022.104)

#### ***Accepted***

- Ehrie, A., A. Iruri-Tucker, Y. Lord, H. Williamson, K. Hunt, P. D. Polly, C. Fitzpatrick, and M. Wasserman. Accepted. Measuring Mantled Howler Monkey (*Alouatta palliata*) testes via parallel laser photogrammetry: expanding the use of non-invasive methods. *American Journal of Primatology*.
- Guiry, E.J., J.R. Kennedy, D.C. Orton, et al., in press, The ratting of North America: A 350-year retrospective on Rattus species compositions and competition. *Science Advances*.

#### ***In Review***

- LaBarge, T.W., Njau, J.K. Taxonomic reappraisal of Nihilichnus from taphonomic perspectives of crocodile predatory ecology. *Ichnos*.
- Lamle, HM, Muckerheide, SM, Baelz, JH, Divish, CJ. Faculty Mentors: Claudia C Johnson (PI) and Charles D Beeker. Submitted 2023 to Undergraduate Research Journal, Indiana University. Title: Biodiversity of coral species in selected Caribbean regions.

#### ***Conference Presentations***

- Chandroth. A., Johnson. C.C. Morpho-functional group diversity of Caribbean corals and their impact on macroevolutionary patterns. Geological Society of America (2023), Pittsburgh, USA (Oral presentation).
- Ely, Ricardo, Machado, Fabio. 2023. Model Adequacy Tests for an Early High Disparity Phylogenetic Comparative Model. Two Conferences: Evolution, Albuquerque, New Mexico (Oral Presentation); Geological Society of America Annual Meeting, Pittsburgh, Pennsylvania (Oral Presentation).
- Grossnickle, D. (Presenter), Brightly, W., Weaver, L., Stanchack, K., Roston, R., Pevsner, S., Stayton, T., Polly, P. David, Law, C. "A novel method for measuring phenotypic convergence", Conference, Society for Integrative and Comparative Biology, Seattle, WA, United States. (January 5, 2024).
- Hawley, Kirsten, C. Beeker, C. Johnson, S. Rader. "Methods to identify Post-depositional Geochemical Alterations to Ceramics in Submerged Archaeological Sites: A Case Study Using Prehistoric Ceramics from Eastern Dominican Republic." Presented at Society of Historical Archaeology Annual Meeting, Lisbon, Portugal.
- J.R. Kennedy. 2024. "Incorporating ancient DNA analysis into the zooarchaeology of the Chinese diaspora." Paper presented at the annual meeting of the Society for Historical Archaeology, Oakland, CA, January 5.
- J.R. Kennedy. 2024. "Food, trade, and connection in two 19th-century Chinese diaspora sites in the American West." Paper presented at the annual meeting of the Society for Historical Archaeology, Oakland, CA, January 5.
- Royle, T.C.A., J.R. Kennedy, L.S. Jackman, Y. Shichiza, D.Y. Yang. 2023. "Investigating the Historical Trade of Cuttlefishes (Sepiidae) through the Ancient DNA Analysis of Archaeological Cuttlebones." Paper presented at the International Council for Archaeozoology Meetings, Cairns, Australia, August 9.
- J.R. Kennedy, E.J. Guiry, T.C.A. Royle, and B.M. Kemp. 2023. "Archaeological Evidence Provides Expanded Insights into Nineteenth-Century Chinese Diaspora Fisheries in the American West and Beyond." Paper presented at the International Council for Archaeozoology Meetings, Cairns, Australia, August 10.
- J.R. Kennedy and K. Lau-Ozawa. 2023. "Culinary Innovation and Political Action in a Japanese Incarceration Camp." Paper presented at the annual meeting of the Society for American Archaeology, Portland, OR, April 1.
- K. Lau-Ozawa and J.R. Kennedy. 2023. "Diaspora on the Block: Neighborhood Archaeology as Theory and Method." Paper presented at the annual meeting of the Society for American Archaeology, Portland, OR, April 1.

- M. Peduto\*, Kennedy, J.R., and S. Couch. 2023. Zooarchaeological Analysis of Fish Remains From the Thompson Turtle Kraal, a ca. 1970s Sea Turtle Corral in Key West, Florida, USA. Poster presented at the meetings of the International Council for Archaeozoology, Cairns, Australia, August 10.
- E.J. Guiry, J.R. Kennedy, P. Szpak. 2023. Sulfur Isotopes, Seagrass, and Sea Turtle Serial Sampling: Exploring the Isotopic Ecology of the Key West Turtle Kraals. Poster presented at the meetings of the International Council for Archaeozoology, Cairns, Australia, August 9.
- LaBarge, T.W. 2023. Troubles in Tiny Terror Bird Taxonomy: Morphometric and Phylogenetic Assessment of AMNH 9157. Great Lakes Student Paleontology Conference. Ann Arbor, MI, USA [Oral Presentation]
- Lopezalles, S. (2023) The Shape of Speed: The Relationship Between 3D Humerus Shape and Maximum Running Speed. Society of Vertebrate Paleontology Annual Meeting, Cincinnati, Ohio (Poster Presentation).
- Njau, J.K. Challenges to scientific cooperation based on equality and reciprocity between the European Union, Latin America, the Caribbean, and Africa. *Panelist*, a high-level workshop organized by *Science Europe* and *Spanish National Research Council*.
- Peltier, D.M., Njau, J.K. 2023. Quantifying Geographic and Temporal Distribution of Vertebrate Fauna During Bed II Times at Olduvai Gorge, Tanzania. Society of Vertebrate Paleontology Annual Meeting, Cincinnati, OH. (Colbert Prize Competition Poster)
- Polly, P. D. Escalante River Watershed Partnership, “Paleontology of the Grand Staircase-Escalante Region”, Grand Staircase-Escalante Symposium 2023, 16 March 2023.
- Salcido, C.J. and Polly, P.D. Can you eat well in Flatland? A case study on when two-dimensional geometric morphometric analysis is sufficient for functional morphological analysis and evolution of “flat” biological shapes. Poster presented at: 83rd Annual Meeting of the Society of Vertebrate Paleontology; 2023 Oct 18-21; Cincinnati, OH
- Salcido, C. J. A paleontological resource inventory of Theodore Roosevelt National Park reveals potential for future vertebrate paleontological research and management. Poster presented at: 83rd Annual Meeting of the Society of Vertebrate Paleontology Special Session; 2023 Oct 18-21; Cincinnati, OH.
- Slattery, J., Linzmeier, B., McCraw, J., Minor, K., Harries, P.J., Landman, N., and Johnson, C. Evolution of the Western Interior Basin: New advances and fresh perspectives. Geological Society of America (2023) Annual Meeting, Pittsburgh, USA. Symposium.
- Zimmerman, A. N. and Johnson, C. C. (2023) Game-based learning for marine science: an online example with lessons learned. Geological Society of America (2023), Pittsburgh, USA (Oral presentation).

### ***Department Presentations***

- Johnson, C. C., Exploring Caribbean reefs: past, present and future. Colby College Department Colloquium, February 23, 2024.
- J.R. Kennedy. The Zooarchaeology of Red Snappers. IU Museum of Archaeology and Anthropology Coffee and Curators Speaker Series, Indiana University, November 10, 2023.
- J.R. Kennedy. Developing Novel Archaeological Approaches to Documenting Long-term Human Impacts to Turtles. Maryland Archaeological Conservation Laboratory Brown Bag Series, Maryland Archaeological Conservation Laboratory, August 3, 2023.
- J.R. Kennedy. Back where I started: zooarchaeological perspectives on 19th-century Chinese fisheries in western north America. Keynote speaker for the Anthropology Graduate Student Association Skomp Research Symposium, Indiana University Museum of Archaeology and Anthropology, March 10, 2023.
- Peltier, D., Johnson, C., Njau, J. 2023. Biostratigraphic Framework of Bed II, Olduvai Gorge, Tanzania. Indiana University Crossroads Conference, Bloomington, IN
- Polly, P. David. "Spatial processes and evolutionary models", Seminar, Seminar Series, School of Biological Sciences, University of Nebraska, Lincoln, NE, United States. (April 6, 2023).

- Polly, P. David. "The assembly of New World cat communities: ecometrics and Neogene faunal turnover", Seminar, Seminar Series, School of Biological Sciences, University of Nebraska, Lincoln, NE, United States. (April 6, 2023).
- Salcido, C.J. and Polly, P.D. 2023. Functional drivers of evolutionary rates in mandible shape of carnivorous therian mammals. Indiana University Crossroads Conference, Bloomington, IN

### ***Book Reviews***

### ***Creative Works***

### ***Awards***

Kort, Anne. Taylor & Francis Award for Best Student Article in the Journal of Vertebrate Paleontology.

### ***Dissertations and Theses - Completed***

- Anderson, Samuel – M.S. thesis completion, Summer 2023. Geoarchaeological mapping with UAV, SfM Photogrammetry and GIS at Olduvai Gorge, Tanzania.
- Kort, Anne E. Indiana University, Earth & Atmospheric Sciences, PhD, 2019-2023. Dissertation title: "Lumbar vertebrae and diversification of locomotion in Paleogene mammals".
- Fulghum, Henry, Indiana University, Earth & Atmospheric Sciences, Masters, 2021-2023. Thesis title: "Dietary indicators in the tribosphenic dentition and their implications for the early diversification of therian mammals".

### ***Qualifying Exam Presentations***

- Anupama Chandroth  
Title: Evolution of hermatypic coral morpho- functional groups and their role in developing and maintaining ecosystem stability
- Kat Sestrick  
Title: How developmental constraints and functional demands interact to shape evolutionary trajectories
- Sierra Lopezalles  
Title: New Function from Old Form: Leveraging new technology, data, and methods to better predict function from form in extinct mammals

### ***Workshops***

- Charles J. Salcido – Photogrammetry workshops held at Indiana University for CBRC student workers, Indiana University Center for Underwater Science, and EAS students and researchers. "Photogrammetry in CBRC: How it works and how to do it".
- Ryan Kennedy and Sam J. Couch- Animal processing workshop for WRAZL student employees and members of Kennedy's Faunal Osteology course on 7 March 2023.
- Njau, J.K., New paleoanthropological investigation of upper beds, Olduvai Gorge, Tanzania. Biogeographic and cultural adaptations of early humans during the first intercontinental dispersals workshop, Madrid, Spain (Apr 24-28, 2023). Funded by European Research Council.

### ***Government Reports***

- WRAZL- Reported all avian acquisitions for 2022 to United States Fish and Wildlife as per their Migratory Bird Permit
- WRAZL- Reported all acquisitions salvaged in Indiana for 2022 to Indiana Department of Natural Resources.



### ***Educational Outreach***

- Matthew J. Koelbel – Letters to a Pre-Scientist: pen pal
- Danielle M. Peltier – Skype-a-Scientist
- Alex Zimmerman – Classroom demonstrations of online game-based learning tool teaching ocean acidification
- Anupama Chandroth - Letters to a Pre-Scientist: pen pal
- Anupama Chandroth - Wonderlab fundraiser exhibit 2023
- Polly, P. D. “Paleontology of Indiana: 500 Million years of Hoosier History”, IU Alumni Association Lifelong Learning program, 23 March 2023.
- Polly, P. D. “National Monuments in Utah: Dinosaurs, Science, and Politics”, IU Alumni Association Lifelong Learning program, 16 March 2023.
- Kat Sestrick – Letters to a Prescientist: pen pal
- Kirsten Hawley, Anupama Chandroth—Girls Inc Sciencefest 2023

***WonderLab Museum of Science, Health & Technology*** is an all-ages, hands-on science museum in downtown Bloomington which regularly partners with WRAZL to facilitate educational experiences for elementary aged children as well as to create exhibits for their gallery. This year WRAZL hosted five episodes of WonderLab’s virtual program “Animal Hour.” This program teaches children about a variety of animal related concepts such as biology, ecology and evolution. WRAZL’s role in these programs was to provide material from the collection to support the educational messages as well as to show the audience what research in a zooarchaeology lab is like and to highlight the tools and techniques scientists use to study animals in the past.

WRAZL hosted a tour for WonderLab Museums’s summer camp, Animal MD. This camp was geared towards 4<sup>th</sup>-8<sup>th</sup> grade students and focused on learning about animal science while exploring related careers. This camp was composed of 20 children and 4 high school student helpers in addition to the teacher who was WRAZL’s Sam Couch. The Paleontology collection hosted WonderLab’s 2<sup>nd</sup>-3<sup>rd</sup> grade camp, A World of Bugs which studied arthropods both modern and extinct, also taught by Sam Couch. This camp was comprised of 20 children and 4 high school student helpers.

**Teacher’s Warehouse** is an organization in Bloomington that collects donations of materials that may be needed in classrooms ranging from furniture to stationary supplies. MCCSC teachers can go to this repository to pick up supplies and materials they need for their classrooms at no charge to the teacher. WRAZL made a large donation of old material from the lab such as glassware and out of date microscopes.

Sam J. Couch- Hosted WonderLab Museum’s virtual program “Animal Hour- You're HOW old?” at WRAZL on 7 April 2023.

Jess Miller-Camp – Toured the Paleontology lab for WonderLab Museum’s summer camp “A World of Bugs” for 20 2<sup>nd</sup>-3<sup>rd</sup> graders, 3 high school interns and the teacher, Sam Couch, to teach about the evolution of arthropods on 9 June 2023.

Sam J. Couch – Toured WRAZL for WonderLab Museum’s summer camp “Animal MD” for 21 4<sup>th</sup>-8<sup>th</sup> graders and 4 high school interns to illustrate how skeletal morphology influences movement on 23 June 2023.

Sam J. Couch- Hosted WonderLab Museum’s virtual program “Animal Hour-No Bones About It” at WRAZL on 11 August 2023.

Jess Miller-Camp- Spoke in WonderLab Museum’s virtual program “Dive Deeper- AMA: Paleontologist” on 6 October 2023.

Sam J. Couch- Hosted WonderLab Museum’s virtual program “Animal Hour- Archaeo or Paleo?” at WRAZL on 27 October 2023.

Sam J. Couch- Hosted WonderLab Museum’s virtual program “Animal Hour- How to be a Scientist” at WRAZL on 8 December 2023.

Sam J. Couch- Hosted WonderLab Museum’s virtual program “Animal Hour- Laboratory Exploration” at WRAZL on 15 December 2023.

**External loans from and visits to CBRC Collections**

- Charles J. Salcido and Charleton Jackson – Filled out a scan request of WRAZL material for researcher at University of Michigan
- IAS Awards to two researchers working with the collection of former faculty member D.Hattin -
- Multiple loan requests involving use of digitized materials made by CBRC and held in IUPC

## Appendix II

**Taken from:** *Response to the External Review Committee Report, December 6, 2023*

### **Recommendations, Plans, and Challenges Ahead of Us**

Categories set forth by the Committee that constitute major *recommendations* are support for digital data, support for collections management, and infrastructure support. Prominent *challenges* identified by the Committee are faculty appointments that do not include formalized curatorial responsibilities, insecurity of future funding, lack of a publicly accessible electronic database, and physical space issues needed for WRAZL.

#### *Digital Support #1 -*

**Recommendations: Place catalog specimen data in an electronic database and serve these collections data to the public. Invest in data management staff.**

**Response:** We agree wholly that an expanded data management system is our #1 priority. An online database for the IUPC and WRAZL will allow researchers to search our holdings for their research needs. We currently have a nearly complete digital specimen management system with more than 10,000 catalog entries for WRAZL. The data are currently used internally while the quality is being improved, after which they will be made accessible to external researchers. For IUPC, which has well over 1 million specimens, we currently have a digital inventory of the geological units represented in the collection that is available externally and a partial digital catalogue of specimen-level data of about 10-15 thousand specimens in spreadsheet format that is intended to form the core of our digital management system.

**Steps taken:** Since receiving the Committee's recommendation to review the kinds of collection data management systems that are now available, we developed a comparative assessment of how those systems would serve our natural history specimens' unique needs. We already invest in yearly membership dues for the open access data management system currently in use at WRAZL (Specify) and have decided on using the same system for IUPC's specific data management needs.

**Challenges:** We have faced and will continue to face challenges in procuring trained staff to develop digital records, maintain electronic databases with appropriate data security, and facilitate web access. We recognize that trained personnel need to be familiar with relational databases and international biodiversity data standards and have experience with database programming. It is a costly investment to hire a professional; at present CBRC funds support students and not staff with technical expertise. Currently, one of the faculty on our Executive Committee manages the server and software systems we use. Our collections manager made some progress in data management with the assistance of mentorship by us, but we find ourselves frequently at a crossroads on this issue. At issue is that the data management needs are almost unique in the university because collection management systems require cataloguing using the Linnean biological hierarchy, geological time, linking specimens to metadata and digital objects, tracking loans, etc. Staff at UITS, libraries, and University Collections do not have the experience that would be required to provide these specialized services for us. We will decide on realistic avenues to consider in technical staff training/hiring to move the task forward.

#### *Digital Support #2 -*

**Recommendations: Digitize and associate related archival records with the specimen record. Continue to digitize specimens for individual research projects and in support of teaching. Serve the images and records on a searchable electronic database for both collections. Facilitate and fund development of local archives that can handle the more complex 3D data and related metadata describing how it is made, or partner with existing federally-funded domain-specific repositories (e.g., MorphoSource) to provide hosting of these types of data.**

**Response:** In recent years we assembled historic records from both collections, including paper catalogs, field notebooks, accession letters, etc. Much of this material has been scanned, but we temporarily halted digitization of archival records in the Paleo collection because of the renovation of the Geology Building,

which has only restarted this year. The scanned records still require considerable processing to make them accessible internally or externally, and linked to specimen records using our data management system. We now have about seven years of experience with specimen digitization for research projects, which has a working system yielding results.

Steps taken: Undergraduate hourly interns are paired with a graduate student or CBRC RA to digitize specimens for their research projects or the projects of CBRC and affiliated faculty. All undergraduates write abstracts, present their research at campus conferences such as the DEAS spring conference and national conferences such as meetings of the Society for American Archaeology, and CBRC will host their 3D images and associated data online. Project-by-project CBRC will host the digitization efforts through funding and faculty research guidance. CBRC funds allow for hiring one RA and 15 undergraduate student hourly interns to accomplish digitization research and collections management tasks.

Challenges: We start with digitization of beautiful specimens and associated metadata, for these are projects with which we can engage students. We also have non-beautiful projects such as digitization of photographic records, scanning of field notebooks, and image processing to accomplish, and for these we need to broaden our student base to recruit students with digital library and archival interests. We will likely archive many of these digital objects with IU ScholarWorks or the Archives of Institutional Memory (AIM) as appropriate, but this does not fully meet the aim of linking those records with specimens.

A larger conversation will need to focus on technological skills and funds available for digital storage of the specialized files that we produced using the GIGAmacro system in our recent external grant projects, and their metadata that will allow for access through online portals. The digital repository we created in partnership with the IU Libraries, IMAGO, could be a successful model to imitate, but the technological capabilities needed to serve the GIGmacro images are more sophisticated than our original system.

An even larger hurdle to be discussed is the cost for storing 3D data and metadata to allow for access while working with the data. At present we have 15TB of GIGAmacro data in storage in Scholarly Data Archive (SDA) Repository, but this is not a permanent solution.

In summary, IU holds no easily accessible solution for storage and access of TB of digital data and associated metadata, which is an increasingly pressing problem to solve as we continue to generate digitized specimens for our many ongoing faculty- and student-led research projects.

The CBRC currently is the only available source of funding for the internal charges needed to archive and maintain those data, pay for the Intelligent Infrastructure server to host data management software, and to cover data management system membership.

#### *Support for Collections Management -*

Recommendations: **Continue to fund collections manager and lab manager positions for the Center. The Center Director may want to evaluate job duties for these positions and consider whether database management and grant writing should be part of these positions.**

Response: We agree completely – having someone in this post has been essential for obtaining external funding, supporting research, engaging students in collection research and curatorial training, and in maximizing the benefit of the collection resources for IU. At the time of this response, the collection manager position has become open again, so we are actively discussing the job duties and considering how to fill the post effectively. The position was first established as an Assistant Research Scientist in the Department of Earth and Atmospheric Sciences as a 10-month appointment, with the expectation that the individual filling the collections manager position would have a PhD, experience in grant writing and scientific publication, and would be a leader in obtaining external funding and promoting (or even conducting) research using the collections. The lab manager position in Zooarchaeology augments the position and makes it easier for the collections manager to split time between Paleontology and Zooarchaeology. We feel that grant writing is a key role because it is difficult for the faculty curators to simultaneously manage grant writing for their primary research and for collection improvement and

digitization. Furthermore, grant writing and scholarly publication are important for the collections manager to advance toward promotion as a research scientist.

Challenges: At the time of writing, the collections manager position has opened and so we are revisiting the duties. This position is vital to the heart of CBRC, as the person in this position connects students to faculty and plays a major role in identifying and implementing science outreach and research opportunities. The faculty position is funded 50% FTE for Zooarchaeology Collection Manager in Anthropology and 50% FTE for Paleontology Collection Manager in EAS. Duties include managing the collection spaces, filling loan requests, hosting researchers, supervising students using collections, managing hourly help, cataloging new and existing accessions, maintaining records, maintaining collection space, engaging in outreach efforts, engaging in improvements to the collection, including identifying projects for external funding, and coordinating activities with IU's other natural history collections and the CBRC.

The external review committee was quite direct in addressing the need to continue support of the collections manager position considering faculty appointments. The Committee asserts that faculty are not assigned curation as a formal part of their job duties that contribute to promotion and tenure, but rather volunteer their time and expertise and are personally devoted to the success of CBRC. Importantly, the external review committee noted that the other duties of faculty necessitate that the Center employ collections management and database staff to keep it running smoothly.

CBRC faculty can attest to the hundreds of hours of volunteer time invested beyond their normal teaching and service responsibilities to service and process requests for specimen loans, catalogue specimens and rocks, curate natural history specimens, host visitors, train affiliated undergraduate and graduate students, promote the prominence of the collections, and secure grants for collection enhancement. We urge the College to add curatorial duties as a formalized part of future recruitment and job offer packages. We offer to the College our decades of experience in collections management and curation to aid in recruitment of qualified researchers and development of new curatorial job descriptions.

Defining the duties and position type for the collections manager position as we move forward requires careful consideration. In its current configuration of a PhD-level research scientist who splits time between the two collections, the position asks a lot of a candidate because it requires knowledge of Paleozoic marine fossils, their materials, and their research uses, knowledge of vertebrate zooarchaeological materials, their care needs, and their research uses, experience with collection management and digitization, and the skills necessary to lead externally funded collection-based projects. While there are potential candidates out there, they are likely to be few in number. Alternatives we are considering include converting the position into two postdoctoral fellows, one for each collection, who have interests in research relative to the collection and in collection management. Each postdoc would stay for about three years and then a new one would rotate in. This strategy would allow for more disciplinary breadth, allow the full range of required skills to be met iteratively over the course of several postdoctoral appointments, and increase the community of researchers who have close ties to the collections. Another strategy would be to fill the collections manager position as a non-faculty collection specialist who does not have research credentials but who would be able to devote more time to day-to-day hands-on collection management.

#### *Infrastructure Support -*

***Recommendations:*** *Plan for infrastructure needs. Consult with University Collections to strategically place some specimens off-site, once stable, climate-controlled storage can be secured. Prioritize infrastructure needs for WRAZL, including freezer updates, specimen preparation space, and additional workspace. Secure additional funds to support these needs once the one-time funding associated with Kennedy's hire runs out.*

Response: Infrastructure needs currently exist and do need to be addressed. The core of both collections is housed in appropriate, climate-controlled space, but both spaces are full, and a substantial amount of material is currently housed off-campus in non-climate-controlled conditions that are inappropriate for maximizing their longevity.

*Challenges:* Currently available off-campus storage is neither climate controlled nor particularly secure. Our off-site material was originally planned to go into ALF-III, which has the security and climate control needed for proper specimen storage, but by the time it was constructed other collections had been given priority. The material that is currently off-campus was sent there approximately 20 years ago and is not what we would currently prioritize for off-site storage because some of it has the potential to be quite research active, such as the Carboniferous aged fossils from Crawfordsville and Monroe County that have a high scientific profile. Logistics of sorting through material at the IU Warehouse, where it currently resides, are challenging yet the volume of material there cannot easily be accommodated in the current collection space to sort it on campus. As we learned during the renovation of the Geology Building, alternative off-site collection spaces are not good because of unclean conditions, lack of temperature and humidity control, and lack of monitoring of environmental conditions, especially important during periods of heavy rainfall or low or high temperatures.

IUPC specimens are in a recently renovated space with room for expansion, but WRAZL lacks quality workspace to host students and researchers, and vital equipment - a freezer is wearing out and will need to be replaced with as-yet-unidentified funds. We understand that the freezer could be upgraded with IU facilities funds and we would like to work with the College to get a replacement prioritized.

Two additional points are important here. Research collections such as those in the IUPC and WRAZL are vital for faculty and student research and must remain with the department and be accessible to active faculty and students to fulfill their research and mentoring obligations to the College and the university. Second, federally funded grants require documentation of secure storage for specimens used in the research, and there is a mandate for public access to holdings. CBRC and the university house these important research specimens and allow them to be accessible to researchers. This is another reason that development of an online data management system is imperative to have fully operational and online. As an extension, the collections manager position to support faculty curatorial duties and collection management duties is also essential to assist in funding.

## **Summary**

We conclude our response to the external committee's report by acknowledging that future funding is, indeed, insecure, and departmental, College, and university funding has been critical to the Center's success. We are pleased to know that the Committee recognizes that funding to-date has been invested wisely and to great effect. *Models for continued funding are unclear and this remains among our greatest challenges.* We, as director and executive committee members, are aware of the immediate need for managing our holdings through a unified collections management system, to publicize the collections and to trace use. Working through these challenges will place CBRC in a more stable position to be competitive for federally funded projects that enhance natural history collection research. We are actively working with the new administration in discussing potential areas for grant funding for CBRC.

*Future funding support from the College is indispensable in supporting the advancement of research, curation, and student mentorship and training in technology.* Within 5 years, CBRC's goals are to have more data online and available to users, with specifics on the numbers integrated into our strategic plan, to gain financial stability through careful planning of acquisition of external resources, and to broaden representation of its core strengths of digitization infrastructure.

The 'economy of scale across collections' considers shared support for all aspects of data. The IUPC and WRAZL collections are organized on the Linnaean system and on geologic time, different than films, books in museums, and costumes in collections. These natural history and physical object collections are essential, non-disposable records of history, and require collection managers and faculty curators, and importantly, hourly support for students to be trained in managerial techniques. These undergraduate hourly workers and graduate research assistants' salaries come into view in planning for future funding for the shared infrastructural support that CBRC advocates and advances. Financial stability through income

from grants must be evaluated as a cost/benefit ratio, with indirects roughly equivalent to the salary of CBRC's collections manager.

We end with an emphasis on the role of CBRC in addressing the IU 2030: The Indiana University Strategic Plan. CBRC focuses on student success and opportunity with our commitment to training students in the use of 3D digitization technology using natural history specimens with associated metadata – technology that places them ahead of students from peer institutions. This transformative research instills a sense of discovery and creativity in our students as they see the physical object in digital space. Students are then guided by CBRC faculty to research further the historical and environmental topics relevant to the State of Indiana.

CBRC has a newly developed Strategic Plan with its mission, vision, goals, and objectives defined and shared with the external review committee. We are certainly appreciative that the Committee recognized our CBRC's faculty dedication to the mission and vision of Center and by extension, to the goals of the College and university.