An Introduction to Hidden Figures- Instructor Guide

OVERVIEW

While natural history collections (NHCs) contain information on taxonomy and when and where a specimen was collected, they also contain the names of the people who collected and/or identified specimens. However, we rarely get the opportunity to learn who these people are. Sometimes a single person may be credited with collecting and/or identifying a species even when several people assisted. This practice, as well as a general lack of knowledge about collectors, can lead to inequities in who is named and therefore who receives credit and acclaim for collecting and describing the natural world.

The term *hidden figures* originated in a 2016 book of the same title authored by Margot Lee Shetterly (Shetterly, 2016). The title of her book has a triple meaning: first, it refers to the hidden mathematical calculations crucial for manned space travel; second, it is a reference to the marginalized people that conducted this work without public awareness or acknowledgment; and lastly, it refers to the fact these women were physically hidden due to segregation on NASA's campus. Since the popularization of Shetterly's book and the subsequent movie (Melfi, 2016), the term hidden figures has been used to describe any individual, task, or contribution in science that is unrecognized, marginalized, and/or erased. In this introduction to hidden figures in NHCs, students will read an article that gives a unique historical perspective of museums and will then participate in a reflection (written and discussion-based) on hidden figures in NHCs.

OBJECTIVE

This module is designed to introduce students and instructors to hidden figures in NHCs. Through readings, videos, and podcasts, this module will help instructors provide a space for students to reflect on whose stories are told and whose stories are left out. Then, together, open a space for discussion on this critical topic, including how we can do better moving forward.

After completing this module, students will be able to:

- Recognize what natural history collections (NHCs) are and what digitization means in relation to NHCs.
- Explain the concept and background of the term *Hidden Figures* and how that relates to NHCs.
- Reflect on whose stories are told and whose stories are left out in NHCs.

CLASSROOM MANAGEMENT

Time to Complete: 50 minutes - 2 hours depending on instructor choices

Implementation Notes

The student activity titled Introduction to Hidden Figures in Natural History Collections introduces the hidden figures concept, NHCs, digitization of NHCs, and the concept of hidden figures in NHCs. This document can be shared directly with students as a reading assignment, or the information can be

Leachman, S., Flemming, A., Mabry, M., Phillips, M., Zeringue-Krosnick, S. E., Kovacs, J., & Aina, O. (2023). An introduction to revealing hidden figures through data sleuthing. BCEENET- Biological Collections in Ecology & Evolution Network, QUBES Educational Resources. doi:10.25334/2JTC-C713

synthesized by instructors and delivered in other ways (e.g. PowerPoint presentation). In addition, there are four associated videos that we believe help with setting the scene for students. Following background information, we highlight the paper, *Nature read in black and white: Decolonial approaches to interpreting natural history collections* by Das and Lowe (2018). We suggest that students annotate the paper while reading, and we provide a suggested resource in the bibliography below. We have included discussion and/or self-reflection questions to accompany the reading, which can be answered as an in-class discussion, a self-reflection assignment, or group work.

We also suggest that instructors, if they are comfortable in doing so, share their positionality. Positionality is the disclosure of how a person's racial, gender, class, or other self-identifications, experiences, and privileges, influence how they perceive the world. A discussion about this concept helps students understand the importance of this practice. Identifying and sharing positionality empowers students to recognize that these concepts may be viewed through an unintentionally biased lens. It assists students in recognizing that people with different identities could interpret these concepts in another way.

ANNOTATED BIBLIOGRAPHY OF ADDITIONAL RESOURCES

We offer below an extensive list below of additional papers, podcasts, and videos that can be assigned or used as alternative readings. We hope that these can also be helpful for instructors, or for students who want to learn more about any of these topics.

Hidden figures

Groom, Q., Bräuchler, C., Cubey, R.W.N., Dillen, M., Huybrechts, P., Kearney, N., Klazenga N., Leachman S., Paul D.L., Rogers H., Santos J., Shorthouse D.P., Vaughan A., von Mering S., & Haston, E. (2022). The disambiguation of people names in biological collections. *Biodiversity Data Journal, 10*, e86089. https://doi.org/10.3897/BDJ.10.e86089

This publication discusses the issues surrounding the fact that although people are unique, their names are not. It discusses the benefits that can be gained by natural history collections and institutions when we know who people are and link those people to their contributions. It discusses how to disambiguate people and advocates that institutions share biographical data and contribute to building an open, collectively maintained dataset. By doing so, it argues that it is possible to collectively deduce the identities of individuals, aggregate biographical information for each person, reduce duplication of effort, and share the information locally and globally.

Groom, Q., Güntsch, A., Huybrechts, P., Kearney, N., Leachman, S., Nicolson, N., Page, R. D., Shorthouse, D. P., Thessen, A. E., & Haston, E. (2020). People are essential to linking biodiversity data. *Database*, *2020*, baaa072. https://doi.org/10.1093/database/baaa072

This publication argues that by linking people to their biographical data and their natural history contributions, this data can then become a powerful tool for understanding the context of a specimen and cross-validating its data. It argues that the metadata about a person can be used to validate data, help integrate data across collections and institutional databases, and can be the basis of future research into biodiversity and science. It also argues that the ability to credit collectors for their work reliably has the potential to change the incentive structure to promote improved curation and maintenance of natural history collections.

Lotzof, K. (2018, October 4). Who was Graman Kwasi?. Natural History Museum. https://www.nhm.ac.uk/discover/who-was-graman-kwasi.html
Archived 9 December 2022: https://web.archive.org/web/20221209124243/https://www.nhm.ac.uk/discover/who-was-graman-kwasi.html

This blog post that discusses Graman Kawal and the Natural History Museum, London with a focus on how natural history museums are not neutral. It emphasizes how important it is to consider the historical and cultural contexts of natural sciences to overcome systemic racism within institutions and their collections.

Melfi, T. (Director). (2016). *Hidden figures* [Film]. Twentieth Century Fox.

This is the film adaptation of the Hidden Figures book (cited below).

Nordling, L. (2022, November 22). Seeding an anti-racist culture at Scotland's Botanical Gardens. Nature News. https://www.nature.com/articles/d41586-022-03797-z
Archived 3 May 2023: https://web.archive.org/web/20230303011054/https://www.nature.com/articles/d41586-022-03797-z

This article discusses the actions being taken by the Royal Botanic Garden Edinburgh (RBGE) to recognize the contributions of people who are not white Europeans and to make the gardens a more inclusive space to visit and work in. This includes an intention by RBGE to ensure that racial-justice work becomes a core aspect of the RBGE and a proposal to have dedicated Ph.D. funds for students from minority backgrounds and promote more equitable collaborations with scholars.

Shetterly, M. L. (2016). *Hidden figures: The American dream and the untold story of the Black women mathematicians who helped win the space race.* William Morrow Publishers.

This is the original publication of the book that tells the true story of four Black women mathematicians who contributed to the success of NASA's space program.

Natural history collections

Cook, J. A., Edwards, S. V., Lacey, E. A., Guralnick, R. P., Soltis, P. S., Soltis, D. E., Welch, C. K., Bell, K. C., Galbreath, K. E., Himes, C., Allen, J. M., Heath, T. A., Carnaval, A.C., Cooper, K. L., Liu, M., Hanken, J., & Ickert-Bond, S. (2014). Natural history collections as emerging resources for innovative education. *BioScience, 64*(8), 725-734. https://doi.org/10.1093/biosci/biu096

In this paper, Cook et al. discuss how NHCs are an emerging resource for innovative education. Their main argument is that collections, the physical and digital resources of collections, allow students to ask questions, think critically, collect, analyze, and interpret data. They note natural history museums are an underused (untapped) resource/platform for "innovative, relevant and significant educational experiences".

Drew, J. (2011). The role of natural history institutions and bioinformatics in conservation biology. *Conservation Biology, 25*(6), 1250-1252. https://doi.org/10.1111/j.1523-1739.2011.01725.x

This paper discusses the role natural history institutions and their bioinformatic resources play in conservation. It discusses how natural history institutions can positively impact conservation biology by undertaking collection-based research, supporting the development of taxonomic expertise, digitizing collections, and engaging and educating the public about conservation.

Funk, V. A. (2018). Collections-based science in the 21st century. *Journal of Systematics and Evolution, 56*(3), 175-193. https://doi.org/10.1111/jse.12315

Funk discusses how collection-based scientific discoveries have had a major impact, changing the way we view ourselves, our environment, and our universe. She discusses the history of science, particularly advances in scientific knowledge resulting from natural history collecting expeditions. Funk gives examples of these advances and then discusses other major scientific advances that have happened in recent times, resulting from the study of natural history collections. She argues that planning for the future of natural history collections is necessary to ensure the health of natural history collection-based science.

Lendemer, J., Thiers, B., Monfils, A. K., Zaspel, J., Ellwood, E. R., Bentley, A., Levan, K., Bates, J., Jennings, D., Contreras, D., Lagomarsino, L., Mabee, P., Ford, L. S., Guralnick, R., Gropp, R.E., Revelez, M., Cobb, N., Seltmann, K., & Aime, M. C. (2020). The Extended Specimen Network: a strategy to enhance US biodiversity collections, promote research and education. *BioScience 70*, 23–30. https://doi.org/10.1093/biosci/biz140

This paper discusses the concept of the extended specimen, the Extended Specimen Network (ESN) initiative, which encourages digitization and the linking of associated extended data, how the ESN will increase biodiversity knowledge and collaboration, and how an ESN platform and stable funding is required for ESN to reach its full potential.

Meineke, E. K., Davies, T. J., Daru, B. H., & Davis, C. C. (2018). Biological collections for understanding biodiversity in the Anthropocene. *Philosophical Transactions of the Royal Society B, 374*(1763), 20170386. https://doi.org/10.1098/rstb.2017.0386

This paper discusses how natural history collections and the specimens they contain have the potential to transform the field of global change biology. It argues that natural history collections are underutilized. It provides examples of the multiple uses of collection data to inform research. The paper discusses the threats to natural history collections, such as under-funding and other institutional pressures, and emphasizes the value of natural history collections to science.

Nelson, G., & Ellis, S. (2019). The history and impact of digitization and digital data mobilization on biodiversity research. *Philosophical Transactions of the Royal Society B, 374*(1763), 20170391. https://doi.org/10.1098/rstb.2017.0391

This paper discusses the history of the increase in the mobilization of biodiversity data, including initiatives such as the United States National Science Foundation's Advancing Digitization of Biodiversity Collections (ADBC), Australia's Atlas of Living Australia (ALA), Mexico's National Commission for the Knowledge and Use of Biodiversity (CONABIO), Brazil's Centro de Referência em Informação (CRIA) and China's National Specimen Information Infrastructure (NSII) that have led to this increase. It goes on to discuss aggregators of this biodiversity data, such as the Global Biodiversity Information Facility (GBIF) and the Integrated Digitized Biocollections (iDigBio), and how these aggregators have facilitated increased access to the data, the challenges of data quality, the impact this aggregation has had on research and argue that natural history collections are becoming increasingly impactful as a result of the mobilization of biodiversity data.

Powers, K. E., Prather, L. A., Cook, J. A., Woolley, J., Bart Jr, H. L., Monfils, A. K., & Sierwald, P. (2014). Revolutionizing the use of natural history collections in education. *Science Education Review, 13*(2), 24-33. https://files.eric.ed.gov/fulltext/EJ1057153.pdf

Archive link:
https://web.archive.org/web/20200710172747/https://files.eric.ed.gov/fulltext/EJ1057153.pdf

In this paper, Powers et al. discuss how NHCs can revolutionize education based on new access to collections. They posit that NHCs provide rich opportunities for science learning due to their inquiry-based, authentic learning capabilities. They suggest a bridge is needed between collections and using data in the classroom for teachers who are not used to specimen-based teaching. They provide examples of existing projects that can be built upon to allow further development of modular exercises from which folks can draw from for Natural History teaching.

Suarez, A. V., & Tsutsui, N. D. (2004). The value of museum collections for research and society. *BioScience, 54*(1), 66-74. https://doi.org/10.1641/0006-3568(2004)054[0066:TVOMCF]2.0.CO;2

This paper discusses the value of museum collections. It essentially notes how relevant museum specimens have been, beyond its typical use of taxonomy and systematics, such as helping us deal with epistemological issues, environmental health and even biological terrorism. They give specific examples, quoting the museums that provided the information that led to scientific discoveries. The author argues that museums save time and money by aggregating specimens into central places, which no longer require people from institutions to travel at exorbitant cost to view specimens. The author also noted that museums are still in the discovery phase, which led to all the examples among several others alluded to in this paper.

Sunderland, M. E., Klitz, K., & Yoshihara, K. (2012). Doing natural history. *BioScience, 62*(9), 824-829. https://doi.org/10.1525/bio.2012.62.9.8

In this paper, the University of Vertebrate Zoology in California Berkley discusses what it means to do natural history. They explain the history of how the research collections came to be through the work of their founder Ginnell and his student Miller. The author explained how essentially the documentation of California's natural history was, given the comparisons that were made possible later as technologies improved and the biodiversity of the place changed.

Winker, K. (2004). Natural history museums in a postbiodiversity era. *BioScience, 54*(5), 455-459. https://doi.org/10.1641/0006-3568(2004)054[0455:NHMIAP]2.0.CO;2

This paper highlights the initial use of NHCs as a way to do systematics (the study of organismal relationships) and then goes into how the uses of collections have and continue to develop over time. One main aspect is the use of collections to answer many environmental concerns, such as using eggs to understand the detrimental impact of DDT. It questions how collections can and will remain relevant in the future. The main argument is that collections must continue growing, but in a way that makes sense to its potential uses.

Digitization

Beaman, R. S., & Cellinese, N. (2012). Mass digitization of scientific collections: New opportunities to transform the use of biological specimens and underwrite biodiversity science. *ZooKeys, 209,* 7. https://doi.org/10.3897/zookeys.209.3313

This paper examines new opportunities to design and implement infrastructure that will support not just mass digitization efforts, but also a broad range of research on biological diversity and physical sciences in order to make scientific collections increasingly relevant to societal needs and interest.

Cantrill, D. J. (2018). The Australasian Virtual Herbarium: Tracking data usage and benefits for biological collections. *Applications in Plant Sciences, 6*(2), e1026. https://doi.org/10.1002/aps3.1026

This paper studies how and by whom digitized data from an NHC is being used. It finds that, between 2009 and 2017, the data was primarily being used for ecological research but that that data is also being used in education and citizen science projects.

Page, L. M., MacFadden, B. J., Fortes, J. A., Soltis, P. S., & Riccardi, G. (2015). Digitization of biodiversity collections reveals biggest data on biodiversity. *BioScience, 65*(9), 841-842. https://doi.org/10.1093/biosci/biv104

This paper discusses the "dark data" contained in NHCs and how, without digitisation, access to natural history collections and the data they contain is limited to a select few. It goes on to discuss how the US National Science Foundation (NSF) is supporting the digitization of natural history collections through the Advancing Digitization of Biodiversity Collections (ADBC) programme.

Popov, D., Roychoudhury, P., Hardy, H., Livermore, L., & Norris, K. (2021). The value of digitising natural history collections. *Research Ideas and Outcomes, 7*, e78844. https://doi.org/10.3897/rio.7.e78844

A report that explores the economic impacts of the Natural History Museum, London collection data. It focused on benefits to the UK only. It used three methods: firstly, analyzing five key thematic areas or sectors where data from NHCs are likely to lead to benefits; secondly, analyzing typical returns on investment in scientific research; and thirdly, examining the efficiency savings that can be reinvested in research if data are available freely and openly. Together, these methods confirm benefits in excess of £2 billion over 30 years, representing a seven to ten times return on investment.

Soltis, P. S. (2017). Digitization of herbaria enables novel research. *American Journal of Botany, 104*(9), 1281-1284. https://doi.org/10.3732/ajb.1700281

This paper discussed herbarium specimen digitization, the resulting subsequent aggregation of specimen data within specific countries and worldwide, and how this aggregation has empowered large-scale, innovative research. It suggests that there are new opportunities for synthetic analyses that connect digitized specimen data with other data (phylogenetic, climatological, genomic, etc.) that may help address both novel and long-standing questions in plant biology.

Video and podcast recommendations

iDigBio. (2016, September 27). Why Digitize? [Video]. Vimeo. https://vimeo.com/184552432 Archive link: https://web.archive.org/web/20230131030909/https://vimeo.com/184552432 (archived 31 January 2023)

This video explains what digitization is, how it is undertaken, and the benefits to institutions, researchers, and the general public that can result. It also discusses iDigBio, the coordinated effort to digitize non-federal collections across the United States.

Jansari, S. (Host). (2019, November 12). Nature Read in Black and White with Miranda Lowe [Audio podcast episode 2]. In The Wonder House. https://thewonderhouse.co.uk/miranda-lowe Archive link: https://web.archive.org/web/20200929205852/https://thewonderhouse.co.uk/miranda-lowe (archived 29 September 2020)

Dr. Sushma Jansari interviews Miranda Lowe, a Principal Curator and museum scientist at the Natural History Museum, London. They discuss Lowe's research into the important contributions

people of color have made over the centuries to the collections of natural history institutions and the study of natural history and science.

Facilitating discussions

Facilitating discussion in the classroom. (n.d.) Office of Diversity, Equity and Inclusion at the University of South Carolina. https://www.sc.edu/about/offices_and_divisions/access_and_opportunity/partner_organizations/faculty_and_staff_groups/facilitating_classroom_discussion/index.php
Archived 26 January 2023: https://web.archive.org/web/20230126230142/https://sc.edu/about/offices_and_divisions/diversity_equity_and_inclusion/partner_organizations/faculty_and_staff_groups/facilitating_classroom_discussion/index.php

Guidelines for discussing difficult or high-stakes topics. (n.d.) Center for Research on Learning and Teaching at the University of Michigan. https://crlt.umich.edu/publinks/generalguidelines
Archived 4 December 2022: https://web.archive.org/web/20221204220225/https://crlt.umich.edu/publinks/generalguidelines

Reading annotations

What is annotating and why do it? (n.d.) The Writers' Center at Eastern Washington College. https://research.ewu.edu/writers_c_read_study_strategies
Archived 22 February 2023: https://web.archive.org/web/20230222010248/https://research.ewu.edu/writers_c_read_study_strategies

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Feel free to reach out to the Hidden Figures team with any questions, requests, or concerns! You can find our contact information on the QUBES publication page (cited in the footer below). We would also love to hear from folks using these resources in your classrooms, so please let us know if you do.

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