Committee members (57): E. Abreu, T. Alberts, J. Alston, T. Androski, J. Baez, M. Becker, C. Burgin, C. Calderón-Acevedo, S. Castañeda Rico, M. Chua, J. Colella, K. Cook, M. Cove, E. Craig, G. D'Elia, T. Demos, T. Dewey, J. Esselstyn, P. Fabre, A. Feijó, A. Ferguson, J. Frey, K. Gorman, H. Handika, M. Hawkins, S. Hess, A. Hinckley, D. Huckaby, B. Kohli, D. Land, T. Lee, S. Liphardt, S. Maher, V. Mathis, M. McDonough, S. Mech, P. Moehlman, D. Morales, A. Mychajliw, J. Nations, R. Norris, G. Oliver, B. Patterson, M. Pierce, J. Pletcher, N. Pradhan, D. Reeder, D. Rivera, I. Rochon, L. Ruedas, R. Short, B. Tanis, H. Taylor, N. Upham (chair), J. Widness, L. Zamora Chavez, J. Zijlstra

Cross-committee links: African Research Fellowship (Alston, Demos, Ferguson, McDonough, Norris); Conservation (Ferguson, Upham), IDEA (Alberts, Calderón-Acevedo), Informatics (Maher, Kohli, Tanis), Nomenclature (Burgin, McDonough, Norris, Pradhan, Reeder), Mammal Images Library (Huckaby, Tanis), Public Education (Mech), Publications (Ruedas), Systematic Collections (D'Elia, Upham).

Mission: The American Society of Mammalogists' (ASM) Biodiversity Committee compiles and maintains the Mammal Diversity Database (MDD), an updatable online database of mammal taxonomic and biodiversity information hosted at http://mammaldiversity.org/. This database aims to provide the latest information on species-level and higher taxonomic changes in extant and recently extinct species, thereby promoting more rigorous study of mammalian biodiversity worldwide. The main objective is to aggregate, curate, and compile the implications of new publications on species and higher taxonomic revisions into regularly released versions that are downloadable in comma-delimited format. Additional goals include the expanded hosting of ecological, geographic, and taxonomic concept data for mammal species, and the coordination with both external oversight subcommittees and biodiversity databases. Overall, the MDD initiative aims to promote the ASM's role as a leader in high quality research on mammalian biology. The MDD continues to release taxonomy versions every few months. See here for full version tracking from v1.0 (Feb 2018) to v2.1 (Apr 2025).

Member changes since June 2024

(+9, -1): Add: J. Baez, M. Cove, K. Cook, T. Dewey, H. Handika, M. Pierce, J. Pletcher, R. Short, L. Zamora Chavez | Drop: C. Parker

Information items:

I. Activities of the ASM Biodiversity Committee from April 2024 – May 2025 included:

a. We released 3 versions of the MDD taxonomy (see Table 1 for all versions):

Version v2.1	10.5281/zenodo.15163494	Apr 6, 2025
Version v2.0	10.5281/zenodo.15007505	Mar 11, 2025
Version 1.13	10.5281/zenodo.12738010	Jul 13, 2024

b. Our core group of taxonomic curators consisted of the following people:

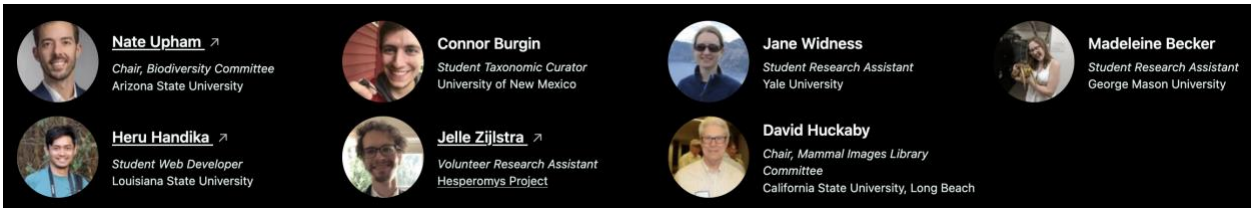

Table 1. Comparison of taxonomies: Mammal Species of the World (MSW), International Union for the Conservation of Nature (IUCN), and 12 of 16 versions of the ASM Mammal Diversity Database (MDD).

Taxa	MSW3 2005	IUCN 2008	MDD v1.0 2018	…	MDD v1.5 2021	MDD v1.6 2021	MDD v1.7 2021	MDD v1.8 2022	MDD v1.9 2022	MDD v1.10 2022	MDD v1.11 2023	MDD v1.12 2024	MDD v1.13 2024	MDD v2.0 2025	MDD v2.1 2025
Species															
Total	5,416	5,513	6,495	…	6,554	6,557	6,567	6,591	6,596	6,615	6,649	6,718	6,753	6,759	6,801
Extinct	75	79	96	…	103	103	101	101	101	101	105	107	113	113	112
Living	5,341	5,436	6,399	…	6,451	6,454	6,466	6,490	6,495	6,514	6,544	6,611	6,640	6,646	6,689
Domestic	0	0	16	…	19	19	19	19	19	20	18	17	17	17	17
Flagged	0	0	212	…	29	29	28	28	34	33	21	27	27	217	223
Wild & valid	5,341	5,436	6,171	…	6,403	6,406	6,419	6,443	6,442	6,461	6,505	6,567	6,596	6,412	6,449
Genera	1,230	1,226	1,314	…	1,335	1,341	1,343	1,342	1,342	1,347	1,345	1,351	1,353	1,353	1,357
Families	153	149	167	…	167	167	167	167	167	167	167	167	167	167	167
Orders	29	24	27	…	27	27	27	27	27	27	27	27	27	27	27

c. We continued to release **'Tracked Differences' files** with every release of the MDD, which contain detailed changes made to the recognized Mammalia taxonomy between MDD versions. These 'diff' files have become more extensive due to the continued partnerships with the batnames.org and hesperomys.com databases, which has led to ~150 changes between each of the last three versions (versus ~30 changes among prior versions). Most recently, v2.1 of the MDD also included a **Cell-by-Cell Tracked Differences** file, which lists 4,683 changes to cells in the matrix that occurred between v2.0 and v2.1 as arranged by column, new value, and old value. This detailed tracking complements the **Summary Tracked Differences**, which for v2.1 included 215 taxonomic changes, including 57 new species recognized (26 de novo, 31 split), 14 synonymizations (lumps), 1 species removal for unavailable name, 4 genera split and newly added (*Afropipistrellus, Casiomys, Megascapheus, Nyctinomus*), 20 species with genus name changes, 6 spelling changes, 2 tribe changes, and 114 species with common name changes (spelling or geographic consistency). In total, there was a net increase of 42 species and 4 genera of extant or recently extinct mammals since MDD v2.0.

d. The **landmark release of MDD version 2.0** (MDD2) on 11 March 2025 was associated with several new content additions that signal a new era of robustness for the MDD taxonomy, including:

i. Curated **species-level synonyms** file ("Species_Syn_v2.0.csv") containing 50,230 valid and synonymous species-rank names, including name combinations and type locality and specimen information for the first time;
ii. Curated **geographic codings** of US state, country, continent, and biogeographic realm geographic categories for each species (fields of subregionDistribution**,** countryDistribution**,** continentDistribution**,** biogeographicRealm, respectively);
iii. Full integration between the MDD and the databases Hesperomys and Batnames for greater data accuracy and completeness;
iv. Updated MDD website and release of new MDD app (see "**e**" below); and
v. Release of a pre-print describing the changes from MDD1 to MDD2 (see "**f**").

e. Our student web developer Heru Handika did a heroic job **re-making the MDD webpage interface**, timed to coincide with the release of MDD v2.0 on 11 Mar 2025. The new interface allows for expanded hosting of synonym-based rich-text content on the per-species pages, as well as future development of higher-taxon pages (see Goals below). This re-write of the website involved a migration from Jekyll (https://jekyllrb.com/) to the Astro web-framework (https://astro.build/), and is integrated with TypeScript (https://www.typescriptlang.org/) and Tailwind CSS (https://tailwindcss.com/). The new website is adaptive to the screen size of the browser, allowing for easy viewing on devices such as smartphones or tablets, and supports dark and light browser themes. Joining this new website is the new MDD app — written in the Flutter framework (https://flutter.dev/) and Rust programming language (https://www.rust-lang.org/) with support on iOS, iPadOS, Android, Windows, Linux, and macOS operating systems. See https://github.com/mammaldiversity/mdd_app for details on installing the app. The MDD app critically allows offline data access to MDD data (e.g., during remote fieldwork without internet). The MDD app also features an export function to download a subset of MDD data to a CSV file. Kudos to Heru for these advances to accessing MDD data on- and offline!

f. **Summary article of the v2.0 MDD taxonomy:** The MDD core team co-authored an article summarizing 7 years of taxonomic changes between MDD1 (15 Aug 2017) and MDD2 (15 Aug 2024). This manuscript was several years in the making, with the first draft starting in 2021, so it is great to fully bring it together now. The article grew in scope along the way while becoming chapter 1 of Connor's PhD thesis, so now covers the last 267 years of taxonomic, nomenclatural, and geographic advances in the study of mammal biodiversity. The article was recently accepted in the *Journal of Mammalogy* (in press) with a pre-print is available on *bioRxiv*:

Burgin, C. J., Zijlstra, J. S., Becker, M. A., Handika, H., Alston, J. M., Widness, J., Liphardt, S., Huckaby, D. G., & Upham, N. S. (2025). How many mammal species are there now? Updates and trends in taxonomic, nomenclatural, and geographic knowledge. (p. 2025.02.27.640393). *bioRxiv*. https://doi.org/10.1101/2025.02.27.640393

- Usage: Released 3 Mar 2025 | Visits 701, PDF downloads 444 (as of 31 May '25)

II. Public usage and visibility of Mammal Diversity Database data:

a. According to our Google Analytics tracker, during the one year period from 19 May 2024 to 18 May 2025, https://mammaldiversity.org logged over 30,000 visits from a whopping 186 countries — with USA (~10k), Mexico (~2k), Brazil (~2k), and China (~1k) leading the way, but extending to Zambia (10) and Yemen (1 visit; see report with full listing). Fig. 1 shows anomalously high MDD web traffic on 16 July 2024, mostly in California, which might relate to a specific research group or workshop (any ideas?). Notably, there has been a steady uptick in MDD web traffic since the March 2025 release of the v2.0 taxonomy, indicating growing traction of the taxonomy globally.

Figure 1. One year of user traffic at https://mammaldiversity.org, with detail on the 186 countries with site visits.

b. The archived versions of MDD taxonomy on Zenodo have also garnered many total views (41,542) and downloads (24,389) since this page was launched in 2020. Over the last 12 months, these values have increased by 51% (+13,979 views) and 90% (+11,579 downloads) — following their doubling last year — again signaling growth in the credibility of the MDD taxonomy in the global biodiversity community. The v1.13 of the MDD taxonomy was alone downloaded 3,404 times from 13 Jul 2024 to 11 Mar 2025 (i.e., ~15 times per day).

c. The 2018 *Journal of Mammalogy* article about v1.0 of the Mammal Diversity Database taxonomy ("How many species of mammals are there?") has now been viewed >116,000 times and cited 1,207 times (+199 since last year; as of 31 May 2025). This summary is among the ASM's most visible products yet will likely be superseded by the v2.0 article.

III. Establishment of External Taxonomic Subcommittees for the ASM MDD (2023-2026):

a. History of this effort: In July 2023 at the IMC/ASM meeting, we hosted a workshop titled "Mammal Species of the World Next: workshop for extended taxonomic data curation" in which we gathered a wide range of feedback about how to push the MDD to the next level of data curation to become a globally respected taxonomic authority. The need to establish external groups of experts to advise us on issues of taxonomic conflict was highlighted along with possible paths for doing so. In May 2024, Nate and Connor drafted an initial set of guidelines for the activities of these taxonomic subcommittees. Discussion on these guidelines at the 2024 ASM meeting in Boulder, CO led to revisions. Nate will present an updated version of these guidelines at the 2025 ASM meeting in Lafayette, IN and formally invite participation from the community of mammal taxonomic experts. Four main goals are being established for taxonomic subcommittees:

1. **Track the literature** for articles newly or previously published that are relevant to the taxonomy of the focal group, compiling full references and PDFs.
    a. Each subcommittee will be expected to perform careful tracking of new and previously published articles relevant to their focal taxa, with particular emphasis on the species and subspecies levels of organization. The most recent version of MDD taxonomic data will be provided, as subset to the group's focal taxa.
2. **Organize and issue subjective decisions** in cases for which taxonomic conflict among one or more published articles is identified, and for which a justified ruling from the MDD is needed to promote taxonomic clarity and resolve cases of ambiguity.

    a. As a growing taxonomic authority, the MDD will increasingly have the responsibility to arbitrate cases of taxonomic conflict among published articles. To do so, we aim to issue 'micropublication' reports that outline the relevant taxonomic evidence and make rulings to resolve conflicts. This micropublication process was piloted from 2022-2023 through a collaboration between the MDD and the Global Bat Taxonomy Working Group of the IUCN SSC Bat Specialist Group, which resulted in the issuance of subjective decisions for three taxa of bats: (i) *Myotis keenii* and *M. evotis*; (ii) *M. lucifugus*; and (iii) *Lasiurus*.
3. **Summarize evidence for species recognition** contained in those articles, by performing a categorization of the quality of taxonomic evidence using an in-development grading rubric that we are calling the GEM (Genetics-Ecology-Morphology) framework.
    a. This goal is inspired by the Kitchener et al. (2022) proposal for a 'traffic-light system' based on quantifying the number of independent **types**, or lines, of evidence supporting a given species. We are extending this system to capture additional key dimensions of taxonomic evidence that will help users assess how the confidence in species-level recognition varies across mammals. We propose a more detailed **quality rubric** that grades the data sampling and statistical strength of evidence relative to 9 evidence categories, yielding an overall GEM score for the recognition of given species. This system is currently inviting input from members of the ASM Biodiversity Committee and external subcommittees.
4. **Communicate about all of the above** on the appropriate MDD Slack channels, which can host up to 250 members thanks to a nonprofit Pro membership through the ASM.
    a. We are collecting comments on a draft listing of per-clade specialists and contact information across a proposed division of subcommittees.

IV. Synergistic activities of the Biodiversity Committee:

a. In Sept 2023, an Ad Hoc Digital Publications Committee was formed on the directive of ASM President Felisa Smith with the goal of investigating how best to transition the journal *Mammalian Species* to a format of real-time updatable species accounts for free and open distribution online. Membership includes: Link Olson, Meredith Hamilton, Sean Maher, Tom Lacher, Jake Goheen, and Nate Upham (Chair).

i. In 2024-25, Nate investigated several possibilities for how these 'living documents' of *Mammalian Species* accounts could look, including the ability to update them in real time. Pensoft Publishers has emerged as a leading potential provider of services. This topic will be discussed further at the 2025 ASM meetings.

b. In Oct 2024, Nate represented the ASM Mammal Diversity Database at the "Bouchout+10 Symposium: Rediscovering Known Biodiversity Knowledge" held at Disentis Monastery (Bouchout, Switzerland). This three-day meeting focused on advancing the digital extraction of biodiversity knowledge from publications, especially the taxonomic parts of articles that are technically not under copyright, to connect those disparate facts into large-scale knowledge graphs. Many key stakeholders were present (e.g., GBIF, IPBES, Pensoft, Berlin and Paris natural history museums). Several advances were made at this meeting, including investigating how best to transition the *Mammalian Species* journal to a real-time format (see above) and loading the MDD

taxonomy into GBIF's ChecklistBank for integration into Catalog of Life. This latter item is now accomplished for MDD v2.1: https://www.checklistbank.org/dataset/9802/about

c. In Jan 2025, Nate's lab at ASU was awarded a five-year early career grant that will provide ancillary funding to develop MDD-adjacent projects, particularly as relates to applications of the taxonomy to studying mammal-virus interactions and co-evolutionary dynamics. The award is an R35 ESI-MIRA (Early Stage Investigator, Maximizing Investigator's Research Award) from the National Institutes of Health, National Institute of General Medicine (NIH: NIGMS—see here: 1R35GM156919).

d. In Jan 2025, Connor, Jelle, and Nate joined Nancy Simmons and several others to meet with Craig Hilton-Taylor of the IUCN Species Information Service (SIS), which is the group that organizes the main taxonomy database for the IUCN. This call was initially to coordinate a major update of the global Chiroptera taxonomy in association with the IUCN Bat Specialist Group. However, we also discussed broader MDD-to-IUCN integration dynamics with a consensus that this is direction everyone wants things to go. Establishing the subcommittee oversight that includes members of IUCN specialist groups will be a key step to advancing that goal. This adds to the formal adoption of the MDD taxonomy by the IUCN Small Mammal Specialist Group (SMSG) in 2024.

V. Goals for work the ASM Mammal Diversity Database (2025-2026 and beyond):

a. Type specimens. We now have type specimen information for 5,750 accepted species in the mammal taxonomy — up from 2,731 at this time last year! — which is due to the scripting efforts of Jelle Zijlstra in particular. Prior work by Ingrid Rochon helped bring in type specimen data from the Smithsonian Mammal Collections, and work by Bruce Patterson and Madeleine Becker aligned these data for Field Museum Mammal types. Through this work, we have identified 87 species with untraced holotypes (number not known), which are likely non-existent and thus in need of neotypes. We will continue to trace the type specimens associated with all accepted and synonymous mammal names.

b. Type localities. We now have type locality information for all species in the MDD accepted list and are working to gather decimal latitude and longitude for all type localities. We currently have geocoordinates for only 1,781 species of the ~6,700 total.

c. Species-level range maps. We have initial range maps aligned to the MDD v1.2 taxonomy (version of September 2020; published in Marsh et al. 2022), now made more available for easy download by species or higher taxa via the **'mddmaps' R package** developed by ASU PhD student Ángel Luis Robles Fernandez (Upham Lab; Github profile). This R package is available for public use, and will soon be submitted to CRAN with an associated publication: https://alrobles.github.io/mdd/

i. These maps have so far been sequentially updated to MDD versions from v1.3 to v1.11 by Upham lab members, with continued work planned in 2025.

ii. The goal is to better curate these range maps into a public resource.

RECAP OF BUDGET 2024

1. Website maintenance:

- Approved (~60 hrs @ $20/hr) ……...… $3,600.00
- Spent during 2024 (Poelen, Handika)……. $4,725.00

2. Student research assistant(s):

- Approved (~5 hrs/w @ $15/hr, 4 graduate students, 18 weeks) …….. $5,400.00
- Spent during 2024 (Burgin) …….…….…..... $4,860.00

Approved (2024) …….. $9,000.00
Additional authorized by F. Smith on 10 Oct 2024……. $1,000.00
Spent during 2024 ….……..…… $9,585.00

TO DATE BUDGET 2025 (Jan – May)

1. Website maintenance:

- Approved (~180 hrs @ $20/hr) ….……..... $3,600.00
- Spent to date (Handika) ……..……. $1,825.00

2. Student research assistants / Student organizers for taxonomic subcommittees:

- Approved (~5 hrs/w @ $20/hr, 4 graduate students, 18 weeks) …….. $5,400.00
- Spent to date (Burgin) ……..…….…….…..... $3,480.00

TOTAL BUDGET APPROVED (2025) …….. $9,000.00
Spent to date 2025 ……..…… $5,305.00

PROPOSED BUDGET 2026

1. Website maintenance:

- Website stability, updates to content and interface, feature modifications
  - Proposed (~180 hrs @ $20/hr) …….……...… $3,600.00

2. Student research assistants:

- We plan to continue needing 2-4 student assistants employed at ~5/hrs per week. These student assistants will facilitate integration of updated taxonomic data.
  - Proposed (~5 hrs/w @ $20/hr, 2-4 students, 18-27 weeks) ……...….. $5,400.00

TOTAL BUDGET REQUESTED (2026) ……..….. $9,000.00

SUMMARY

Overall, we expect that the MDD will continue establishing value as a global authority for mammal taxonomy in 2025-2026. We now have growing support from the IUCN to adopt the MDD taxonomy, which is a tangible type of impact that the ASM is having on the quality of mammal biodiversity research globally. Through this work, the ASM is serving up-to-date information to the IUCN RedList, Intergovernmental Panel on Biodiversity and Ecosystem Services (IBPES), the UN Biodiversity Conference (COP), as well as to similar efforts at

country, state, and local levels. Given the central role of mammal biodiversity in understanding ecosystem health, we expect that real-time taxonomic knowledge about mammalian species will continue to be essential for policymakers and researchers alike. Keeping track of "How many species of mammals are there?", "in which countries?", "according to who?", and "with what ecologies?" are questions that are only growing in importance in our changing world. Continued ASM support for the MDD initiative is critical to advancing these meaningful goals. The ASM Biodiversity Committee is well positioned to lead curation efforts for the accuracy and completeness of this knowledge and should continue to do so.

Respectfully submitted,
Nathan S. Upham, Chair (nathan.upham@asu.edu)