Database for Vermont Fungi

Final Report

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Abstract: This proposal sought funds for 1) the creation of a database of the known fungal species that have been documented in Vermont, and 2) to conduct two fungal forays in rare and/or threatened natural communities for species distribution and abundance. This database is an aggregation and digitization of disparate fungal data sets that expand the relevance of future research related to carbon storage, old growth characterization, and forest regeneration capacity. It also addresses conservation needs and begins to identify site-specific fungi species in natural community assemblage patterning. The database will be used to create a checklist of fungi that currently and historically existed in Vermont and will be published and maintained at the Vermont Atlas of Life Integrated Publishing Toolkit (IPT) server to Global Biodiversity Information Facility (GBIF) as a Darwin Core Standard (DwC) checklist dataset and archived with the Forest Ecosystem Monitoring Cooperative. This checklist will be publicly available to expand on research and knowledge of fungi's contribution to our New England forests.

Rationale: The kingdom Fungi contains an estimated 2.2- 3.8 million species worldwide and is one of the most widely distributed organisms on Earth (Hawksworth and Lücking, 2017). Fungi can live freely in soil or water and often form a spectrum of symbiotic relationships with other organisms, including animals, protists, bacteria, plants, and algae. Despite their cosmopolitan range and broad habitat, only approximately 144,000 species of Fungi have been described worldwide, with only 1,165 macrofungi being observed and reported in Vermont (Willis 2018, VT Atlas of Life). Thus, their diversity remains largely unknown, especially in rare and threatened natural community types. Fungi play a crucial role in the recycling and distribution of nutrients, are parasites/pathogens, aid soil stability, sequester carbon, mediate ecosystem stability, and facilitate ecosystem resilience. A Fungal Scientific Advisory Group (Fungal SAG) was established in 2023 to elevate the importance of fungi among Vermont's community members and perform the necessary tasks of documenting their diversity, rarity, sensitivity to current and further development in Vermont, the roles they play in forest ecosystems in the Northeast, and their crucial role in natural communities. The groups of fungi under the scope of this SAG are the multicellular fungi commonly referred to as macro- and microfungi.

The Fungal SAG has been working on reviewing regional fungaria and personal collections to determine which species are known to have occurred in Vermont, as well as reviewing online databases such as MyCoPortal, GBIF, iNaturalist, and Mushroom Observer, to help build a current list of fungal occurrences in the state so that we can have a more comprehensive representation of the forest ecosystems in the state. The iNaturalist Project *Fungi of Vermont* alone has led to the collection of over 80,000 records comprising more than 1500 species, which is growing daily. To efficiently keep up with the ever-growing citizen science occurrence records, as well as corresponding data from personal collections and published fungaria, the Fungal SAG met with database experts at the Vermont Center for Ecostudies (VCE) to create a database to serve as a clearing house for these records. This database will allow the Fungal SAG group to analyze historical trends, create a baseline data set from which to track future trends, and explore landscape patterns of fungi in Vermont and subsequently surrounding states. In addition, it will serve as a backbone for data storage and comparison for additional fungal forays in rare, threatened, and endangered natural communities in Vermont.

Approach/Methodology for database creation: The basic steps VCE followed to create a checklist of known fungal species documented in Vermont are as follows:

1. VCE queried GBIF for all macro and microfungi in the phyla Ascomycota, Basidiomycota, Chytridiomycota, Glomeromycota, Zygomycota, Blastocladiomycota**,**

Neocallimastigomycota, and Microsporidia. This pulled occurrence records from multiple data sources and countries, while simultaneously matching synonyms with accepted species names, creating a GBIF taxonomic backbone.
2. GBIF was then queried for all fungi that are labeled as Vermont, USA. The output of this query is a list of all species, including accepted names and synonyms, from the GBIF occurrence queries.
3. This output was reviewed by the Fungal SAG experts to confirm presence in Vermont and make edits and additions. This included comparing nomenclature and linking to other biodiversity name datasets.
4. Add higher-level taxonomic names and other necessary information needed for DwC checklists.
5. The DwC checklist and metadata were published to the Vermont Atlas of Life IPT server and harvested by GBIF as a checklist of fungi from Vermont, USA, with authors and DOI. This DwC checklist will be updated and republished as more information becomes available or is edited.
6. A data explorer was made available at the Vermont Atlas of Life based on the published checklist. This checklist will be published and maintained at the Vermont Atlas of Life IPT server to GBIF as a DwC checklist dataset.
7. New occurrence datasets will be added to the Vermont Atlas of Life IPT and published to GBIF as they are discovered or become available. This will allow for undigitized collections as well as databases that do not share with GBIF automatically (ie, Mushroom Observer) to be shared and available for public use.

Approach/Methodology for fungal surveys: The Fungal SAG hosted two fungal forays with other mycologists and members of the public to gather diversity and abundance data.

1. 2024 Foray Sites included Gifford Woods and Woodbury Mountain. The Fungal SAG had been permitted to survey and sample (if needed) there.
2. During the foray, mushrooms were photographed and uploaded to iNaturalist, and a subset was collected and preserved for our fungaria using the following collection protocols. These protocols are informed largely by The Fungal Diversity Survey (FunDis), and the appropriate links are provided to their site for more details throughout this protocol. FunDis - Collecting Mushrooms for Science

    a. **INaturalist Observation Protocol:**

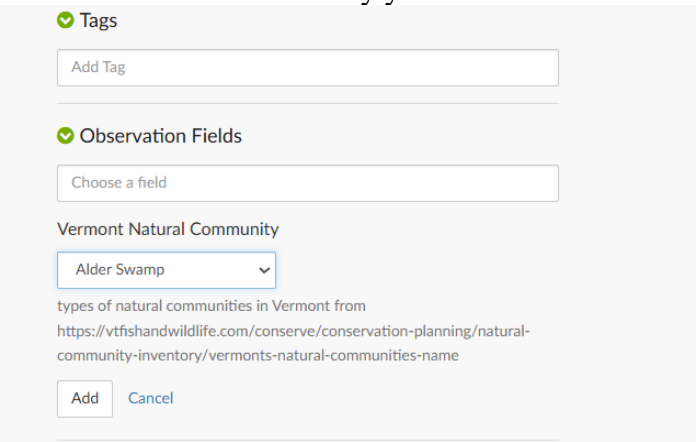
        i. **Take High-Quality Photos:** Your best chances at correctly identifying and verifying your specimen's ID as 'Research Grade' must include clear and focused images of the entire mushroom.
        ii. **Photo of the Entire Mushroom** (Fruiting Body) in its habitat, and if possible, including surrounding vegetation/plants and trees.
        iii. Clear **Photo of the Cap**: This is to capture any surface features such as scales, hairs, and tissue, etc.
        iv. Clear **Photo of Spore Surface (Gills, Pores, Teeth):** In most fleshy fungi, the gills and pores are located on the underside of the cap. Pay special attention to where the gills/pores meet the stem. This will provide evidence of the 'attachment' style of gills.
        v. Clear **Photo of Stem** (Top to Bottom): We are looking for features on the surface of the stem, such as a ring/annulus or patterns on the stem like

webbing/reticulation, hairs etc. This may also include features of the base of the stem, such as a cup/volva. This may be done in one or more photos, depending on the size of the stem.

vi. **Uploading Photos to INaturalist:** Photos may be taken directly into the INaturalist app using a smartphone or uploaded later on a desktop/tablet.

vii. Add **Natural Communities** to your observation (For more information, check this link)

1. Scroll down to the observation fields
2. Type "Vermont Natural Community" in the observation, then click on it when it appears
3. Select the natural community you are in



4. If a whole project is in one Natural Community (NC), then in setting up the project, select the NC so all entries have that. Otherwise, encourage and remind all participants to be vigilant about doing this for each entry and to record NC on their slip.

b. **Complete Collection Sheet:** If you are interested in contributing a voucher specimen for later research and genetic sequencing, follow the next steps for preservation and storage. Complete this sheet as fully as possible and in your most legible handwriting. The specimen and sheet should remain together from the point of collection through to preservation and storage of the specimen.

i. **Habitat:** For instance, mushrooms found growing on an elm tree in a group or bunch. Or mushroom growing from the ground, scattered, in a mixed hardwood forest near sugar maple, yellow birch, and white pine.

ii. **Spore Print:** Color (Photo of spore print included)

iii. **Measurements**: Include Cap, stem (length & width) measurements

iv. **Unique characteristics:** Bruising, exuding latex, distinct smell, texture, reactions with reagents such as KOH, Ammonia, etc.

v. **Permanent Observation Number** Label your specimen with the iNat Observation number. This number is the last series of digits in the URL of your iNaturalist observation. For example, https://www.inaturalist.org/observations/**125057737**

c. **Preserve & Voucher Specimen:** Drying & Storing Mushroom Specimens-FunDis.org

i. **Dry the Specimen immediately** in a food dehydrator between 100-120°F until entirely dry/brittle. For large fleshy mushrooms, it may be necessary to

cut the specimen into slices for complete and expedited drying. If you plan to collect a spore print, you'll need a specimen for the spore print and a separate specimen for a voucher.

ii. **Storage:** Place the dried specimen and collection sheet in a resealable plastic bag. We recommend that a desiccant package be added to the bag to prevent additional moisture.
iii. Label the outside of your bag with the INaturalist Observation Number along with collection date, collector's name, species name, and collection location.
iv. Temporary Storage: Choose a location and system of temporary storage of specimens at your home. This could include plastic totes or airtight buckets stored in a cool and dry location. Voucher specimens are personally stored until requested by researchers, mycologists, or to be included in the state of Vermont's fungarium collection.
v. Record the specimen as '**Vouchered Specimen'** in the 1st line of the INaturalist Observation Notes, including its final storage location. Ie, Personal Collection D. Muska, UVM Fungarium, etc.

Database Results

This project resulted in the creation of the Vermont Fungi Atlas (https://val.vtecostudies.org/projects/vermont-fungi-atlas/), an online fungal database that is open to the public. As of August 1, 2025, this database includes 36,186 records of fungi observed in Vermont, that was compiled from 117 online datasets from 4,183 contributors. These records represent 3,826 species (as well as variations and/or subspecies) of fungi that have been recorded and positively identified in Vermont. Every species represented in this database has a species page that has a summary of its known history, distribution, description, and phenology tracking.

Foray Results

Two forays were conducted by members of the fungal scientific advisory group to supplement the Vermont Fungi Atlas. The first foray took place on June 14, 2024, at Gifford Woods State Park. This parcel was chosen for its old-growth characteristics and was a northern hardwood forest community type. This early-season foray resulted in the observation of 35 mushrooms that represented 29 genera and 26 species. The second foray took place on September 27, 2024, at Woodbury Mountain Wilderness Preserve. This parcel consisted of a rich northern hardwood and northern hardwood forest natural community types, and resulted in the observation of 76 fungi that represented 57 genera and 41 species.

Conclusion

This publicly available database is now available to expand on research and understanding of fungi's roles in our New England forests, to gather baseline data, and to track changes in species composition over time due to pests, climate change, and other inevitable threats. The fungal forays supplemented this database by contributing observations of fungal communities present in various VT habitats. The database is updated regularly with additional observations of fungi in Vermont and will serve as an important tracking tool and educational resource for the public and land managers in perpetuity.

Budget: The total budget amount for both years of the project was $6,000. Of this total, $3,000 was provided through funding from FEMC, which covered the expenses of contracted services of Vermont Center for Ecostudies for the creation of the database. The remaining $3,000 of the budget was covered by non-federal matching funds, which included $1752 for individual personnel, $735 for personnel fringe benefits, and $513 for indirect costs.

References:

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