SITUATED KNOWLEDGE AND FUNGAL CONSERVATION: MOREL MUSHROOM MANAGEMENT IN THE MID-ATLANTIC REGION OF THE UNITED STATES

by

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ABSTRACT OF THE DISSERTATION

Situated Knowledge and Fungal Conservation: Morel Mushroom Management in the mid-Atlantic Region of the United States

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Fungi are a mega-diverse group of organisms, currently estimated at 1.5 million species, yet their conservation has attracted little attention. Beginning in the mid-1980s in Europe, and the mid-1990s in the United States, fungal management and conservation discourses have developed noticeably in the last ten years. Reported declines in true morels (*Morchella* sp.) in the early 2000s raised concerns about overharvesting by visitors to national parks in the mid-Atlantic region of the U.S., where morel collecting is a popular and long-standing activity. In this dissertation, I explore this confluence of events, and ask: why is the conservation of this mega-diverse group of organisms emerging now, how is this happening, and what are the effects? Drawing on critical and poststructural perspectives on discourse and knowledge, I examine the ways in which fungal conservation emulates existing conservation discourses based on expert knowledge, state regulated land management, and capital investment. Like other biological scientists, mycologists emphasize biodiversity protection, data accumulation, and regulations for conservation and sustainable exploitation of fungal resources.

Data on current and emerging fungal conservation discourses were collected using a mixed methods approach, including interviews with stakeholders and participant observation at three mycological meetings. Ecological knowledge, opinions, and relationships among mycologists, managers and long-term harvesters, vis-à-vis management and conservation, were examined. Finally, an ecological assessment based on harvester ecological knowledge demonstrates the integration of different methodological approaches.

Shifting from studying accumulated scientific knowledge to examining the ways and places in which scientists create such knowledge emphasizes the practice of knowledge production. Managers and harvesters also produce knowledge and practices relevant for conservation. Participants' biological and ecological knowledge is the epistemological foundation for their approach to fungal conservation; and these emerging "models" seem to diverge based on stakeholder group membership. However, further analysis shows that some stakeholders share concerns regarding conservation that are consistent with a specific logic, rather than with their group identity. These processes of analysis and documentation acknowledge and disrupt uniform truth regimes, giving voice to those that have been traditionally absent or marginalized in the formal protection and preservation of their own environments.

Acknowledgements

To believe in community, for me, is to be aware of the physical and emotional presence that we have in each other's lives through shared experiences. These moments may be short - offering to return a book to the library - or they may be more significant: taking care of each other when we are sick or spending months in dialogue working through complex ideas. When I think about what I have accomplished over the past six years, I know that it would not have been possible without the support of the different communities that I have been a part of during this time. I am deeply grateful to those communities, and especially to certain individuals, named and acknowledged below.

The tasks of the advisor are numerous and time consuming, and precariously balanced with a full schedule that we, as graduate students, only begin to realize the complexity of when we face the possibility of going into academia ourselves. So, I begin with my academic advisor, Richard Schroeder. For all the assigned readings, the gentle pushes in new directions, the many, many hours spent reading my work, the letters of recommendation, and the "quick questions," thank you is an understatement. To Rick, thank you for showing me how to be strong in the face of adversity. The same can be said for Marla Emery who, as the original contact person for the morel study and its co-PI at Rutgers, has been closely involved in my Ph.D. studies from the very beginning. When I first started at Rutgers, Marla told me that her job was to teach me everything she knew, and help me through this process of becoming a geographer. With site visits, long phone calls, writing retreats, and *so* much more, this job accomplished with compassion and verve. To Marla, thank you for showing me how to be gracious, but determined.

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In forestry, you do not have to ask trees for permission to measure their age, to learn their story, or even to drive nails into their bark. When I began to design this research project and realized that I was not only going to have to ask people for their permission to talk to them, but somehow convince them that they wanted to spend anywhere from one to four hours talking to *me*, I was wary. That wariness turned into surprise and joy when I found out that people were not only willing, but in many cases happy to talk to someone about their interest in morels and in fungal conservation. Some participants went above and beyond in welcoming me into their lives and work, and in sharing with me well kept family secrets that I have sworn to never reveal (so if you are reading this dissertation with any hope of finding a good morel spot, you might as well quit now). I want to especially thank Dale and Carol H., Richard L., and Rob M. for allowing me into their homes and their lives on several occasions.

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Program, which allowed me to expand the initial research project on mid-Atlantic morels to one on American and European fungal conservation discourses. Additional funding from the Association of American Geographers, the Mycological Society of America, and the Andalusia Regional Government: Ministry of the Environment, helped me delve deeper into the realm of mycology and fungal conservation than would have otherwise been possible. John Dighton, David Minter, Anders Dahlberg and Greg Mueller all deserve extra thanks for helping with this.

The last six years and been professionally and personally transformative for me in many ways, and I have gotten through them thanks to the friendship and support of many. Thanks to Rebecca McLain for helping me make connections in the Pacific Northwest, and for extra fungi-specific mentorship of NTFPs. I want to thank John Stanovick at the USFS Northern Research Station for statistical support on the ecological data and analysis. Thanks to Paul Robbins for talking me through the Q method, analysis and interpretation. Thanks to Mary Mannix and the staff at the Frederick County Public Library Maryland Reading Room for spending upwards of two weeks going through the history of Frederick and Washington Counties with me. Although most of the information gathered there did not make it into this final version, it enriched my understanding of the region in a way that I hope is apparent in these pages. On a more personal note, I would like to acknowledge Claire Dacey, Rachael Freeman, Liza Knapp, Lora Wondolowski, Vitor Sousa, Mary Ellen Rhoderick, Sam Maples, Allen and Joan Maples, Cliff and Dottie Harrison, Barbara Daniels, the community of ERUCC, Jared Barron, Mary Jo Sanna, Danny Thompson, Ron Barron, Ina Wilhelm, and Adrienne Ash. To Suzanne DeCoursey, no matter what, you are the best.

Although some are thanked already elsewhere, I want to close with special thanks to three strong, powerful women that put me on this path. Julie Graham, and her course "Rethinking Economy" at University of Massachusetts Amherst, introduced me to geography. One day after class, when my totally confused look briefly turned into a moment of understanding, Julie took me by the shoulders and said, "Now, you're a geographer," and so I was. When I first came to Rutgers for my interview, I asked Marla Emery why she did her Ph.D., and she shared with me her experiences of the true value of three letters and two dots. Since then her continued advice on how to navigate academia as a woman and as myself, and her unyielding support, has gotten me through these six years. Finally, to my mother, Mary Jo Sanna. She gave me everything she was able to give, and that is why I am here today.

Highland Park, NJ
July, 2010

Dedication

This dissertation is dedicated to:

Mary Jo Sanna
1944-2006

&

Julie Graham
1945-2010

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BMS:	British Mycological Society
CATO:	Catoctin Mountain Park
CHOH:	Chesapeake and Ohio National Historical Park
ECCF:	European Council for the Conservation of Fungi
EEM:	Exclusionary Ecosystem Model
EMA:	European Mycological Association
IBC:	Inclusionary Biodiversity Conservation Model
IEK:	Indigenous Ecological Knowledge
IUCN:	International Union for the Conservation of Nature
LC:	Localized Conservation Model
LEK:	Local Ecological Knowledge
LEKA:	Local Ecological Knowledge Access Model
MAB:	Man and the Biosphere
MAR:	Mid-Atlantic Region
MAW:	Mycological Association of Washington, D.C.
MSA:	Mycological Society of America
NAMA:	North American Mycological Association
NCR:	National Capital Region
NPS:	National Park Service
NWFP:	Northwest Forest Plan
OMS:	Oregon Mycological Society
PNW:	Pacific Northwest
SSC:	Species Survival Commission
SEK:	Scientific Ecological Knowledge
TEK:	Traditional Ecological Knowledge
USFS:	United States Forest Service
WorldFungi:	1st World Conference on the Conservation and Sustainable Use of Wild Fungi

Chapter 1: Introducing Fungal Conservation

1.1: Introduction

Fungi are a mega-diverse group of organisms, currently estimated at 1.5 million species. Of these, only 8 – 10% have been discovered and described. At the current rate of description, a total inventory will take 1290 years (Hawksworth 2003). While this is somewhat of a concern to mycologists, the more pressing issue is the relative lack of attention being paid to the species already named and described, especially relative to other organisms. Mycologists call this "Flora and Faunaism."

This bias is very apparent at the international level. Global biodiversity is a central concern for the International Union for the Conservation of Nature (IUCN). The IUCN assesses threats to biodiversity by assessing the status of individual species. These reports are called Red Lists, and they are the only internationally accepted evaluations of the level of threat of extinction for individual species. They are created at the national and international levels, and are accepted at the global scale. "Naturally, these lists, and subsequent conservation priorities, have a bias towards well-known groups of species. The global red lists comprise almost 45,000 species, of which 26,000 are vertebrates. In contrast, only three fungi are listed; two lichens and the Sicilian endemic fungus *Pleurotus nebrodensis*" (Dahlberg, Genney, and Heilmann-Clausen 2009:2). Furthermore, fungi are not included in any international conservation agreements.

The diversity of North American fungi (37,800 species) is estimated to be twice that of plants (18,400 species) and yet their conservation has attracted little attention (Wilcove and Master 2005). In North America, only 226 fungal species (0.6%) are classified as imperiled or critically imperiled. In contrast, 2917 plant species (16%) are assigned to these categories (NatureServe 2008). Either fungal species are less likely to be endangered than plant species, or there is a critical and immediate need for more information on their conservation status. Understanding how and why this need for fungal conservation information has only recently emerged, and whose interests are being served in the process, is the subject of this dissertation.

1.2: Study Background

In the early 2000s, reported declines in true morels (*Morchella* sp.) raised concerns about overharvesting by visitors to national parks in the greater Washington, D.C. area, where morel collecting is a popular activity. To address these concerns, the National Park Service (NPS) funded two concurrent research grants to examine the ecological and social dimensions of morel harvesting in the region. The social sciences study, *Protecting Resources: Assessing Visitor Harvesting of Wild Morel Mushrooms in Two National Capital Region (NCR) Parks*, aimed to develop and administer a social science assessment of visitor morel harvesting activity (Emery 2004).

At the outset, park personnel recognized that they: (1) lacked quantitative data on morel distribution and abundance; (2) had limited information on the experience of visitor-harvesters; and (3) had not assessed the impact of harvest on the morel population. The *Protecting Resources* study was commissioned specifically to address the second point above regarding the experiences of visitor-harvesters at Catoctin Mountain Park (CATO) and the Chesapeake and Ohio Canal National Historical Park (CHOH). The companion ecological study was focused on points 1 & 3 at these two parks and two additional parks: Antietam National Battlefield and Harper's Ferry National Historical Park.[1] Results were intended "to determine whether morel or associated rare species populations [were] being adversely impacted" (Emery 2004:1). Regardless of the findings of both studies, it was agreed from the beginning that: "Any management actions undertaken for these natural resources will be regulating human activities and …fundamentally social in nature" (Emery 2004:1).

There were a number of challenges inherent in these studies from the outset. At the macro-level, morels are known to grow in all northern hemisphere countries that have temperate or boreal forests, as well as some subtropical and Mediterranean regions and the Middle East. They can be found throughout the United States in a variety of forested habitats. At the local level their distribution is dependent on micro-habitat requirements such as areas of recent disturbance (ranging from a gap in the canopy to a large scale forest fire), and the occurrence of associated tree species, which vary by region (Pilz et al. 2007). These general observations notwithstanding, the only way to determine if morels are in fact found in a specific area is to observe them there. Morel inventory is further complicated by the fact that they do not fruit in the same spot every year. This makes quantifying their distribution and abundance a difficult and time consuming task.

Assessing the impact of harvest on the morel population is also a long-term endeavor. There have been at least two long-term studies that attempted to examine the effects of harvesting on fungal species. The first, by Lorelei Norvell (1995) with assistance from the Oregon Mycological Society, was undertaken after concerns arose over declining populations of wild chanterelles in Oregon and Washington. After 10 years of study, no significant change was observed in chanterelle abundance at the PNW

[1] Managers at these two parks chose not to participate in the social science study.

study sites. The second study, by Egli et al. (2006) included edible and non-edible fungi, but did not focus on particular species. Based on 29 years of data, they determined that mushroom harvesting does not impair future harvests, although forest floor trampling appeared to reduce fruiting body numbers. A third study of shorter duration drew similar conclusions. Funded through the larger Man and the Biosphere Project (MAB) ,[2] the study of chanterelle mushrooms integrated biological, socioeconomic, and managerial data. Researchers concluded that harvesting was unlikely to have adverse effects given estimated chanterelle productivity in the PNW, combined with the known picking habits and areas covered by pickers (Liegel et al. 1998).

As these studies suggest, the goal of inventorying morels and assessing changes in their abundance over the course of three years, the initial duration of both the ecological and the sociological studies, was ambitious to say the least. Therefore, it became apparent that data on the visitor-harvesters were going to be the primary basis for changes in management specifically because after only three years, the bulk of the available data would be related to human use. This raises the question of how the NPS anticipated integrating the two studies, and what they intended to do with the findings.

With an awareness of this issue, I went to Maryland in the spring of 2005 with a list of objectives. For this preliminary field season my main goals were to learn more about the area, meet regional park staff, assess existing resources, test interview protocols, and meet with the principal investigator for the ecology study. Several things happened in the spring of 2005 that changed the course of my own research. I was originally interested in the subject of differential access to morels that I assumed would

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[2] "The mission of the United States Man and the Biosphere Program (U.S. MAB) is to explore, demonstrate, promote, and encourage harmonious relationships between people and their environments" (Barron and Emery 2009)

exist between state and national parks, and public and private lands. I assumed that people were primarily hunting for morels on public land, making them susceptible to changes in land tenure and access. I envisioned a project that explored how rural people maintained their livelihoods, at least in part through morel hunting, and where exclusionary management practices related to fears of scarcity would emerge as a rationale for separating people from the land and environment around them (Robbins 2004).

I went to the region with Dr. Emery in April 2005 to give presentations to park staff at CATO and CHOH, only to be told by a park employee who had moved to the area several years ago that no one would talk to me. I was told that people would be very upset if whole parts of the park (CATO in this case) were closed off to hunting. I was warned that people would not trust me because of my connection to the NPS. Then I had my first interview. It lasted an hour and a half, and ended with Ray[3] taking me morel hunting across the street from his house. We found eight morels that day; well, I should say Ray found eight morels and gave me hints until I saw them. Then he carefully instructed me on proper harvesting technique – pinch, never pull – and I went home from my first morel hunt with all eight, just enough for a thin sandwich. I discovered that Ray learned to hunt morels from his father, had lived on the same patch of land his whole life, and was absolutely dedicated to morel hunting. He was also recently retired from a U.S. government position at which he made over $60,000 a year.

In fact, of the fourteen people I interviewed in 2005, 43% of them reported making over $45,000 a year from their primary employment. This was not the subsistence lifestyle I had expected. Many also hunted primarily on private lands, making

[3] Names have been changed for confidentiality.

development and posting of private property, not changing federal regulations, their main concerns. A passion for morel hunting was evident in several of the oral histories I collected during this trip. Participants' comments showed that morel hunting was important to people for a wide variety of reasons, from getting exercise and being out in nature to what might best be described as a spiritual need. Morel hunting in this area was a long-standing practice, and locals considered it part of the region's cultural heritage. Most participants had an extensive understanding of ecological associations and expressed an interest in learning more about morel habitat, ecology, and biology in hopes of finding the increasingly elusive morel spots.

That spring I also learned more details about the companion ecological study that was supposed to start in 2005. A world leader on myxomycetes (slime molds) was originally the principal investigator for this project, but eventually subcontracted the project to researchers at University of Toronto. This led to the postponement of the ecological study until 2006. At the time, I believed that this postponement would allow for the incorporation of harvester input into the design of the ecological study. With data from the 2005 field season, the mycological researchers would be able to more accurately place their study plots, and mimic harvesting methods employed by the local harvesters. Unfortunately, the integration of the two studies was never accomplished. Feeling there was a need to document a basic ecological profile for the morels occurring in this area, I decided to add components to my study design to collect these data.

Ultimately, the goals of the morel project focused on building a case for morel management and conservation based on anecdotal concerns of declining morel populations in the region, and knowledge of intensive morel hunting in the U.S. Pacific

Northwest. This approach to natural resource conservation has been termed the "depletion crisis" model, where after a real or perceived resource "depletion crisis" occurs, new knowledge is sought or created to deal with and mitigate its effects (Berkes and Turner 2006). While the state of the morel decline in the NCR may not have been considered a "crisis" in the early 2000s, the epistemological starting point for the initial work plan was formed around underlying assumptions based in determining scarcity and human use patterns, and building connections between these two data sets.

Prior to learning about the research design of the companion study, I was already reading the extensive literature published by the Pacific Northwest (PNW) research station on wild edible mushrooms. Spearheaded by Dave Pilz, Randy Molina, and Rebecca McLain, this body of literature artfully combines ecological and social studies on matsutake, chanterelles, and morels harvested on public lands in the PNW (Pilz et al. 2007; Pilz, Molina, and Amaranthus 2001). Specifically, the MAB study was "designed to promote sustainable natural and human communities and to involve multiple stakeholders …A core assumption…is that sustainable forestry requires developing and maintaining strong interdisciplinary links among scientists, land managers and diverse forest users" (McLain, Jones, & Liegel 1998:34). I based my research design on the idea that this same assumption holds true for the sustainable use of other resources, namely wild edible fungi. Starting with the focus on harvesters from the initial research plan, I envisioned a project that looked "out" to managers and "up" to scientists to find out how to conserve morels. But morels are only one genus of macro-fungi. In 2005, I found relatively few references to fungal management and conservation in either policy documents or academic literature. What little I did find in the American literature focused heavily on commercial species of mushrooms and fungal nontimber forest products (NTFPs). What I found in the European literature emphasized species inventory and analysis, and mapping. There was no readily accessible information on fungal conservation incorporated into the agendas of national or global conservation organizations, and very little in government. This review of available resources led me to ask why fungi were not a visible component of biodiversity conservation. And, given the interest in this project and fungal NTFPs in the 1990s, was this changing?

1.3: Research Questions

Moving forward from 2005, I observed that this question of scarcity was being confronted in different ways by local harvesters in the NCR and scientists in the U.S. and in Europe. The core question of my research broadened accordingly: how do you conserve fungi?

I identified three stakeholder groups as being important to any analysis of fungal conservation: mushroom hunters, protected-area managers and mycologists. Work in community forestry and fisheries provides U.S.-based examples of the importance of recognizing community involvement in resource management (Kusel and Adler 2003; Singleton 2001; St. Martin 2006). Moreover, the MAB mushroom study stressed the importance of interdisciplinarity and connection between scientists, land managers and resource users when developing sustainability research (McLain, Jones, and Liegel 1998). In mycology there is a history of stakeholder group collaboration, although these connections are not expressed in either contemporary fungal management or the newer mycological research that is focused on genetics and laboratory work. Therefore, my study design examines the available knowledge of these three stakeholder groups, building on past and existing relationships with the common goal of fungal conservation and management. I do this through interviews with stakeholders, combined with quantitative research meant to demonstrate how different ecological knowledges can contribute to this nascent discourse.

Examining the emergence of fungal conservation and management forms the basis for my research. This leads to three overarching research questions. The chapter in which these questions are addressed is in parentheses following the question:

1) What is the structure of the field of fungal conservation, i.e. who is involved in the creation of this discourse: management institutions; conservation agencies; intellectual disciplines; user groups; etc.? (chapters 2, 3).

2) What is the state of the theory and practice of fungi conservation? How do scientific and managerial theories and practices differ from lay or traditional theories and practices? (chapters 3, 4, 5).

3) How can local ecological knowledge (LEK) inform and contribute to fungal management and conservation? What are the effects of constructing a space for LEK and harvester participation? What are the prospects for building a new consensus around the goal of sustainable mushroom management that incorporates the concerns of all those involved? (chapters 6, 7).

Morels serve as the focus of this case study because: (1) they are widely known and very popular; (2) they have been the subjects of much ecological study in the PNW; and (3) they are currently being considered in terms of their management and conservation in the NCR, where managers are specifically interested in the impact that any management activities could potentially have on harvesters.

1.4: Methods and Sampling Procedures

In order to address these research questions I used a mixed methods approach based in ethnographic research. Data collection consisted of four components: (1) semi-structured interviews with the three groups that were identified as involved in fungal conservation issues: scientists, managers and harvesters/users; (2) quantitative assessments of participants' opinions and observations through the use of a questionnaire and Q method; (3) an ecological field study at CATO based on harvester participant observation; and (4) participant observation at three mycological conferences in Europe and the U.S. I present an overview here of the different methods used in the first three components and in-depth information about the interviews. Greater detail on the quantitative methods are provided in chapter 6 with the results.

Qualitative Components of Interviews: Semi-structured Interviews

Ethnographic data were collected through semi-structured interviews. The interview format was developed following a grounded theory approach, which requires the researcher to continually assess the data as it is collected and adjust the protocols accordingly (Glaser and Strauss 1967). Preliminary interviews were conducted with harvesters and two NCR managers in 2005. These informed and shaped a second round of interviews in 2007, which was expanded to include mycologists and additional managers. Interviews for all three groups focused on the same subject areas. Questions were labeled alpha-numerically in the harvester set (Appendix A). Although wording, order, and emphasis were sometimes adjusted for the managers and mycologists (Appendices B and C), questions were labeled consistently so that answers could be correlated in analysis. The sections were: general questions (section A), morel productivity and harvesting practices (section B), abundance, conservation, and overharvesting concerns (section C), fungal biology and ecology (section D), management and inter-group relationships (sections E and G), and other (section F).

Not all sections of questions were consistent throughout all sets of interviews. For example, section B was more extensive in the harvester questions because it was the core of the morel study. Section B was less extensive in the other two sets of questions, and sometimes interspersed into other sections for managers and mycologists. Similarly, sections D and C were expanded for the scientists because they were the core of the FCP.

To facilitate dialogue, and the accessibility of the interview instrument for participants, in some cases vocabulary was changed. For example, question D2 was worded as follows: For harvesters: *Describe for me how morels reproduce and grow. Where do the mushrooms come from?* For managers: *Can you explain how morels reproduce and grow? Where do they come from?* For scientists: *Can you explain how morels propagate and grow? What are the different types and how are they differentiated from each other?* In the harvester form, special attention was made to use both 'morel' and 'mushroom' because based on the 2005 interviews, many local harvesters refer to morels only as mushrooms. The manager form mirrored the harvester form, but this distinction between morels and mushrooms was not made because of seeming redundancy. For scientists, 'reproduce' was changed to 'propagate' to signal awareness of different reproductive strategies. The second question, 'where do they come from?' was deleted because its meaning, for scientists, is different than its intended meaning in the question in D2 (Appendix A). Instead, a question from section B was added to query scientists' knowledge of different types, from a species perspective, specifically based on how they reproduce.

Each participant was given a participant identifier code (PIC) for anonymity and confidentiality. The codes were developed sequentially based on the stakeholder group (H, M, S) and the year of the interview (2005 or 2007). For example, the oral history of first harvester who participated in 2005 was labeled as H0501. The first from 2007 was labeled as H0701. Based on the NPS study design, harvesters that frequent both CATO and C&O, as well as surrounding areas, were included in the study. Interviewees were identified through the use of press releases, community presentations and meetings, and snowball sampling. In snowball sampling, interviewees suggest additional people who are later contacted. Sampling is complete when the information being collected becomes redundant or repetitive. In 2005, the NPS issued press releases informing the public about the study, and several people contacted me as a result. At local presentations throughout the region in early 2007 people were asked to sign up if they were interested in participating in the study.

All interviews were transcribed into MS word documents from digital audio files using WAVpedal software version 5.05 (The Programmers' Consortium 1997). The transcripts contain the following information: PIC; date of interview; length of interview; basic description including gender, age group, type of work; field notes; and transcript key. This process produced a total of 1,510 pages of raw data for analysis.

Analysis of interview data was conducted using MS Excel and NVivo 7, software for qualitative analysis (QSR International 2006). Excel was used for bookkeeping and organizational purposes, and for basic charting and tallying of data. NVivo software is designed to facilitate the integrated analysis of textual and audio materials by creating a 'project' to organize and query large amounts of data, thereby revealing commonalities and patterns that may not otherwise be apparent. This is done through the development of codes in a hierarchical coding structure, created by the researcher(s) based on the study design, research questions, and observations of the data. Selected textual data is then assigned to relevant codes. The result is a series of files, one for each code, that contain only the "coded" text. These code files can then be examined individually, comparatively, queried, or combined.

Due to the magnitude of the transcript data, and the overlapping but different themes in the morel study and the FCP, interview transcripts were analyzed in separate groups. Parent nodes were created based on the major sections (sections A through G above). Within each parent node a series of more specific nodes were created that mirrored the interview questions themselves. Transcripts were then imported into NVivo projects by group, and the text was "coded" as described above. The labels of the major sections and the individual study questions were carried over into the coding structure of all three projects for comparison and consistency. The harvester project had 76 codes, the manager project had 62, and the scientist project had 51.

Quantitative Components of Interviews: Questionnaires and Q analysis

In addition to semi-structured interviews, participants also completed questionnaires on morel habitat in their area, and participated in a Q analysis.[4] At the end of each interview, participants were given a list of environmental variables determined to

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[4] Q method is a quantitative method which is meant to elicit, evaluate and compare respondents' subjectivity by reducing researcher bias. This method will be explained in-depth in chapter 6.

be important for morel fruiting based on the preliminary field season data and the literature.[5] They were asked to rank up to five variables that they felt were indicative of morel fruiting areas, and up to five that were counter-indicated. Tallies were compiled within the three groups and all together as one group. This questionnaire overlapped significantly with the content of the interviews, but imposed a specific vocabulary for environmental variables. Through the use of these two methods to address the question of morel habitat, participants had opportunities to express both personal interpretations and vocabulary (in the interviews), and operationalized modes of interpretation (in the questionnaire, Appendix D). This provided additional insight into which environmental variables the different stakeholder groups deemed important for morel fruiting and habitat, and how they interpreted those variables.

The third part of the interview process was the Q method. Participants were given 48 cards with statements expressing a range of opinions about fungal conservation and morel biology and ecology (Appendix E). These statements were developed based on excerpts from the 2005 interviews, National Park Service websites and management documents, and the peer-reviewed fungal conservation literature. The participant was required to place the statement along a continuum from those that they most agreed with to those with which they disagreed most with. These placements were recorded, and the data were analyzed using factor analysis (chapter 6).

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[5] The format and clarity of this list was pre-tested with 23 college students taking a mycology class at Rutgers University. Adjustments, such as the inclusion of graphics to show variations in slope and canopy cover, were made according to the comments from pre-testing.

Ecological Field Study

A small ecological study was conducted in the summer of 2007 to create ecological profiles of morel and non-morel areas. One hundred meter square ($100m^2$) plots were located using a stratified random design (Figure 1). Plots were selected based on harvesters' long-term collecting sites. Site evaluations included the following variables: overstory stem density, understory stem density, percent ground cover ($1m^2$ nested plot), litter depth, canopy cover, slope, aspect and a basic soil profile.

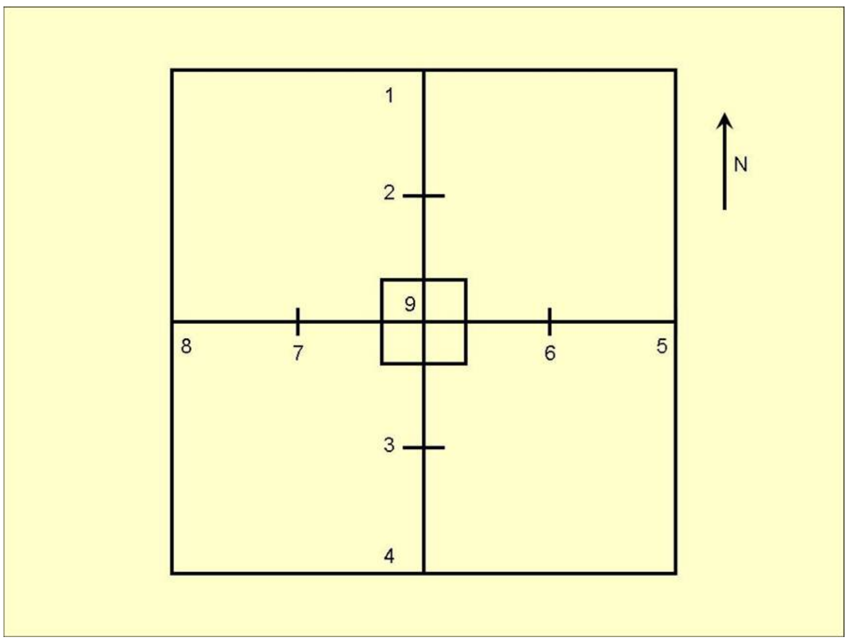

Figure 1: Ecological Study Plot Design. Plot area is $100m^2$. Numbers indicate sampling points for litter depth and soil sampling. Nested quadrat is for ground cover assessment.

The study design was "morel plots" (A plots) and "non-morel plots" (B plots); paired "A" plots and "B" plots made up one site, labeled numerically. "A" plots were located at harvesting spots identified through the interview process and located with the aid of harvesters. "B" plots were randomly located at least 50 meters in a straight line from corresponding "A" plots. A total of five sites (10 paired plots) were assessed in the summer of 2007. Results were analyzed with analysis of variance using SAS software (SAS Software 2009).

1.5: Study Area and Demography

Primary Study Area

The "morel study" described in section 1.2 and the "fungal conservation project" (FCP) in section 1.3, are related, but theoretically distinct. The morel study was specifically focused on morel hunting activities at two parks in the NPS designated NCR. This mainly empirical research is more thoroughly described elsewhere (Barron and Emery 2009). The FCP, in comparison, is a broader theoretical examination of fungal conservation, which uses the morel project as a case study. Due specifically to this project history, the primary study area is referred to both as the National Capital Region (NCR), and the mid-Atlantic region (MAR) (Figure 2). Both acronyms are seen throughout this dissertation; NCR is typically used in reference to the official NPS-delimited region, whereas MAR is used to refer to a looser regional conception of my own, specifically associated with the FCP.

The MAR is the primary research area because: (1) the FCP maintains its grounding in the NCR morel study; (2) the majority of the research participants are located there; (3) the ecological research was conducted there; and (4) it is through the morels located there that this work maintains its biophysical grounding. Yet, this research is multi-sited, both spatially and subjectively, in part due to the grounded theory approach (Glaser and Strauss 1967; Dey 1999).

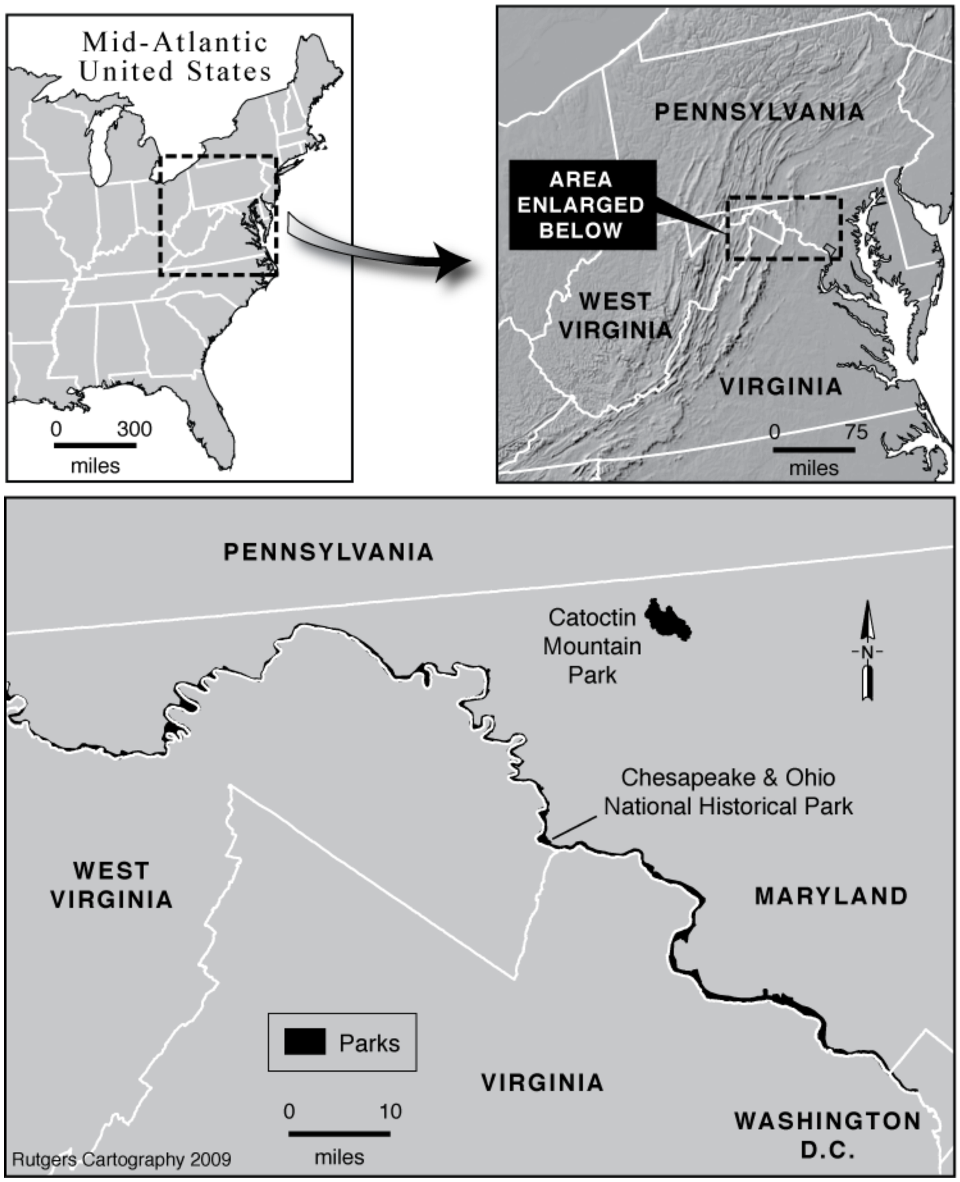

Figure 2: Map of mid-Atlantic Region, with an emphasis on the areas around CATO and CHOH.

The research remains grounded in different sites, at different scales, and through different subjectivities because it is focused on filling an empirical and conceptual gap: how do we theorize fungal conservation? It started with lines of inquiry and sets of knowledge concepts and practices focused around the morel mushroom, but as it became clear that the morel played a very small role in fungal management and conservation discussions outside of the U.S., I expanded the study to include whatever species were of interest in a given area. This allowed for movement between discourse and material grounded reality for each participant, based on their own experiences. Ultimately, interviews were conducted with harvesters and managers in the MAR, with managers and mycologists in the PNW, and with mycologists who reside throughout Western Europe. Regional perspectives certainly affected participants' responses.

As the primary study site, a more in-depth discussion of the history and how it is that morels are at the center of defining this region is warranted. Mushroom hunting has been a popular activity in this region for at least several decades, long before the national parks were established (Hufford 2000, 2006). The government acquired the C&O Canal in 1938, and after several failed alternative plans, it became a national historical park in 1971 (High 2000). The C&O is comprised of approximately 12,000 acres of canal, towpath, and surrounding property, much of which was seized through eminent domain to create the national park. It fluctuates 605 ft. in elevation from beginning to end, and due to its length (184.5 miles) it is one of the most diverse parks, in terms of vegetation, in the entire NPS system. Morels may occur throughout the park, but morel hunting is concentrated in specific sections where associated species are found.

Catoctin Mountain Park was established in 1936 as part of New Deal legislation that focused on agricultural assistance and land protection. The 5,810 acre park is located in the Catoctin Mountains, two and a half miles west of the town of Thurmont, MD in Fredrick County, with the western portion of the park extending into Washington County. It is about an hour's drive from Washington, D.C. and Baltimore, MD. An estimated 98% of the land within CATO boundaries is deciduous forest containing a mixture of oaks, hickories, maple and tulip poplar. Cherry, ash, sassafras, elm, butternut, locust, walnut, hemlock, white pine, and table mountain pine are also found in the park, although declines in several of these species have been reported. These species define a complex known as the Mid-latitude Deciduous Forest (Catoctin Mountain Park 2006).

Basic Demographics

Forty-four oral histories were collected from harvesters. Two participants from 2005 were selected as key informants and were interviewed again in 2007. Due to poor audio quality, one participant from 2007 was eliminated. Therefore, the results reported here draw on information from 43 oral histories, provided by 41 individuals; including residents of Maryland, Pennsylvania, and West Virginia (Figure 2).

Morel hunting is a predominantly male activity in the mid-Atlantic region, and 61% of harvester-participants were male (Table 1). Of the 16 women included in this study, seven of them did not hunt morels or only went with their husbands.

Table 1: Study Participants by Age and Gender (categories not represented in table had no participants.) [6]

Age	Male	Female	Total
Harvesters			
2: 18 – 24	3	1	4
3: 25 – 44	4	4	8
4: 45 – 64	10	4	14
5: 65 and over	8	7	15
Managers			
3: 25 – 44	0	1	1
4: 45 – 64	5	1	6
Scientists			
4: 45 – 64	4	3	7
5: 65 and over	4	0	4
TOTAL	**38**	**21**	**59**

[6] Different age categories were used in data collection in 2005 and 2007 that were not always consistent with each other. In 2007, US Census data collection categories were followed, so the 2005 data has been merged into the 2007 categories.

The majority of participants in each group were men over 45 years old. The greater representation of older participants in the harvester group was to some extent an artifact of the sampling methods. Participants were recruited in several ways as outlined above. These techniques had a greater appeal to older people, who were generally more likely to read the newspaper and to attend public meetings. Once initial communications were set up, the snowball sampling technique relied on existing networks within the community. Especially in the case of harvesters, this technique accentuated family lines, friendship networks and peer groups. Indeed, of the three participants in this group under 30, one was a NPS employee, and two participated at the request of older relatives or work colleagues. However, there is no evidence to suggest that young people are not engaging in morel hunting and opinions differed on whether there were more or fewer young people doing so today. Many participants reported hunting with their children and grandchildren.

The greater representation of older manager and scientist-participants is closely related to the selection process for those groups, which focused on mid-level to senior career professionals. Effort was made to secure a diverse, yet representative, sample from each of the three groups identified for this study, however it is clear from table 1 that the groups were not equal in size. They are somewhat proportional to the relative overall population of each group.

The second group of interviewees included land/resource managers dealing with issues of mushroom management. In addition to the above, managers were interviewed on their knowledge of fungal diversity, their perceptions of scarcity of fungi, and the basis for their fungal management approach. Two groups of managers were selected. The first was comprised of five NPS employees working in the D.C. area. The second was of two land managers with extensive experience in fungal management in the PNW, included specifically because I believed that there was likely some type of inter-agency interaction on this topic. Additional PNW managers were unavailable or inaccessible during my visit in January 2008. Ultimately, despite the lack of inter-agency collaboration, PNW managers' insights and experiences were consistent in many ways with NCR managers', because they operate within similar structural and institutional frameworks. Therefore, these participants were kept together in a single group.

Those working on fungal conservation in the academic and scholarly communities comprised my third stakeholder group. The most important criterion for inclusion in this group was participation in fungal conservation activities in Europe *or* active research on fungi in the PNW region of the United States.[7] Members of this subset of mycologists were contacted by email, at two European mycological conferences and during two trips to the PNW, in October 2007 and January 2008. Interviews with this group were conducted in person and via email. In addition to the above, mycologists were questioned specifically about the development and history of fungal classification and fungal conservation, which species they felt were the most important to conserve and why, and their concerns about scarcity. Their perceptions of traditional ecological knowledge were also explored. While there were a total of 11 participants in this group, only eight completed the semi-structured interview portion of the interview (Table 2).

[7] Research in the PNW, originating out of the Northwest Forest Plan, was considered by many the only significant work on U.S. fungal conservation as of 2007.

Table 2: Data Collected through Semi-Structured Interview Process

Stakeholder Group	# Interviews	# Hours of Audio	Pages of Transcripts
Harvesters	41	40 hours, 48 minutes	1,034
Managers	7	13 hours	266
Scientists	8	15 hours, 20 minutes	210
Total	**56**	**69 hours, 8 minutes**	**1,510**

1.6: Theorizing Fungal Conservation

This dissertation addresses the need to understand the conservation status of fungi by systematically examining the current literature on fungal management and fungal conservation (Chapter 2). Scarce in comparison to actions and publications on floral and faunal conservation, there has nevertheless been a significant amount of scholarly and government effort for fungal conservation in specific locales in the last 30 years. Publications from the 1980s and 1990s especially emphasized environmental degradation and the importance of fungi in forest ecology (Arnolds 1997, 1991a, 1989c; O'Dell and Ammirati 1996; Pilz and Molina 1996). Since the 2000s, the published literature on fungal conservation has begun emphasizing the need to build a social infrastructure to support fungal conservation (Watling 2005; Hawksworth 2003; Moore et al. 2001). Through participant observation at two conferences in 2007, and one in 2009, I observed this growing momentum and how scientists are connecting fungal conservation to larger conservation discourses (Chapter 3). These first two chapters engage with questions of how fungi and fungal conservation are currently understood in the formal literature and expert discourse (Mitchell 2002). In chapters 4 and 5, I re-center the discussion on the morel case study to examine the practices of multiple groups of stakeholders participating in the active creation of multiple fungal conservation discourses. What emerges are three distinct approaches to the conservation of fungi. These are currently disjunct, but have the potential to be mutually informative (chapter 6 and 7).

Chapter Summaries

Chapter 2 makes the case for fungal conservation. In this chapter I present and analyze what I refer to as "dueling epistemic constructions" of fungi: fungi as commodities, fungi as biological organisms, and fungi as subjects of conservation. Political ecology provides the theoretical framework for integrating these three strains of thought, which are the historical backdrop to the current discussion, and illuminate the significance of the various stakeholder groups.

The way fungal conservation science is being institutionalized by technology and the state mirrors the botanical and zoological conservation efforts that preceded it. These policies and actions are explored in chapter 3. A brief review of the history of the conservation movement in the U.S. shows the larger political spheres that influence conservation science. These operate in ways not readily connected to actual lived, local experiences with natural resources (Agrawal 2005; Kosek 2006). A closer relationship between science and the state was evident at two mycological conferences in Europe. Furthermore, the intense use of technology in molecular analysis and genetics research has completely destabilized fungal taxonomy, and because conservation policy remains closely tied to taxonomy and phylogenetic research, this has major implications for fungal conservation.

In the second half of the dissertation I move past the domain of the experts and of formal modes of conservation by giving equal attention to the knowledges and practices of harvesters, managers, and mycologists. Specifically, in chapter 4, I explore discursive aspects of how participants understand morels to exist in the environment, and how that knowing is expressed. These situated knowledges inform participants' beliefs about threats to fungi, and appropriate actions to mitigate those threats. While chapter 4 maintains a strong emphasis on knowledge, chapter 5 is about practice. In fact, chapters 3 and 4 both include data on and references to practice. Separate chapters seem to support a separation of knowledge and practice as two separate and related concepts; this is not my intention. Rather, these chapters are separated for the sake of in-depth examination of different but closely related dimensions of knowledge/practice, a term that I explore in detail in Chapter 7.

In Chapter 4, an in-depth look at morel ontologies of harvesters, managers, and mycologists yields insights into why these different stakeholders are approaching the management and conservation of fungi so differently. Different understandings of what morels *are* leads to different interpretations and insights into what is or could be harming them. Embedded within this discussion of knowledges is a discussion of intersubjectivity: how the groups perceive each other's members and their knowledge. This in turn relates to the "reach" of each group's knowledge and therefore the power of the knowledge to influence and be incorporated into fungal conservation discourse.

Chapter 5 deals directly with how each stakeholder group is practicing fungal conservation. Harvesters maintain specific sets of practices in relation to one, and sometimes two, fungal genera. Managers' practices emphasize spatial management and ecosystem management, creating a particular kind of managerial domain where fungal conservation is often subsumed under larger goals. Production of knowledge itself is a practice, and one that scientists engage in as a fundamental part of their work. In this case, they produce knowledge about fungal conservation in the form of IUCN red data lists, scholarly publications, and consulting work. Many mycologists also have strong opinions about proper management, stewardship, and conservation of fungi that inform their research and subsequently direct fungal conservation overall.

Research can be an opportunity for active intervention. Initially, three distinct models of fungal conservation emerged during this research, each based on the practices and the knowledges of the three groups. In chapter 6, I present two ways in which I attempted to understand and integrate these models. These quantitative approaches are: (1) an examination of opinions about fungal conservation and management using Q method, a quantitative examination of participant subjectivity; and (2) an ecological study based on harvester knowledge, where stratified-randomly selected sites were studied to provide a baseline for morel habitat in the NCR. These integrations of knowledge and practice combine a focus on conservation born out of scarcity with a conservation ethic based on ecological understanding (Berkes and Turner 2006; Turner and Berkes 2006).

I go on to work through some answers to these and the following questions: What are the chances of stakeholder integration in creating a new fungal conservation discourse, and what would it look like to insert traditional/local ecological knowledge and harvesters into fungal conservation? Finally, because the stakeholder groups operate at different levels within spatial, temporal and institutional scales, I examine the relationship between political ecology, policy and praxis.

Approaching fungal conservation from multiple scales and perspectives, my intention is that this dissertation contribute to current discussions about alternative forms of resource management such as adaptive management (Davidson-Hunt 2006) and co-management (Olsson, Folke, and Berkes 2004); and conversations about power, knowledge and conservation (Agrawal 2002; Robbins 2006; Berkes and Turner 2006; Turner and Berkes 2006). Two examples illustrate the potential that is explored along these lines in the following chapters. First, mycologists have a long history of working collaboratively with amateurs, which they define broadly as “non-professionals.” In fact, amateur foray records form the basis of the research that established fungal conservation in Europe (Arnolds 1989c), and also of recent work on climate change and fungi that was published in the well known journal, *Science* (Gange et al. 2007). This fact positions fungal conservation to emerge as a new branch of conservation science in which the active incorporation of knowledge and practices of amateurs and local people is welcome and actively pursued in an unprecedented way. Secondly, mycologists are poised to engage with international conservation policy in a revolutionary way through the transformation of their discipline by the genetic revolution. Scientists working on conservation issues related to animals have struggled with the criteria established to determine conservation priorities and risk, but their struggles pale in comparison to those of mycologists. Due to the reality that international conservation criteria are so grossly mismatched with how fungi are currently understood, mycologists may be the strongest advocates for an overhaul of international conservation. The following chapter lays the groundwork for the further development of these statements in the following chapters.

Chapter 2: Dueling Epistemic Constructions of Fungi

2.1: Introduction

This chapter broadly answers the question: what is the structure of the field of fungal conservation? There are three distinct perspectives expressed in formal literature on how fungi are currently constructed and understood: as commodities (political economy), as biological organisms (biology), and as objects of conservation (policy and science). These categorizations are not mutually exclusive, and the separation here is partially artificial for the sake of explanation, but each one is centered on a specific epistemology of macrofungi that has resulted in different potential entry points into a discussion of their conservation.

I conceptualize these different approaches as “dueling epistemic constructions,” each of which informs this dissertation. First, in considering mushrooms as commodities the emphasis is on the relationships between people and macrofungi. In this literature mushrooms are objects of social discourse relating to subsistence livelihoods and informal economies (Jones, McLain, and Weigand 2002; Barron 2005), migrant labor relations (Hansis 2002), politics and control of public spaces (McLain, Christensen, and Shannon 1998; McLain 2008), and local ecological knowledge (Emery 2001). The commodification of wild edible fungi has also led to several management-driven ecological studies. These are included in this section because of the close relationship between the commercialization of Pacific Northwestern fungi and the applied research that was subsequently conducted and funded in large part to “improve management decisions” for sustainable harvesting and ecosystem management (Pilz and Molina 1996).

In contrast to the anthropocentric approach to fungi outlined above, fungi are perhaps most widely understood as living organisms. From this perspective, determining what fungi are biologically, how they exist in the environment, and how they interact with other organisms in the environment are all primary areas of interest. Therefore, this section is a brief review of fungal classification and cladistics, fungal biology, fungal ecology and fungal biogeography. This is not meant to be an exhaustive review of these literatures by any means, but rather to present an overview of the epistemology most common to scientists and land managers.

In comparison to publications on floral and faunal conservation, there has been considerably less published on fungal conservation. Publications from the 1980s and 1990s especially emphasized environmental degradation and the importance of fungi in forest ecology (Pilz and Molina 1996; Arnolds 1989c). Re-envisioning macrofungi as objects of conservation specifically focuses on their contributions to global biodiversity and the effects of environmental degradation on functional groups of species (Lizon 1995). At times this creates an obvious tension between pure and applied mycologists, giving rise to political actions and lines of research meant to make a case for fungal conservation.

Political ecology provides a theoretical framework to integrate these diverse perspectives. Using neo-Marxist interpretations of political economy, in the 1980s political ecological research focused on developing arguments against neo-Malthusian notions of the connection between growing environmental crises and a growing global population (Biersack and Greenberg 2006). Influenced by poststructuralist and postmodern thought in the 1990s, political ecology took a decidedly discursive turn to focus on the social construction of nature in a foundational way: "The question is no longer whether the representation of reality is accurate - whether 'cognized' models parallel 'operationalized' models, but what reality is being constructed, by whom, for whom, for what political purpose, and to what political effect" (Biersack and Greenberg 2006:14). This shifts the entry point and discussion away from how accurately biological and ecological sciences represent a fixed reality, and onto those individuals and groups creating and conserving that knowledge, and why. It also emphasizes an historical perspective on environmental problems, which has remained an important component of political ecological research.

Poststructural attention to how power, knowledge and practices create ideas of nature dominated during this period (Watts and Peet 2004). In the 1990s, critiques of development policy, environmental science, and the social and political dimensions of conservation were central themes in political ecology, but with this discursive turn a tension grew over the marginalization of biophysical realities and ecological systems, the very material reality of which was now being contested (Walker 2005).

This theoretical divide remains as a significant tension within political ecology, and some advocate for a "constrained constructivism" that acknowledges both local narratives and power relationships, *and* scientific inquiry and empirical evidence (Demeritt 1998; Neumann 2006). Seen in this light, fungal conservation cannot be understood or further theorized without due attention to why macrofungi are important in both social and ecological systems. The following section reviews the literature in which these interpretations are grounded.

2.2: Dueling Epistemologies

Fungi as Commodities, Fungi as Subsistence

The literature on non-timber forest products provides an entry point into a discussion about fungi as commodities because it is the literature that has best captured the depth of relationships between people and mushrooms. Fungi have been increasingly commodified within the capitalist marketplace, but historically they have also been a part of subsistence lifestyles and informal economies, the latter defined here broadly as "a specific set of relationships of production…unregulated by the state (Alexander, Weigand, and Blatner 2002). Different sets of values are often attributed to those picking for different reasons; and harvesters are often classified as "recreationalists, temporarily unemployed seeking income, or highly skilled commercial harvesters" (Pilz et al. 1996:45). Assumptions about harvesters' motivations influence NTFP policy and regulations, and affect harvesters' positionality vis-à-vis managers and scientists.

Research on NTFP harvesters suggests that people engage in these activities for a variety of reasons: to earn income, to meet subsistence needs, to maintain lifeways and a sense of identity, and to strengthen intergenerational ties (Emery and McLain 2001). Indeed, wild edible fungi are collected for food in more than 80 countries (Pieroni et al. 2005), and morels are one of the most popular. "Globally, 300,000 pounds of dried morels are traded annually, [representing] nearly 3 million pounds of fresh morels," (Pilz et al. 2007:75). Very large quantities of morels are extracted every year from Oregon, Washington, California, Idaho, Montana and Alaska.

When the global market for wild edible fungi exploded in the 1980s, harvesting increased dramatically from public lands in the Pacific Northwest and intermountain states, leading to new regulations and management concerns. The expansion of international markets for matsutakes, morels, chanterelles, and boletes brought fungi to the fore in the 1990s for management and research in this region. As the values of mushroom commodities increased, commercial timber practices such as permitting were adapted for these "special forest products" to protect and maintain them, while capitalizing on this new revenue stream (McLain 2008).

To develop "sound" and "appropriate" management practices for species that were poorly understood up to this point, the Forest Service funded several multi-year research studies into the biology and ecology of key genera. Many of these were undertaken by the Forest Mycology and Mycorrhizae Research team (Pilz and Molina 1996; Pilz et al. 2007; Pilz et al. 2003; Hosford et al. 1997), which collaborated on integrated social-ecological research as well (Jones and Lynch 2002; McLain, Jones, and Liegel 1998). This research team was in place at the time of the creation of the Northwest Forest Plan (NWFP) in 1994, a major conservation initiative in the region created in response to political and environmental debates over the spotted owl. Hundreds of fungal species were included in the NWFP as a result, leading to additional research and some of the most comprehensive fungal surveys ever conducted. This upsurge in fungal research jump-started fungal conservation in the United States (Molina 2008).

The growth of the wild edible mushrooms industry in the early 1990s required more "workers in the woods" (Hansis 2002), and as the industry grew and changed, so did the workforce. Schlosser and Blatner (1995) report that in 1992 approximately 50% of mushroom harvesters in Washington, Oregon and Idaho were Caucasian, 37% were Asian and Pacific Islanders, 9% were Native American, and Hispanics accounted for approximately 4%. Within two years, based on surnames on permits from eastern Oregon, Parks and Schmitt (1997) estimated 51% Asian, 44% European, and 5% Latino. A similar analysis for one specific ranger district in Oregon from 1996-1998 reported 62% European, 28% Southeast Asian, and 10% Latino (McLain 2000). Conflicts between ethnic minorities and "worker camps" drew media attention, and the mushroom harvesting industry was frequently portrayed as heavily dominated by immigrant laborers and ethnic minorities (Sullivan 1998; Bilger 2007; Stutz 2005). Others describe an industry full of treasure seekers, "regular guys" seeking supplemental income, and nonconformists looking for something to do (Wolf 2006). This research highlights the consumptive nature of mushroom harvesting. It focuses on the economic needs and conflicts of immigrants, racialized workers and the poor. Scientific research and the imposition of government intervention and regulation is juxtaposed against these socioeconomic portrayals in the name of environmental protection and for the protection of others such as recreationalists and outdoor enthusiasts (McLain, Christensen, and Shannon 1998).

Many of those picking for informal markets, recreational enjoyment, or personal consumption have been affected by regulatory changes aimed at commercial harvesters, and must simply adapt to new regulations (McLain 2008). However, for certain groups of mushroom harvesters, it has been suggested that the environmental knowledge they possess should be seriously considered in ecosystem management. Local resource users often possess detailed information about species and ecosystem dynamics (Berkes, Colding, and Folke 2000; Olsson, Folke, and Berkes 2004). In some cases, this information may be longitudinal, drawing on the experience of multiple generations

(Turner and Berkes 2006) or records kept by individuals over several decades (Emery 1998; Barron and Emery 2009). The Karuk tribe, whose ancestral lands coincide with prime matsutake habitat, maintain "traditional tribal practices… include[ing] sustainable harvesting of tanoak [matsutake] mushrooms" (Richards 1997:5). As keepers of traditional ecological knowledge, it has been suggested that Karuk elders should actively participate in ecosystem management (Richards 1997). Mycological Society members, 79% of whom collect for personal use, are also included among those whose voices and actions have been given special consideration (McLain, Christensen, and Shannon 1998).

Fungi as Biological Organisms

In addition to these complex social dynamics, concerns relating to overharvesting and scarcity have steadily increased for wild mushrooms. This may be due in part to misunderstandings about fungal biology, and a common misconception that in picking a mushroom, harvesters take the whole organism or damage it in some way. This is sometimes the case with plants, for example when people dig up orchids to transplant to home gardens. Yet biologically, picking a mushroom is not the same as picking a plant.

Plants are made up of three tissue systems, the dermal tissue system (epidermis), the vascular tissue system, and the ground tissue system. These systems make up the various components of a plant: the roots, the body, and the reproductive structures. They are responsible for growth, nutrition and reproduction (Campbell 1993). When a plant is picked out of the ground, all three of these systems may be removed, disturbed or destroyed. Alternatively, when an apple is picked from an apple tree only the reproductive structure, the seed, is removed. The structures responsible for growth and nutrition, as well as potentially many additional reproductive structures, remain as does the ability of that plant to produce additional reproductive structures in the future. Apple picking is analogous to mushroom harvesting. Fungi have very different structure from plants. Macro-fungi are made up of hyphae (singular, hypha), strings of cells that often join together into thicker “ropes” of cells called mycelia (singular, mycelium). The mycelium can be considered the “body” of the fungus and is responsible for growth, nutrition and reproduction. The mycelia grow through the fungus’s habitat searching for and absorbing food. In mushroom producing fungi, the mushroom represents a specialized reproductive structure to facilitate spore dispersal. In other words, the mushroom is akin to a fruit (Campbell 1993). This is why mycologists will often say “picking mushrooms is like picking apples off an apple tree.” This confusion is related to the history of biological classification.

Plants and animals have been separated into distinct kingdoms since the time of the ancient Greeks, but it was not until the early 20th century that additional divisions were suggested at that basic level of classification (Bessey 1950). In 1950, classification efforts were still based on morphological characteristics, a system originated by Linnaeus (Linnaeus 1735). Fungi were classified within the plant kingdom, and the suggestion that they be separated into a third kingdom seemed somewhat radical; the two kingdom system had been working for over 2000 years.

It is now commonly accepted that classification should reflect the principles of evolution and common decent, although this approach was integrated into mycology much later than it was into other fields in biology. This timeline remains present in the living memory of practicing mycologists:

> Up until the '50s, we were being taught [in mycology] about similarities in morphology. Those similarities were purely end products and it didn't reflect the development. Now animal classification, plant classification, inherently have in them a developmental aspect. When you look at the development of the ovules and so on, you look at the skeleton of the animal and its teeth, development and so on, whereas that was never the case in fungi. We looked at the end product and that was our downfall. It's been corrected, it's been changed now. (S0709)

Whittaker proposed the five kingdom system in 1969 based on evolutionary principles, three levels of cellular organization (prokaryotic, eukaryotic unicellular, and multicellular-multinucleate), and the three principal means of nutrition expressed by multicellular-multinucleate organisms (production, consumption, decomposition). In this system Fungi (decomposers) were elevated to their own "Higher Kingdom" on par with the Plantae (producers) and Animalia (consumers) (Whittaker 1969). I am using the classification system published in Kendrick (1992), which follows the five kingdom system, because this is still the most widespread and commonly accepted system even though additional classification systems have been proposed since (Kendrick 2003).[8]

The five kingdom system starts at the most basic level, the cell. Ancient cells called Prokaryotes lack nuclei, mitochondria and cytoplasmic organelles, making up the Kingdom Monera. It is hypothesized that Prokaryotes were the original, and only, form of life for about 2,000 million years. Eukaryotic cells developed about 1.4 billion years ago, incorporating their DNA into discrete chromosomes in a distinct nucleus. Evolutionary biologists theorize that several prokaryotic cells were somehow engulfed into a single cell and "made to work together," eventually becoming the various organelles of complex, or eukaryotic, cells. Eukaryotic cells that are also single-celled organisms form the Kingdom Protoctista. Eukaryotic cells later merged into multi-cellular organisms. Most

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[8] These new classification schemes do not have a direct impact on the macrofungi and therefore are less relevant here.

recently, those multi-cellular life forms have been organized into the three kingdoms: Plantae, Animalia, and Eumycota, also known as producers, consumers, and decomposers in the cycle of life. The functional group, Fungi, briefly its own kingdom, is actually divided between two kingdoms, with three phyla in the Protoctistan (the lower fungi) and two phyla in the Eumycotan (the higher fungi). In essence, the lower fungi were taken out of the Kingdom Fungi and placed into the Kingdom Protoctista because of their cellular structure. This organization is based on characteristics of the organisms, where organisms from different evolutionary backgrounds (and therefore in different kingdoms) share similar life strategies, putting them in the same functional group. Fungi are not alone in this; algae are actually divided across three kingdoms. For students learning elementary biology these cellular differences are too complex, so most students who encounter this material actually learn about a Kingdom Fungi, such as that proposed by Whittaker. Kendrick, after outlining this complex history and classification system, acquiesces to the common misconception in the title of his book, "*The Fifth Kingdom*" (1992).

These fluctuations in cladistics and taxonomy have had practical effects on mycology and mycologists. Despite the new classification, old relationships between plants and fungi remain in academic departments, where mycologists are often housed with *botanists*. They are maintained through terminology: species are often referred to collectively as the fungal *flora*. Lastly, they are upheld with taxonomic conventions, where mycological taxonomy is still determined within the International Code of *Botanical* Nomenclature.

Mycologists have various reactions to these established modes. One outcome seems to be that many senior mycologists are highly knowledgeable of the history of their discipline. Many know the names of significant figures in biological and mycological history such as Carl Linnaeus, Elias Fries, Robert Whittaker, and Arthur Buller. They are very aware of the development of a specifically mycological epistemology, as demonstrated in the following excerpt:

> Linnaeus based his first scientific botanical classification on the sexual organs. Fungi with hidden sexual organs were put in a last class, the cryptogams. Later Elias Fries proposed an elaborated system for 'all' fungi based on macroscopic characters of the fruit bodies. He tried to underline a classification with seven items (seven species in one genus, seven genera in one family, seven families in one order and so on, as the idea was popular that God as the Creator followed this system). In the second half of the 19th century, microscopic, since 1850, and physiological characters, since 1870, were included and the classification ameliorated. From 1950 onwards crossing experiments tried to apply the genetic species concept to classification, originally a zoological concept with a phylogenetic approach. Statistical methods have been applied since the 1970s, the so-called numerical taxonomy. Since 1985, molecular characters are used in combination with more and more sophisticated statistical methods with a phylogenetic approach. (S0711)

The vast majority of academic research focuses on the Eumycotan phyla, also known as macrofungi or higher fungi. These are the phyla that contain all of the common species of interest for amateur mycologists and mushroom harvesters, and as such, they are the focus of this dissertation. The classification of fungi is important to understand because it highlights the position of this functional group relative to other life forms. When mycologists say consideration and concern over fungal conservation is important, they are not talking about charismatic megafauna like leopards or obscure species like the snail darter, they are talking about thousands of known and undiscovered species that perform critical functions for all the other organisms on earth. As such, understanding the biology of fungi carries significant weight:

> Fungi probably rival flowering plants in their species diversity, and outweigh the animal kingdom. Whilst wielding great destructive power as agents of disease and decay, they drive the global carbon cycle, sustain our forests and grasslands via

> mycorrhizal associations, and clothe, as lichens, what would otherwise be bare parts of the planet. Their developmentally versatile body forms provide immense scope for industrial exploitation as well as experimentally accessible systems for studying fundamental biological issues. Yet most people's appreciation of fungi stops at mushrooms, moldy food and fairy tales. (Alan Rayner, quoted in Kendrick 1992).

Concerns over the conservation of fungi were increasing raised in the mid-1980s for three reasons: 1) research led mycologists and ecologists to be concerned over the possible decline of fungi and likely consequences for ecosystem function; 2) knowledge of ecology and geographic distribution of fungi increased significantly in Europe and the U.S., enabling an analysis of trends of specific species; and 3) public and political interest in nature conservation grew substantially, and international treaties were created for biodiversity and species protection (Arnolds 2001). A fourth aspect that Arnolds does not highlight is that an international economy started to develop around mushrooms in the 1980s when a shift in American cuisine and rising overseas demand caused mushroom enthusiasts to seek out new sources of wild mushrooms (Arora 1999; McLain, Christensen, and Shannon 1998).

The role of fungi in forest ecosystem dynamics has been shown to be significant in Australia, the United States, Scandinavia, and in grasslands throughout Europe. It is assumed that fungi also play significant roles in tropical ecosystems, although there is significantly less research on tropical fungi; therefore their ecological significance has yet to be been delineated. Understanding the role of fungi in global environmental processes provides insight into why fungi are uniquely valuable. Fundamental aspects of major biogeochemical cycles are controlled by fungi, for example, the weathering of Earth's surfaces (Hoffland et al. 2004; Taylor et al. 2009), and decomposition in terrestrial (Hattenschwiler, Tiunov, and Scheu 2005) and freshwater (Nilsson, Baath, and

Soderstrom 1992; Hackney, Padgett, and Posey 2000) systems. Moreover, the diversity of fungi in a community affects the diversity of plants in a community. This is the case, for example, when mutualist fungi serve as positive drivers of plant diversity (van der Heijden et al. 1998; Dighton 2009), or when emerging pathogens (chestnut blight, or more recently sudden oak death) kill common species (Rizzo et al. 2002).

Changes in our understanding of fungal biogeography have distinct implications for fungal conservation. It was previously believed that because spores were able to travel in upper level atmospheric currents, many fungal species had a cosmopolitan distribution. More recent research has shown that in fact this is not the case, and that fungi, like many plant and animal species, are subject to major biogeographical processes such as genetic drift, isolation, and dispersal. Like plants and animals, they exhibit specific patterns of distribution as expressed through phylogenetic research (Mueller et al. 2001; Hibbett 2001). As a result, species and genera that were once believed to have cosmopolitan distributions are now being reclassified into many individual species, they are assigned to new or different genera, or they are sometimes moved into different families. These changes in the understanding of fungal taxonomy are significant because so much conservation policy and attention is directly related to species differentiation, and its geographic referent, endemism.

Fungal reproduction is closely connected to fungal biogeography. Many fungi are able to reproduce sexually through spore creation and dispersal, and also asexually through cell division. The ability to reproduce asexually, or clonally, means that individual organisms can be extremely long-lived. In fact, fungi are the largest, and among the oldest living organisms: a “single” honey fungus (*Armillaria*) in Washington state was estimated to extend over 15 hectares with a possible age of about 1500 years and biomass exceeding 100 tons (Webster 1996). Because the mushroom is the mechanism for spore distribution and therefore sexual reproduction, whether the fungus is reproducing sexually through sporocarps or asexually through cloning is very relevant in terms of assessing the potential impact of harvesting practices.

Fungi as Objects of Conservation

The intense interest in fungal conservation mirrors similar calls for floral and faunal conservation. Lizon states that, like other groups of biota, at least a fifth of all fungal species will be permanently lost in the next few decades. Based on his assessments of European Red Lists, he calculates that more than 600 species of macrofungi are already extinct or threatened with extinction in one or more European countries, and that 30-50% of the 5000 recorded European macrofungi may be threatened (Lizon 1995). Fungi comprise a significant portion of the earth's biodiversity, and play fundamental roles in the earth's biogeochemical cycles. Yet, while the conservation of fungi is based in these estimates, conservation itself may be driven by a set of factors not related to the organisms per se, but to how they are conceptualized as objects in need of protection.

In this section, I examine the existing literature on the conservation biology and ecology of fungi. This includes reviewing the scope of the problem, the areas where this type of work has taken place, methods of assessment, causes for declines in fungal populations, effects of these declines, proposed strategies for conservation, and finally the emerging work on the relationship between fungal fruiting and climate change. The majority of references in this section are from the only existing book on fungal conservation (Moore et al. 2001), and from the work of Eef Arnolds.[9]

Like other organisms, fungi are negatively affected by large scale environmental degradation such as habitat loss, deforestation, and pollution (Watling 2003), and many of the reasons for their conservation are actually similar to plants and animals: ecological significance, value as indicator species, economic importance, scientific value, aesthetic value, and the ethics of biodiversity and conservation (Arnolds 1991b). Given these factors, fungal conservation is important at the global scale. Unfortunately, reliable empirical data have been primarily restricted to the Pacific Northwestern region of the United States (Molina et al. 2001) and Europe (Courtecuisse 2001). Consequently the majority of conservation research has been done in these areas, with a few notable exceptions (Cannon, Mibey, and Siboe 2001; Minter 2001).

As micro-organisms, many fungi occupy fairly specific ecological niches. For this reason, mycologists posit that fungi are threatened when their ecological niche, or habitat, is threatened (Moore et al. 2001). Habitat protection and restoration are therefore the most significant considerations for fungal conservation. There are two primary reasons for this. The first is related to the biology of many fungi. Plantae is the only higher kingdom that can exist independently of other organisms (as producers of their own food through the process of photosynthesis). Animals, as consumers, typically eat plants and animals. Fungi, the decomposers, also "eat" or acquire their nutrition from or in association with plants and animals. However, unlike animals, many fungi may also live,

[9] Much of the literature on fungal conservation is actually social in nature. Mycologists have published about the lack of appreciation for fungi, the dearth of mycologists, and the current problems in fungal taxonomy (Moore et al. 2001). Publications documenting the social dimensions of the institutionalization of fungal conservation will be reviewed in the next chapter.

to some extent and in varying capacities, *within* their food. This makes the relationships among host, habitat, and nutrition especially complicated and significant for fungi, and greatly complicates any discussion of fungal conservation because many macrofungi cannot be considered outside of the context of host *and* habitat (Watling 1997). Molina concisely states the second reason: "mycologists recognize the impossible task of protecting fungal species one at a time, so the fungal conservation literature emphasizes the need to protect and restore habitat as the primary method to conserve fungal diversity (Berglund and Jonsson 2003; Courtecuisse 2001; Watling 1997; Molina et al. 2001)." (2008:632).

Methods from community ecology and biogeography are commonly utilized in conservation biology, and this is the case for fungi as well. Species inventory and monitoring provide baseline data on existing species abundance, range, and dispersal that can then be monitored over time (Courtecuisse 2001; Lizon 1995). Preliminary inventories and checklists exist or are in preparation for most European countries (Senn-Irlet et al. 2007) and the Pacific Northwest (Molina et al. 2001). Monitoring can take several forms. One notable study, focusing specifically on the popular edible chanterelle, incorporated the effects of harvesting into inventory and monitoring over a 15-year period (Norvell 1995). Extensive data on Dutch macrofungi, as well as European ectomycorrhizal (EM) fungi, have been compiled and published by Eef Arnolds (1989c; Arnolds 1984, 1989a, 1989b, 1991a). Utilizing amateur and professional foray records dating back to the early 20th century, Arnolds has published extensively on changes in frequency and distribution of many fungal groups, and subsequently assessed their decline and status as species in need of protection (Table 3).

Table 3: Major Works on Fungal Conservation by Eef Arnolds demonstrating inventory and analysis based on foray records of the 20th century.

Year	Groups Affected	Increase or Decrease in Abundance	Factors/Causes of Decline
(Arnolds 1989a)	Terrestrial saprophytic species common to nutrient rich soils	Increase	Eutrophication of forest soils
	Neophytic wood decomposers	Increase	Unknown
	Lignicolous macromycetes (esp. with parasitic capacity)	Increase	Generally, forest aging. Specifically on facultative parasites: reduced forest vitality
	Saprophytic macromycetes of grass and heathlands	Decrease	Use of artificial fertilizers
	Lignicolous saprophytes	Decrease	Unknown
	Overall significant decline in EM spp.	Decrease	Direct effect Air pollution, acidification, changes in soil, indirect effect: diminished carbohydrate supply because of damage to trees' abilities to photosynthesize.
(Arnolds 1989c)	944 species placed on red list for Netherlands: 91 presumed extinct, 182 directly threatened with extinction	Decrease	Natural factors: succession, natural decline of plant species. Anthropogenic factors: destruction of habitats, alteration of habitats, changes in management, side effects of agricultural measures, air pollution.
(Arnolds 1989b)	Decreased frequency of occurrence of 13 of 14 species of hydnaceous fungi; additional eight species considered extinct	Decrease	Nitrogen accumulation in forest soils due to air pollution
(Arnolds 1991a)	Decline of EM sporocarps: esp. those associated with trees >40 yrs old (eg. Tricholoma, Cortinarius), based on assumed decline in mycorrhizas	Decrease	Forest succession, collection of edible sporocarps, changes in management, air pollution, acidification of forest soils, nitrogen deposition, increased litter accumulation, changes in herb layer of forests, reduced tree vitality.

In conjunction with inventory and monitoring, species mapping provides information to assess species rarity, heritage value, and possible decline (Courtecuisse 2001). Mapping is complicated by problems of detection, poor taxonomic knowledge, availability of data, and accessibility of data, yet mycologists proceed despite these limitations (Arnolds 1997). Arnolds (1989b) has mapped changes in distribution of stipitate hydnaceous fungi, and changes in the distribution and frequency of several species of macromycetes, both in the Netherlands (Arnolds 1989a).

Declines in fruiting bodies may be explained by both natural and anthropogenic factors (Table 3), but determining direct cause and effect relationships often remains a challenge. While ecologists now conceptualize the theory of forest and plant succession somewhat differently than in the past, the idea of a shifting steady state mosaic still incorporates the fundamental concept that species present in plant communities change over time (Turner 1989). Arnolds (1989c) points out that changes in the plant community have a direct impact on changes in the fungal community. Furthermore, aging trees and increased litter and humus layers affect soil chemistry, negatively affecting some mycorrhizal fungi. Decline of specific species, especially tree associates, may also lead to decreases in fungi and fungal fruiting.

The connection between biodiversity and climate change has not escaped the notice of mycologists. Available data imply that fungi will be significantly affected by global climate change. The close connections among fungal diversity, plant diversity, and biogeochemical cycles (Wardle et al. 2004) imply that as the ecologies and physiologies of fungi change, both plant diversity and especially the carbon cycle will also be altered. Moreover, because fruiting bodies provide food and habitat for many organisms, changes in fungal phenology may have profound influences on a wide range of systems, from invertebrate (Jonsell, Weslien, and Ehnstrom 1998) to human communities (Kauserud et al. 2008). Recent research has established specific links between a changing climate and the changing phenology of large groups of fungi at specific sites in the United Kingdom and in Norway. In the UK, Gange et al. (2007) found that changes in the appearance of fungal fruit bodies parallel the changes in temperature that have been occurring since 1975. The fruiting seasons of many species have changed, and a significant number of species that previously only fruited in the fall are now also fruiting in the spring. Moreover, in contrast to the earlier flowering and fruiting noted for many plant species in relation to climate change, Kauserud et al. (2008) documented late and compressed fruiting seasons for many species of fungi in Norway, and these changed patterns were directly correlated to changes in climatic patterns.

There are several potential anthropogenic factors causing declines in fungal populations. These include destruction of habitats, alteration of habitats, changes in management, side effects of agricultural measures, and air pollution. These can be further divided into direct and indirect effects. Destruction of habitat is the irreversible conversion of actual or potential fungal habitat (eg. grasslands, forests, woodlots, bogs, dunes, etc.) by infrastructure improvements such as road building or mining, and development of residential, municipal, and industrial sites. In contrast, the alteration of habitats signals changes to habitat that significantly alter the area in a short period of time. Examples of these types of activities include pumping of groundwater (Nauta and Jalink 2001), afforestation of heathlands in the name of landscape preservation, silvicultural practices leading to monocultures, draining of bogs for conversion into forests or agricultural land, and the conversion of nutrient poor pastures or hayfields into highly productive grasslands or agricultural fields (Arnolds 1989c).

There are many indirect anthropogenic factors as well. Large amounts of open space in the U.S. and throughout Europe are now actively managed by public and private land management and preservation agencies, and the decisions these agencies make regarding maintenance and preservation, or alteration, of plant and animal communities affects the mycoflora as well (Nauta and Jalink 2001). The intensification and industrialization of agriculture and air pollution have all significantly affected the basic chemistry of air, soils and water all over the world. Common effects of these processes include eutrophication of soils, acidification of soils, and damage to plant communities.

Declining fungal populations may have widespread repercussions for biotic and human communities alike. Different strategies are underway to mitigate these effects based on perceived threats to the mycoflora. Given the concerns for habitat protection and restoration, it is not surprising that key fungal conservation strategies include integrated ecosystem management strategies (Molina et al. 2001; Molina 2008), and inventory and monitoring to contribute data to biodiversity-based land protection (Venturella and Rocca 2001). Elevating the value of specific species by deeming them "indicator species" is a strategy that is used in floral and faunal conservation, and may be of use for fungi as some species are indicative of old-growth forests, and also of other species that may also play a vital role in ecosystem function (Parmasto 2001). In the UK, fungi have found a place in the UK Biodiversity Action Plan (Fleming 2001). The Scottish Wild Mushroom Forum has taken an innovative approach to fungal management and protection through the inclusion of conservation organizations, landowners, public land agencies, mushroom buyers and mushroom pickers in drafting guidelines and regulations for use on public and private land (Dyke 2001). Reminiscent of the British and American Mycological Societies' (BMS-AMS) joint statement on fungal biodiversity and conservation (Watling 1997), David Hawksworth (2003) has recently proposed the widespread development of "mycoaction" plans. These plans would be at the international, regional, and personal levels to address the key themes of collaboration, promotion, education, and conservation.

All of these strategies recognize the importance of fungi for biodiversity, ecosystem integrity, and landscape preservation. For the preservation of fungal species for their own sake, Red Data Lists are the number one strategy and tool (Courtecuisse 2001).[10] Red lists are lists of species that scientists have determined are in a state of emergency and demand immediate attention. Begun in the 1960s for charismatic species, the use of these lists was expanded in the 1980s and 1990s to incorporate all multi-cellular organisms. Red lists are meant to be applicable at any geographical level, and are currently the only internationally accepted system for assessing risks to biodiversity (IUCN 2010). Eef Arnolds wrote the first red list for fungi of the Netherlands in 1984 (Arnolds 1984), and by 1989 had increased the number of species on the list by over 200% (Arnolds 1989c).

The European Council for the Conservation of Fungi (ECCF) is the organization that is currently responsible for coordinating and advising on red data list creation for all European countries. They published a report in 2007 that reviewed the current conservation status of macrofungi in Europe (Senn-Irlet et al. 2007). This report included information on the existence of checklists (inventories), red lists, presence of professional and amateur mycologists, and overall awareness of fungal conservation in 37 countries and at the European level. The ECCF aims to compile a European-wide red list for macrofungi by 2010 (Anonymous 2007). Similar to the BMS-AMS joint policy statement, and the mycoaction plans, the report emphasizes data collection, conservation,

[10] A more in-depth discussion of red lists as a form of the practice of knowledge creation, and the political dimensions of these activities is presented in chapter 5. This section specifically refers to the use of red lists as a strategy for fungal conservation.

increased education and awareness of fungi, and capacity building within the mycological community and beyond. These publications represent an emerging consensus, and articulate several next steps toward improving the state of fungal conservation both biologically and politically.

2.3: Conclusions

Separated here for the sake of explanation, these three epistemological approaches to fungi provide necessary depth and background to both the morel project and the fungal conservation project outlined in chapter 1. Conservation requires an understanding of what is to be conserved, how it is to be conserved, and why it should be conserved. In the American context, as the value of fungal commodities increased, what was once an invisible activity became visible (Emery 1998). Fungi were viewed as special forest products, and were managed as such. To improve the efficacy and effectiveness of management, the Forest Service funded research into the biology and ecology of target species. Yet, despite the functional significance of fungi to global ecosystems, basic aspects of their biology, ecology and biogeography remain highly mutable. These factors have contributed to keeping fungi out of mainstream conservation discourse. The Northwest Forest Plan, a key piece of environmental legislation passed during the Clinton Administration, affected multiple aspects of land management, but had an especially significant effect on fungal management and conservation. Because of concern over the spotted owl, U.S. fungal conservation emerged in the PNW and has converged with European fungal conservation over the last several years based on shared concerns of widespread ecological and anthropogenic degradation affecting fungi.

These epistemologies can also be examined based on what is missing. The above chain of events was based in the empirical evidence of mushroom harvesting and a market for wild edible fungi. Answers were sought to conservation oriented concerns through scientific inquiry. Yet local narratives and recognition of power relationships are almost completely absent in the literature reviewed here. The voices of harvesters, and the contributions they may be able to make in how we think about macrofungi, are noticeably absent. The next chapter continues to demonstrate this point by examining the institutionalization of fungal conservation through a review of the social history of fungal conservation discourse, and through observations of its active creation at four conferences in 2007.

Chapter 3: The Institutionalization of Fungal Conservation

3.1: Introduction: Conservation Discourses, Forests, and Fungi

Since the 2000s, conservation oriented mycological literature has focused on the social infrastructure necessary to support fungal conservation (Watling 2005; Moore et al. 2001; Hawksworth 2003). This is also apparent in the professional and government organizations that have become progressively more active in this time period (ECCF, MSA, Andalusian government). Fungi are increasingly considered objects of conservation through this process of institutionalization. These institutions in turn legitimate a specific approach to the conservation of fungi which is consistent with dominant conservation discourses.

Robbins (2004) synthesizes the recent critiques of conservation through what he calls the "Conservation and Control" argument: that dominant conservation discourses are forms of social control perpetrated by the powerful on the less powerful. This argument has four main components: (1) that conservation reflects a form of hegemonic governmentality; (2) that traditional resource management strategies are institutional systems that have been devalued; (3) that wilderness is a social construction, specifically taking the form of nature without people; and (4) that conservation occurring only within spatially bounded areas is ecologically and socially problematic. Political ecologists have written extensively about how conservation has led to the systematic disenfranchisement of local people throughout the global south (Goldman 2003; Schroeder 2000; Neumann 2004; Peluso 1993; Neumann 2000; West 2006). Within this framework, conservation is understood as a perpetuation of the separation between nature and society.

Scott (1998) explores the many ways science and modernity make nature legible in relation to society: for example by changing the symbolic meaning and use value of species, physically reorganizing (trees in) space, and reinterpreting nature through the use of statistics (cf. Agrawal 2005). Mitchell (2002) shows how the modernist project of dam building led to clearer separation of people from the environment in 1940s Egypt. His analysis draws specifically on the use of science in dam construction, but also on the ways the dam building project furthered the science itself. This new knowledge was produced in part through lectures, publications, and conference talks.

A significant side effect of this process was that "the farmers and local irrigation experts who had managed and maintained the earlier hydraulic system had much of their knowledge taken from them" (Scott 1998:37). Ultimately, Mitchell argues that the colonial production of science, and the power of technology meant to support infrastructural improvements, silenced local knowledges and further divided nature from society. Twentieth century floral and faunal conservation have proceeded in strikingly similar ways, where what is meant as a reaction to resource scarcity (Berkes and Turner 2006) or the need for greater environmental protection (Sutherland et al. 2009) may be practiced as social control, and result in environmental conflict. A brief review of the U.S. conservation movement shows long-standing emphases on resource utilization, scientific expertise, and state regulation.

In 1901, Gifford Pinchot wrote that conservation: 'demands the complete and orderly development of all our resources for the benefit of all …, but it [also] recognizes equally our obligation so to use what we need that our descendents shall not be deprived of what they need" (Johnston et al. 2000:106). Pinchot was an early participant in a discussion that has been playing out in the U.S. over the last century, where definitions of what needs to be conserved, why, and for whom, are highly contested (Cronon 1995). In the early 20th Century, conservation in the United States was not yet a broad social movement, but was an area of interest and concern for experts from many scientific disciplines ranging from forestry to hydrology.

During the rapid accumulation of land by the government in the early part of the 20th century, experts strongly influenced federal resource management policies, which became grounded in the applied science of resource utilization. After the dustbowls of the 1930s, soil protection and conservation became a major national issue (Nash 1990). This early conservation movement in the U.S. "was an effort on the part of leaders of science, technology and government to bring about more efficient *development* of physical resources" (Nash 1990:144). Natural resource management emerged as a field closely connected to "the scientific management of physical commodities and [one that] brought together technical specialists for a common purpose" (Nash 1990:148). In other words, natural resource management developed as a field emphasizing water for farming and urban settlement, soil for agricultural productivity, trees for timber, and wildlife as a recreational commodity.

In contrast to this focus on resource commodities, the environmental movement that emerged after the end of World War II emphasized the quality of the environment for improved quality of human lives. It was specifically focused on the protection and preservation, rather than utilization, of nature. Picking up on the work and writings of John Muir and Aldo Leopold, and the political battles they waged in the early and mid-

20th Century, this movement played out in national politics throughout the1960s and 1970s. The national zeitgeist shifted from use to protection.

During those decades several key federal environmental protection acts were passed, and environmentally focused government agencies founded. Legislative actions such as the creation of the National Wilderness Preserve System (1964), the passage of the National Environmental Policy Act (1970) and the creation of the Environmental Protection Agency (also in 1970) are just a few examples. In this same period, Greenpeace was organized (1969), the first “Earth Day” was celebrated (April 22, 1970), the League of Conservation Voters was formed (1972), and books such as *Silent Spring* by Rachel Carson (1962) and *Small is Beautiful* by E.F. Schumacher (1973) were published (Nash 1990).

For forests, the Multiple Use Sustained Yield Act of 1960 dictated that rather than focusing solely on timber production, the Forest Service was to actively manage all the resources in the national forests: timber, wildlife, range, water, and outdoor recreation. The National Forest Management Act (NFMA), passed in 1976, was meant to “provide a comprehensive blueprint for managing the national forests. Maintaining the earlier emphasis on outside experts, one of the NFMA's provisions was that the Secretary of Agriculture appoint a committee of scientists—*not officers or employees of the Forest Service*—to provide scientific advice and counsel on how to implement its intent” (Williams 2005:SF650/sec8.htm. Emphasis added). Ecosystem management became the dominant paradigm for the Forest Service in the 1990s and remains so today. The ecosystem approach attempts to delicately balance science, commodity extraction, and recreation. It is centered around the following tenets: (1) a focus on scientific research to better understand, maintain and protect ecosystems and natural diversity at multiple scales; (2) working collectively and adaptively across agencies in response to new information; and (3) understanding that humans are part of ecosystems, and therefore striving for humans and the land to exist together in balance across space and over time (Williams 2005).

Two major points are evident from this brief review of conservation and land management in the United States over the last 100 years. First, fungi are noticeably absent from this history. Two facts may contribute to why they were not singled out for conservation or management until relatively recently: (1) fungi were officially considered part of the plant kingdom until 1969 (Whittaker 1969), and (2) wild edible fungi only became visible as commodities in the 1980s (McLain 2008). In the previous chapter, I reviewed how fungi were made visible through the NTFP industry and through scientific research in the 1980s and 1990s. However, it is apparent that within the broader context of American conservation, they have remained relatively invisible.

Second, understandings of the forest and of human relationships with the forest have changed over time, as the emphasis has shifted increasingly onto scientific expertise and state management of resources *and* all human interactions with resources. Like in 1940s Egypt (Mitchell 2002) or 1930s India (Agrawal 2005), scientists and the state have become the legitimate voices for the accepted relationship between nature and society. Furthermore, in all three cases modernization and commodity extraction have played a significant role in resource development.

A series of hierarchical relationships emerge from this historical perspective, with capital driving science, and science dictating land management. Citizens are separated from the decision making processes affecting the land where they live, while others have become engaged in managing and speaking for land they often have never seen. As I suggested earlier, this is not a revelatory observation, and it is one that is almost axiomatic in political ecology (Robbins 2004), although often with an emphasis on the Global South. Specifically in relation to conservation, alternative approaches meant to include communities/stakeholders in decision making processes are also widespread at this point (Berkes and Turner 2006; Olsson, Folke, and Berkes 2004; Cestero and Belsky 2003; Kusel and Adler 2003; McCay 2001), although their efficacy is contested (Brosius and Russell 2003; McCarthy 2005). The focus has been on the empowerment of disenfranchised and indigenous people in the Global South, and work on resource users in the Global North is increasing (Schroeder 2005; Schroeder, St. Martin, and Albert 2006; Emery and Pierce 2005; St. Martin 2005, 2001).

Brosius and Russell (2003) are at once critical of contemporary conservation policy, and skeptical of its attempts to include communities through "shallow" social science research. They propose alternative approaches for more effective conservation practices. Rather than accepting a conservation approach that may be oversimplified in order to give it legibility, they propose a critical perspective that seeks to understand how the environment is constructed, represented, claimed and contested. This leads directly to the question of who is involved in these processes of environmental discourse formation.

Campbell (2007) argues that constructing discourse allows for the control of ideas, so the study of the powerful in the process of discourse creation is necessary to understand the theoretical landscape of fungal conservation. "Knowledge does not operate within a social void" (Hay 2005:174) and mycologists maintain the position of authoritative power to make assertions of what is true about fungi and their conservation. Textual analysis is an entry point for this discourse analysis, but "to understand discourses and their effects, it is imperative to understand the social contexts in which they arise" (Hay 2005:174) and are reproduced.

Therefore, this chapter begins with a review of the social history of fungal conservation through examination of the particular discursive structures in which mycologists are embedded, and how they participate in the creation and continuation of those structures. Then, based on participant observation at two European mycological conferences in 2007 and an American mycological conference in 2009, I report on the building momentum of how fungal conservation is being theorized in such a way as to connect to larger conservation discourses. If the close relationship between science and the state was apparent at sessions on IUCN guidelines, it was especially glaring at the 1st World Conference on the Sustainable Use and Conservation of Fungi, organized by the Adalusian regional government of Spain. The intense use of technology in molecular analysis and genetics research is also discussed because conservation policy remains closely tied to taxonomy and phylogenetic research. The destabilization of fungal taxonomy due to the molecular revolution thus has major implications for fungi.

3.2: The Institutionalization of Fungal Conservation

The field of fungal conservation originated in Europe in the 1980s, which puts the Europeans roughly 15-20 years ahead of their American counterparts. In both cases, there is only a small body of literature on this topic (see chapter 2 for a review of technical literature). Despite relatively few publications, significant efforts have been made over the last few decades to insert fungi into larger conversations on biodiversity conservation. Much of this activity has taken place within the context of mycological societies. These societies can be a bit confusing to tell apart because there are so many of them. David Minter, a senior mycologist at CABI and president of the European Mycological Association, explained to me that there are various international societies (e.g. European Mycological Association), continental societies (e.g. European Mycological Association, Mycological Society of America, which includes Canada and Mexico), national societies (e.g. British Mycological Association), and many local societies (e.g. Oregon Mycological Society, Mycological Association of Washington, D.C.). Some of these are government based, some are professional, some are learned societies, and others are comprised of amateurs. He believes that this pluralist approach is best so that societies can focus on specific topics. Many societies are strong in education and science, but not in conservation. As a result, he feels specific conservation associations are needed.

Mycologists in the UK, Scandinavia, Italy, Spain and Switzerland have been especially active in this regard over the last few decades. The European Council for the Conservation of Fungi (ECCF) was founded in 1985 in Oslo. This council, now situated within the European Mycological Association (EMA), aims to bring the conservation of fungi to the attention of government agencies, non-governmental organizations, politicians and mycologists; stimulate research; support the creation of red data lists of threatened fungi; and promote international cooperation for all of these activities (Anonymous 2006). In practice, the creation of red data lists following IUCN guidelines has become a central focus for many ECCF activities. Most recently, in 2004, the ECCF proposed protection for 33 species of fungi, which they recommended for addition to the

Convention on the Conservation of European Wildlife and Natural Habitats (Dahlberg, Genney, and Heilmann-Clausen 2009). [11]As of this writing, these species have not been added to the Convention.

In the early 1990s, mycologists working through the Species Survival Commission (SSC) at the World Conservation Union (IUCN) succeeded in establishing the Fungi Specialist Group. This was a significant achievement because mycologists see the IUCN as both powerful and "skilled at attracting the media's interest." In 2009, the SSC was divided into five specialty groups to more accurately reflect the diversity of fungi: Basidomycetes (mushrooms, puffballs, and relatives); Lichens; Mildews, Moulds and Myxomycetes; Non-Lichen-forming Ascomycetes; Rusts and Smuts (Anonymous 2009).

Amateur mycologists have a long history of participation in mycological societies, especially through the publication of species lists and reporting on local ecologies. Amateurs' emphasis on localized areas has contributed greatly to the field of mycology by providing information that was otherwise overlooked by professionals (Watling 1996). The membership in amateur societies may consist of both professional scientists and amateur mycologists. These societies are often regionally focused, or state based in the United States. In contrast, modern professional mycological societies are scholarly organizations with little inclusion of amateurs. They are usually nationally focused. Historically, there has been a lot of overlap and collaboration between amateur and professional societies, although one mycologist felt strongly that as professional mycology becomes increasingly lab based this overlap is becoming less common. The

[11] Also known as the Bern Convention, this significant legislation was originally adopted in 1979 by the United Nations Environment Program, and entered into force in 1982.

different nature of these types of associations is not always readily apparent based on their names. For example, the North American Mycological Association is the amateur mycological group in the United States, while the Mycological Society of America is the scholarly group.

Professional mycological societies have been very active in creating policy and appropriate use statements. The British and American Mycological Societies (professional groups) created a joint policy in 1995 outlining six specific goals for fungal conservation: (1) to conserve fungi and their habitats; (2) to encourage research on decline in fungal populations and diversity; (3) to promote a wider understanding of fungi through contributions to environmental education; (4) to provide information on fungal habitats, particularly those which may be threatened; (5) to encourage the development of standard methods for measuring and monitoring diversity of fungi; and (6) to train mycologists at all levels (Watling 1997). The BMS further created a 10 point policy on conservation in 1997, which "acknowledges the importance of edible wild fungi as a resource to be utilised, but accepts harvesting of such fungi only where it is non-threatening to the viability of fungal populations, and their associated organisms and habitats" (Anonymous 2008). The Dutch Mycological Society has a specific committee for Fungi and Nature Conservation, which supports the harvesting of fungi only for scientific, educational or identification purposes (Moore et al. 2001).

As momentum has built, fungal conservation has gradually gained traction, and new organizations have continued to form (Figure 3). Mycologists are essentially building their own infrastructure for conservation in association with global conservation organizations.

Recent Events in Fungal Conservation (Minter 2009)

- September 2007: Three prototype specialist committees were established [at the IUCN] for conservation of microfungi (Non-lichen-forming Ascomycetes; Rusts & Smuts; and Mildews, Moulds & Myxomycetes).
- November 2007: The *Sociedade Brasileira de Micologia* established a national fungal conservation group, perhaps the first in South America.
- December 2007: At an international meeting in Spain on sustainable use of fungi, over 150 mycologists from 35 countries published the Declaration of Córdoba, establishing global principles for fungal conservation.
- August 2008:[12] The *Mycological Society of America* established a continental-level fungal conservation group for North America.
- November 2008: The *Asociación Latino-Americana de Micología* established a working party to set up a continental-level fungal conservation group for South America.
- January 2009: The *African Mycological Association* established a continental-level fungal conservation group for Africa.
- February 2009" The *Species Survival Commission* of the IUCN formally recognized fungi as being fundamentally different from animals and plants and needing fully separate representation within the Commission's structure. The Commission also decided to increase the number of Specialist Groups representing fungi to five by adopting the prototype specialist committees described above.

Figure 3: Recent Events in Fungal Conservation

Conservation of fungi first received attention in the U.S. due to the creation and implementation of the Northwest Forest Plan (NWFP) in 1994. Species were selected for inclusion in the NWFP by three mycologists, who essentially sat down together and created a list of species they thought would be important to study based on their expert knowledge (Molina 2008). Under this plan, scientists adopted a "fine-filter" adaptive management strategy for fungal conservation. This included a survey approach that was the "largest, systematic targeted search for rare macrofungi in the USA (and perhaps the world) by way of number of species and area of coverage" (Molina 2008:10). In association with the NWFP, a 1994 conference devoted to the theme, "Ecosystem Management of Forest Fungi," led to the publication of inventory, monitoring and

[12] The 2008 date contrasts with my notes, which indicate that this committee was formed at the 2007 MSA meeting. I believe the 2007 date refers to when this was first approved as an idea. The 2008 date refers to when the committee was officially approved based on it being written into the bylaws of the organization.

biodiversity assessments for PNW fungi. These were among the earliest studies on fungal conservation in the U.S.

Fungal conservation is increasingly gaining momentum in the U.S., but there is, as yet, no organization in the United States or the Americas analogous to the ECCF. It is unlikely that such an organization will be independently created, and much more likely that conservation will remain a committee priority within the MSA. Although more recently involved in this area of research, American mycologists point out that European studies have shown the importance of old growth forests for fungal diversity and rare species habitat (Arnolds 2001), and they also note that there is more old growth and "virgin" habitat in the U.S. (Molina 2008).

The National American Mycological Association is the national amateur organization in the U.S. They have not been closely involved in any significant conservation activities. At the state level, the Oregon Mycological Society, an amateur society with many professional mycologists as members, has been actively engaging in research and management related questions for several years (McLain, Christensen, and Shannon 1998; Norvell 1995). The Mycological Society of America (MSA) approved an amendment to its bylaws to create a new council on fungal conservation in May 2008, which was submitted to the membership and passed.

3.3: Saving the Macromycetes: Emerging Models of Fungal Conservation

EMA Meeting: September, 2007

In September 2007, I attended the XV Congress of European Mycologists conference in St. Petersburg, Russia. This meeting occurs once every four years, and was the second official meeting of the European Mycological Association (EMA), which was established in September 2003 at the XIV Congress of European Mycologists. The EMA was established specifically to reach out to eastern European mycologists, who have apparently been marginalized over the years due to political barriers and lack of funding (D. Minter, personal communication 2007). The meeting was indeed heavily attended by eastern Europeans, while western Europeans were noticeably absent.[13] Exceptions to this were members of the ECCF, who were in attendance for their annual meeting. There were very few Americans at this conference. In practice, many of the American and western European mycologists seemed relatively calm and relaxed during most of the conference. They dressed professionally, but carried backpacks or simple notebooks. They were interested in attending the meeting, but also in sightseeing and field trips. Many eastern Europeans wore suits and carried briefcases. They seemed excited and anxious, and very attentive to the schedule.

Overall, the EMA conference was dominated by "pure science," although by some accounts science which was not very current. A Portuguese graduate student studying in the U.S. commented to me that many of these presentations were relatively elementary and would not meet the more rigorous standards of western European or American mycological research. Many presentations were, in her opinion, descriptive in nature and lacking in scientific rigor. Although there were 64 presentations listed in the program under the theme "Fungal diversity and conservation" there was only one full session devoted to fungal conservation specifically (significant observations from that

[13] According to one attendee, this was apparently due to the fact that the British Mycological Society (BMS) meeting was held the previous week, and that is the de facto western European conference.

session are reported on in section 3.4). The bulk of participant observation reported on here is from the ECCF meeting.

As mentioned previously, the ECCF came under the EMA in 2005. As an unfunded affiliation of scientists, the ECCF maintains its focus on demonstrating the diversity and significance of fungi, and on supporting the compilation of red data lists within each European country and for Europe as a whole. The ECCF meeting took place on Monday evening of the conference. This was a "public meeting" essentially for the purpose of updating attendees on status reports from different countries. Private meetings are apparently much longer, multi-day events, and more intensive. Representatives from at least 17 member countries were present, as was then MSA president, Greg Mueller, who was singled out and praised for attendance. The meeting included progress reports on national red lists, an update on the European Species Mapping project, a report from the most recent Planta Europa conference, and a discussion about terminology for the public.

At the meeting there was some heated discussion on the fact that not every country was following the IUCN red list criteria. It is widely accepted within the fungal conservation community that the IUCN criteria for red listing are highly problematic for fungi due to several challenges in assessing populations that are required criteria when creating red lists. These include defining mature individuals, assessing generation length, and identifying instances of population fragmentation (these issues are discussed further in chapter 5). This has created a divide between those who feel IUCN red lists are therefore meaningless for fungi, and those who feel they are the only avenue for fungi to gain equal footing in international conservation. The latter group dominates the ECCF, and they feel they must conform to the IUCN guidelines or else they will be “left behind” as conservation moves forward. Even so, this process of red listing has been ongoing for about 20 years. The current goal is the formalization of a European Red List for Fungi in 2010 (Anonymous 2007). This part of the meeting clearly demonstrates the desire of the ECCF and European mycologists to be active and present in global biodiversity conservation discourse.

Next was a review of the results of the ECCF project, “Mapping and monitoring of macromycetes in Europe,” prepared by André Fraiture (Belgium) and Peter Otto (Germany). Maps were generated based on questionnaires sent out to all members, and returned by representatives of 35 countries. Fifty rare species in Europe were selected for further analysis, and maps of their distribution were produced, a single map for each species. The maps were meant to demonstrate species occurrence in various countries before and after 1970. In so doing, they drew conclusions on the different species movement, dispersal and abundance, although no data on those aspects were specifically presented. My Portuguese friend commented to me at this point that because of this lack of data and explanation, these maps were relatively meaningless and did not represent “good science.” At the meeting, all of the maps were reviewed and commented upon. These maps represented the first output of a successful collaborative project organized by the ECCF at the European level, which pleased many meeting attendees. The maps are one of the three tools mycologists feel they have in furthering fungal conservation (Courtecuisse 2001). However, like with red lists, the emphasis on single species is problematic and contradictory due to an overall lack of data.

Finally, there was a return to what has clearly been an ongoing discussion about terminology, and whether to speak of "Fungi" or "the Mycota." Much of this discussion had clearly taken place previously, so this was primarily a final update. The consensus was to use the term "Fungi" as much as possible. Based on one member's conversations with a linguistics professor, there was a feeling that people would talk about flora, fauna and fungi more easily, "the rule of Fs." Again, the emphasis on connecting to other fields in biology and conservation was evident.

This discussion about how to reference fungi continued during the coffee breaks. Drs. Minter and Hawksworth are senior mycologists who have been active internationally for several decades. Dr. Minter was one of the driving forces behind the original creation of the EMA in order to encourage the inclusion of under-represented mycologists. He has been active in the promotion of Cuban mycology for this same reason, and has held several prominent positions over the years. He spoke to me of a "Flora and Faunaism" that is rampant in the biological community. Both men display palpable frustration that botanists claim representation for fungi, and the fact that mycological taxonomy is still managed under the International Code of Botanical Nomenclature was referred to as "catastrophic." Dr. Hawksworth will not publish in botanical journals or attend botanical meetings. Dr. Minter referenced his experiences that decision makers will ask botanists about fungi, and "because botanists don't really care, they'll say, sure they can talk about that. Then five years later when mycologists come along and say we need an International Biodiversity of Fungi plan, the government says, 'Oh, we have already dealt with that.'" As a result, he will not support any "biodiversity" plan, action, or board that does not include a mycologist, unless it's for something specific. Dr. Minter also feels strongly that conservation includes a political element - "you're not doing conservation if there's no political element" - and commented on the tension between habitat protection and the need for recognition of official endangered species. He informed me about the upcoming First World Conference on the Conservation and Sustainable Use of Wild Fungi, in December, and garnered me an official invitation.

Although the mood of certain attendees conveyed that research being presented was outdated, the EMA conference was centered on traditional scientific research areas of biology, ecology, and biotechnology. At the ECCF meeting, the strategy was to work towards a complete red data list for European Fungi to be used to support conservation strategies throughout Europe. This emphasis on pro-active research and reporting represents a divergence for conservation mycologists from the majority of other mycologists represented at the EMA meeting. However, this sentiment, the need to *act now*, is still couched in scientific rhetoric. Mycologists view political advocacy as separate. Dr. Minter actually suggested a new political organization to address the political and social elements of fungal conservation. The regional government of Andalusia, rather unintentionally based on several conversations, attempted to address this gap.

WORLDFUNGI: December, 2007

In December 2007, I attended the 1st World Conference on the Conservation and Sustainable Use of Wild Fungi (WorldFungi for short). As the name indicates, this was the first meeting of its kind, and originated not through the ECCF or the EMA or any other mycological association, but through the Regional Ministry of the Environment of

Andalusia, Spain. Many ECCF and IUCN mycologists were invited, but they were not centrally involved in the development or planning of this conference (A. Dahlberg personal communication 2007). This was a high profile event put on by the government, with hundreds of journalists there the first day. It was heavily subsidized by the EU as part of regional development for southern Spain. According to one conference attendee, this was the first fungal conservation conference she had attended where Americans were present, referencing the presence of PNW mycologists Randy Molina, Jim Trappe, Efrén Cazares, and others in the program and at the conference. This was intended to be a workshop of the world's best and brightest, those deemed relevant and important enough by the Scientific Committee to include in the development of a global plan for fungal conservation and sustainable use, plus everyone else who heard about it. ECCF mycologists commented to me that the amount of money spent, the amount of press generated, and the declaration created at the end of the week, were all bigger and showier than most of the mycologists in attendance were used to. This seemed to lead to some skepticism and doubt. Non-Spanish government participants seemed simultaneously pleased and confused at the goals of the conference, and its intended results.

Worldfungi was a relatively small conference centered on a set of plenary sessions. There were officially 550 participants. There were over 60 invited speakers from all over the world; the vast majority of whom were hand picked by the Scientific Committee who helped organize the conference. Participants took coffee breaks together, ate a two hour lunch together, and then reconvened for submitted papers and posters in the late afternoon. Special workshops were convened in the late afternoon as well that were technically by invitation only. There were also several evening events. Days were organized thematically. Monday was on Taxonomy; Tuesday was on Biodiversity and Conservation; Wednesday was on Sustainable Use and Exploitation; Thursday was on Truffle Growing; and Friday was on Legislation and Mycotourism.

WorldFungi grew out of Plan CUSSTA, which translates from Spanish as Plan for the Conservation and Sustainable Use of the Mushrooms and Truffles of Andalusia. A more in depth examination of the specific presentation on the CUSSTA plan in many ways exemplifies the entire conference. CUSSTA was the personal project of Baldomero Moreno Arroyo, now the Director of Plan CUSSTA, a mycologist, and, as one ECCF mycologist said to me, "a government man." The CUSSTA plan is a multilateral approach to fungal conservation including research, social involvement and environmental education, preservation, sustainable use, and regulation (Figure 4). As such, it ranges from the scientific to the regulatory aspects of use and protection of fungi. Dr. Arroyo's highly polished Wednesday morning presentation included very professional slides, videos, and a detailed overview of the entire plan. One video stated: "In Andalucía since 2001 we have seen a new kingdom coming into play…Now, the fungal kingdom will be treated at the same level as plants and animals." The following review is based on photographs of slides I took of his PowerPoint presentation.[14]

The CUSSTA plan was developed in response to environmental and social rationales. It relies heavily on market-based strategies as well as regulation, education, and research for sustainable use and conservation of fungi. There are eight environmental rationales for the plan. These can be summed up as an appreciation for Andalusian mushroom and truffle diversity and a desire to learn more about these little known

[14] I was originally highly skeptical of this type of documentation, which is not acceptable behavior at American conferences. However, at the EMA meeting and the WorldFungi meeting photographing slides was commonplace among attendees and so it did not seem overly intrusive.

species, the ecological importance of mushrooms and mycorrhizal plants, a "sustainable development paradigm," and observation of an overall decline of mushrooms and truffles in Europe. The social rationale of the CUSSTA plan is that "until 7 or 8 years ago Andalusia was mycophobic." Now, "mushrooms are of great interest for Andalusian society." This has had four significant consequences: "unregulated and chaotic use of mushrooms, increase in mushroom related poisoning, unregulated collection and marketing, and a legal gap." To address these issues requires research such as "inventory of species, inventory of areas where mushrooms and truffles are exploited, studies on the productivity of species with economic interest, culture and mycorrhization techniques, and toxicological and bromatological studies."[15] It is meant to contribute to species preservation efforts such as the creation of a red data list for Andalusia and the creation of mushroom reserve areas. However, it is interesting to note that all of these areas of research, except species inventory, are directly related to human use and exploitation.

In Plan CUSSTA, sustainable use has seven tenets: regulation of outdoor and recreation activities, regulation of exploitation of mushrooms and truffles, appreciation of the grounds where mushrooms and truffles grow naturally, certification of quality (Natural Park mark and Organic Growing mark, i.e. branding), fostering plantations of truffles and mushrooms on natural grounds, creation of mycological wholesale markets, and development of a mycotourism program (Figure 4). Parks will be created that are intended for education, and for income generation through tourism. Government regulations for use will be based on: "technical/scientific criteria" and have a "high degree of consensus and involvement."

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[15] Bromatological studies are a type of chemical analysis that assesses food quality. It is an analytical method for separation, identification and quantification of proteins in foods.

Figure 4: Slides from B.M. Arroyo Presentation. From top: Overall plan for CUSSTA Program; proposed mycoparks; existing wholesale market.

Government operated and managed wholesale markets are meant to replace commonplace informal exchanges like selling wild mushrooms out of the back of the truck, or back door sales at restaurants. Instead, harvesters come to the marketplace. In order to sell wild mushrooms, harvesters must demonstrate their knowledge of wild edible fungi and be approved by official government agents as sellers. Their harvests remain subject to approval by government agents at the marketplace who are trained to distinguish edible from poisonous mushrooms. At this time the government is not charging for this service or collecting any of the sale, only regulating the transaction. However, a presentation later in the day heavily emphasized the tax revenues available precisely at this moment of government managed exchange.

While the CUSSTA plan has many environmental rationales, an in-depth examination of the components of the plan indicates that it is in direct response to perceived social “problems” and maintains an emphasis on economic development. The research proposed under CUSSTA is intended to inventory species, but focuses specifically on finding those species for inventory that occur in areas where mushrooms and truffles are being harvested. Species of economic interest are the focus for ecological and chemical research. Similarly, brief attention is given to preservation, but extensive plans are underway for building infrastructure around sustainable use. These structural improvements are explicitly to control “chaotic” use, to protect the public from mushroom poisoning, to protect the environment from unregulated collection, and protect the economy from unregulated marketing.

This government program is especially interesting in comparison with U.S. Forest Service responses to harvesting activities. In the PNW, the response to harvesting and resource utilization was increased research and regulation under the auspices of proper ecosystem management. In Andalusia, the response to increased social interest in mushrooms and harvesting is also related to ecosystem management, but is decidedly more focused on resource exploitation and economic development. The PNW response is consistent with the social emphasis on environmental protection through integrated ecosystem management that dominates U.S. land management today. The Spanish plan is particularly interesting because it juxtaposes global emphases on sustainability and conservation with a pre-1960s desire for active resource utilization (section 3.1).

Scientific research and scientists themselves are at the heart of these discussions. Accordingly, the sessions on taxonomy emphasized species of economic interest and technologies for improved documentation. Mycologists view molecular and genetic analysis as a tool for taxonomy, morphology and ecological research, to find answers to questions on conservation and sustainability. However, the amount of information being generated is so vast that it is difficult to determine how it is being used to productively address these issues.

Even estimating the magnitude of what more there is to learn, and who will do it, is time consuming. Dr. Hawksworth started the day on taxonomy by estimating that there were approximately 1.5 million fungal species, with a minimum of 710,000 species (Hawksworth 2001). According to these figures, roughly 13% of species have now been named. In his lecture he presented specific details on European and British species delineation. By his estimates, less than 50% of the species in Europe have been named, and this is where the most research is occurring. In countries leading the research effort, like Spain, UK, Italy, and the Czech Republic, they are still discovering new species of

Cortinarius and *Boletus*, two of the largest and most significant fungal genera. This would be analogous to commonly discovering new species of bears or oak trees for zoology or botany taxonomists. In Surrey, England, a long-term study has identified 3,282 species at one field site which is "ecologically insignificant."[16]

Because of increased attention to genetics and micro-characteristics (like cell shape as seen through an electron microscope), the species concept is unstable and this has led to further problems for taxonomists.[17] For Dr. Hawksworth, this is a problem that is secondary to the intense need for taxonomists, technicians, reference collections, collaboration between specialists, publications, and financial resources. Based on his recent analysis, there is only a small group of people currently naming the majority of new species, and they are rapidly retiring or dying.

At the same time, massive collaborations like "Assembling the Fungal Tree of Life" project (www.aftol.org), the "Deep Hypha" Project (now part of AFTOL), and "Index Fungorum" (www.indexfungorum.org) are bringing mycologists together at this critical time to "reconcile disparate morphologies," revise Friesian taxonomy, and make this information available to any mycologists that have an internet connection.[18]

Index Fungorum, for example, is a massive database managed by Paul Kirk. The original online database contained 32,000 species names. Now, with better technology and collaboration, the Index trolls through the literature online, "captures" new names, and compiles them. The new list is sold every six months to subscribers. Through it,

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[16] In this case, "ecologically insignificant" means that there is nothing particularly interesting or special about this field site as an ecologically unique or highly valued environment.

[17] This point is further developed in chapter 4 specifically in relation to species in the genus *Morchella*.

[18] These projects represent major collaborations among mycologists working on fungal evolutionary biology and phylogenetics including databases and tools for assessment. These projects aim to catalogue species and delineate taxonomic relationships based on evolutionary biological principals.

mycologists are producing a digital library of systematic mycology, a consensus taxonomy resulting from the literature, which is also open to contributions. The library currently includes roughly 40% of known species.

The power of these new technologies is extensive, but they are also expensive, and this is creating a divide within mycology. Jorinde Nuytink, from Belgium, presented on taxonomic controversies within the Russalales, and specifically on *Lactarius* phylogeny. Through microscopy, ecological and molecular work, she determined that there are 10 European species of *Lactarius*, and that these species are endemic to Europe. This is of major interest because the species *L. deliciosa* (a very popular edible) has been previously described in China and North America, and her work shows that these are in fact other species that need to be re-named.

Nuytink's presentation was followed by Kanad Das, of India. He also presented on the taxonomy of the *Lactarius* and *Russula* genera in India. His work was based on extremely detailed hand drawings of macroscopic and microscopic morphological traits, and included observations on phenology. He presented his work as "classical mycology" and commented that "taxonomy is the satisfaction of one's ego, hence consideration of parameters vary from one taxonomist to another." He advocated for collaboration between molecular and classical approaches. Controversy erupted after this talk. It was the only talk that day where the speaker was put on the defensive about his work, and the mycologists in the audience seriously questioned the validity of his research. The previous talk, on the same genera, was very well received. There was intense discussion about his parameters, and he admitted that even missing a few observations can result in misclassification.

I make two observations about this series of events. First, mycologists without access to new technologies are increasingly marginalized. Without the funding and the facilities for molecular analyses, Das's extremely detailed work was invalidated. This is similar to the challenges faced by eastern European mycologists that were present at the EMA meeting, who had comparatively little funding and institutional support in relation to their western European and American colleagues. As a result, their work was considered "outdated" and "descriptive." Second, senior mycologists "grew up" academically in the time before molecular analysis. Genetic research relies heavily on machines and technologies that must be learned separate from the field of mycology. Whole new vocabularies are necessary. For example, the presentation following Das's was by Ursula Eberhardt from Sweden on the prospects for DNA barcoding.[19] Dr. Eberhardt pointed out, and many mycologists agree, that DNA barcoding "is very hot right now." This was followed by a series of slides with images of chromosomes, and phylogenetic trees with hundreds of species. The final image was of a young, blonde, white woman in a field with a plant in one hand and a small electronic device in the other, demonstrating that she would be able to identify this plant in seconds by removing a piece of its tissue and placing it in the device, where it would find the DNA barcode and identify the specimen. This presentation was very well received. This line of research is exciting and interesting, but also a bit intimidating. I observed a generational divide among mycologists vis-à-vis the power and increasing domination of genetic research. The reaction to Das's work was critical about his lack of molecular data to be sure, but there was also intense discussion about these drawings and the morphological

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[19] A DNA barcode is a short gene sequence taken from a standardized and easily amplifiable part of the genome, so that it can be found in all species.

characteristics he had selected. Senior mycologists deeply understood this type of taxonomic research, which they have been practicing for decades, and their comments may have simply reflected the comfort they felt with this type of analysis and their own abilities to critique it.

Following the day on taxonomy, the rest of the week was clearly dedicated to more socioeconomic and regulatory issues related to macro-fungi. The fact that these were the primary concerns of Dr. Arroyo became increasingly apparent. As the conference drew to a close, there was some concern that there be a final product of the 1st World Conference to specifically address fungal conservation. Dr. Minter apparently convinced Dr. Arroyo that there was a need for some type of significant statement or declaration to demonstrate the success of the event, and Drs. Minter, Molina, and Dahlberg were tasked with helping Dr. Arroyo draft a consensus document in one day to be presented during closing remarks. The result, "Fungi of the Earth: Declaration of Cordoba 2007" is six pages long. It begins with the following statement:

> This is a message aimed at all the inhabitants of the Earth; a message for the present and for the future in an attempt to learn from the past; a message that endeavours to promote activities and policies that assume responsibility for our collective future, and that preserve the unique and essential values for life on Earth that the Fungi Kingdom has to offer (Arroyo et al. 2008:3)

It is all encompassing in its scientific, political, and economic scope, speaks for all attendees of the conference in a unified voice, and establishes that a conference of this nature should be held once every four years (Arroyo et al. 2008).

The WorldFungi conference connected conservation to economic development, some said at the expense of science. I overheard several comments, especially from graduate student attendees, that they were not impressed by the scientific presentations.

At the WorldFungi conference the majority of sessions focused on political issues of access, regulation, and market-based strategies for conservation. Even the full day on taxonomy centered around delineating the taxonomic relationships of economically valuable species, species which were noticeably absent from the EMA presentations. Opening remarks specified that this conference demonstrated how the mycological world was having an impact, by bringing together the corporate world and people that are interested in hunting and eating fungi.[20] I found this comment especially interesting since I did not meet or observe anyone at the conference who was attending specifically as a mushroom hunter. The opening remarks concluded with a comment that increased attention to mushroom hunting necessitated regulations and rules for sustainable harvesting, and a technique to assess economic value of fungi. The financial significance of the conference was underscored by the end of the movie that looped between sessions: a Euro coin bouncing from mushroom to mushroom in a circle, turning the mushrooms into the stars of the EU flag.

MSA Meeting: July, 2009

Conservation has been gaining momentum within the Mycological Society of America (MSA) since Greg Mueller's attendance at the ECCF/EMA meeting in September, 2007.[21] This year's MSA meeting was a joint conference with the American Bryological and Lichenological Society, the American Fern Society, the American Association of Plant Taxonomists, and the Botanical Society of America. The increased

[20] Jesús Peinado Álvarez, Thematic session on Legislation and Mycotourism, December 14, 2007.
[21] Over the last few years, Dr. Mueller has become heavily involved in conservation activities, and is now the chair of the basidiomycetes and puffballs SSC group of the IUCN. I often observed him in intense conversation with Anders Dahlberg throughout the MSA meeting.

size of the overall conference influenced the division of sessions. There were two specific sessions devoted to fungal conservation. These were a workshop led by Dr. Dahlberg on "Evaluating Conservation Status of Fungi Using IUCN Criteria," and the "Conservation Biology of Fungi" session organized by Dr. Anne Pringle of Harvard University. Details on the symposium are below. Details on the workshop are discussed in chapter 5.

The symposium took place on the second to last day of the conference. It was in a very large room, and there were at least 100 people in attendance. Of note were Tom Volk, a major advocate for amateur mycology; Lorelei Norvell, well known for the OMS study on harvesting impacts; Randy Molina, Greg Mueller, Anders Dahlberg, Roy Holling, recent president of MSA; and various additional speakers. Dr. Pringle gave an introduction where she discussed the serious lack of data relevant to fungal conservation, and enumerated a number of threats to biodiversity. She then petitioned the audience for submissions to an upcoming issue of *Fungal Ecology* devoted to conservation biology of fungi. This last point is interesting because in conversations with Randy Molina, he shared with me that he had tried to organize a special issue of the journal *Conservation Biology*, with a focus on fungal conservation, but that the editors had not been very interested.

Dr. Pringle gave the floor to Mike Castellano, the sitting chair of the MSA Fungal Conservation Committee. He noted the history of this committee, which was initiated by the British mycologist, David Minter, at the 2007 meeting and originally chaired by Greg Mueller. The committee is now in the process of drafting a mission statement, which will emphasize biodiversity, education, international coordination, and liaising with amateurs, with the hope of accomplishing these goals in conjunction with other MSA committees.

Practically, these goals translate into three main objectives. The first is the need for a massive education and communication campaign about fungal taxa diversity. They want to "get the public eye through a good marketing campaign." This, he suggested, could be accomplished through an online presence; pamphlets; posters; fact sheets for primary, secondary and higher education; materials for decision makers; social consciousness organizations; and land managers. The second major issue for the committee would be to collect data to assess the threatened status of species. He argued that the number of species currently estimated as threatened is probably drastically low. "In North America we do not do a good job of documenting species in distress." For this, the committee would like to coordinate with the NAMA, with local amateur societies nationwide, and with FungiMap for methodologies (Australia based). Finally, Dr. Castellano suggested that it might be possible to "get a better handle of the data" by coordinating data storage and cataloguing among mycologists.

Next, Randy Molina led an open discussion for about 20 minutes about what attendees felt the priorities should be for American fungal conservation moving forward. Comments during this time included a reference to the work of Paul Ehrlich (author of the 1969 book, *The Population Bomb*), on the short timeline for intervention, and on the need for communication. Mycologists are interested in finding fungal biodiversity hotspots and working in world heritage sites to document the fungal presence there. The politics of teaching mycology in schools, of influencing decision makers, and communicating mycology to the public were all discussed, as were interest in fungi as edibles, medicinals, and cultural values. Greg Mueller pointed out that "we need a research agenda to provide tools so that after we convince people that this is important, we can give them tools to work on it.” Tom Volk reminded everyone “that there are thousands of amateurs in mycology and we can get help from them.”

The rest of the session was somewhat de rigueur for any organized discussion of fungal conservation at this point. In other words, the emphasis on experts, government regulations, and global conservation discourses were clear. Greg Mueller presented on the value and significance of IUCN red lists, including slides and information from Dr. Dahlberg’s workshop from earlier in the week. The take home message was that the IUCN does not require complete data sets, only expert extrapolation. He reviewed the recent research demonstrating that, in contrast to earlier theories, fungal groups are biogeographically discrete. He commented that at this point, there are only three fungal species on the global Red List, two of which are lichens. There are 60-70 species on federal agency lists in the PNW. There are no fungal species in the Environmental Species Act. David Roberts presented on lessons from plant conservation for fungi and mycologists. Randy Molina presented on how to protect and conserve rare species (Raphael and Molina 2007), and what researchers have done in the PNW (Molina 2008). He focused on the importance of expert knowledge, and the need for research to be driven by conservation oriented questions rather than available tools (i.e. genetic analysis). Anders Dahlberg presented an overview of ECCF/European activities in fungal conservation, and challenged the audience to consider whether mycologists should be developing their own conservation agenda, or joining with others in conservation in order to present a unified voice to decision makers. At the end of his talk he pointed out the importance of coordinating with amateurs: “They do a lot of evaluating based on ecological knowledge of species and indirect development of specific habitat ideas over time." As long as you specify your methods, he stated, this is an acceptable way to collect data. The emphasis in this talk was on acquiring data, and processing it in such a way to make it accessible for decision makers.

In conversation with David Minter at the EMA meeting we chatted about a session he had organized at the 2007 MSA meeting the previous August. The topic was the Rio Declaration on Environment and Development from the UN conference in Rio de Janeiro in 1992; "What has the Rio Convention done for fungi?" He pointed out to me that the U.S. has been isolated in global conservation because of its lack of participation in the Rio Convention. Other countries not in Rio, he commented, were Vatican City, Andorra, Somalia, and Iraq. He organized the session such that attendees from "Rio countries" had to speak politely about the state of fungal conservation in the U.S., but could "trash" Rio, while American attendees had to be polite about Rio, but could "trash" the U.S. (which apparently no one did). The end result, in his opinion, was that mycology has faired "terribly" in both Rio and non-Rio places.

For Dr. Minter, this non-participation in the Rio Convention served to illustrate how the U.S. has severely isolated itself in terms of global conservation. He mentioned to me later that he believes this is in part because the country is "like a continent" in size and ecological diversity, but that as a result we know little about much about the rest of the world. Although this conversation occurred at the EMA meeting, I include it here because it is consistent with my observations at the 2009 MSA meeting. The majority of MSA sessions were broadly focused on ecological and evolutionary aspects of mycology. American mycologists discover new species, and work on taxonomy and basic biology, but these aspects of mycological research and discovery are almost always connected back to elucidating ecological and evolutionary relationships. In this respect, American mycology is focused on the cellular/microcellular scale and the landscape/ecosystem scale, but not on the individual scale. As evidenced at the EMA meeting, It is precisely at this individual scale, in this case in terms of individual species, that European conservation is focused. Recognizing the scalar politics of continental conservation movements yields insight into tension points in international fungal conservation.

Fungal Conservation: Science, Infrastructure, and Politics: October, 2009

Most recently, a meeting co-sponsored by the IUCN, the UK Darwin Initiative, and the ECCF/EMA was held in Whitby, North Yorkshire, UK. The purpose of the meeting was to formalize the global infrastructure of fungal conservation. The title of the conference was: “Fungal Conservation: Science, Infrastructure and Politics.” This conference was organized by the ECCF, the IUCN, and the UK Darwin Initiative (Dr. Minter holds a significant position in this organization and he was the head of the organizing committee for this conference). The program on the website listed presentations predominately by ECCF members; the only American was Dr. Mueller. Although I was not able to attend the meeting, the main page of the conference website highlighted the meeting objectives (Figure 5). These objectives clearly state the current priorities for fungal conservation that I observed at the ECCF meeting and through conversations with Dr. Minter: a focus on status updates from various countries regarding fungal conservation, emphasis on coordinating with conservation strategies utilized for other organisms (plants and animals), and a desire to develop infrastructural and political elements to the fungal conservation agenda to expand its scope and significance.

The objective of the present meeting is to bring people interested in fungal conservation up to date with recent developments. Representatives from the five IUCN Specialist Groups and from continental-level and national fungal conservation groups will be involved, but anyone with a genuine interest in promoting fungal conservation is also welcome to participate. The programme will address three important aspects of conservation - science, infrastructure and politics - and will aim to:

- review scientific developments relevant to fungal conservation;
- compare and contrast the conservation infrastructure for other groups of organisms with that available for fungi, identifying important elements currently missing from the movement for fungal conservation;
- become familiar with courses of political action used by conservationists working with other groups of organisms, and determine which might also be appropriate for fungal conservation;
- debate and, if possible, agree on strategies and actions to develop missing infrastructures and implement appropriate political actions (Minter 2009).

Figure 5: Objectives for Global Fungal Conservation

3.4: Conclusion: Getting a Seat at the Table

Fungal conservation, like forestry, revolves around the relationships between scientific expertise, state management, capital, and regulating human interactions with mushrooms (Scott 1998; Agrawal 2005). However, the relationship amongst these components varies in different contexts. Institutions are emerging along two separate paths, one primarily centered on scientific agency, and the other around sustainable economic growth using these “new” natural resources. The EMA meeting focused on classical scientific approaches to conservation, whereas the WorldFungi meeting was organized around sociopolitical and economic aspects of conservation. Conservation sessions at the MSA meeting, and the entire October 2009 conference, focused heavily on raising the profile and organizing efforts in fungal conservation, per se.

The number one priority of the ECCF is species inventory. From these inventories red lists may be developed. These lists are the basis for connecting with the international conservation biology community, to aid in building the necessary infrastructure for fungal conservation. Species inventory also assists in furthering "the biodiversity argument," that conserving fungi is important because it contributes to documenting the ever expanding number of species. Species inventory is something that only mycologists can do; they have the expertise and the technologies. However, those expertise are at times contested and the *right* technology is not always available because of financial constraints. Building on existing institutional structures of the ECCF and IUCN committees, scientific European fungal conservation is now turning to infrastructural development and political strategy, but always with the preservation of biodiversity and the stability of the global environment as the underlying motivations.

American fungal conservation, through the MSA, is less concerned with species inventory and more concerned with ecological stability. Yet simultaneously, because of available resources and technologies, molecular work in the U.S. is widespread. In this respect, with different aims, both Europeans and Americans maintain a focus on delineating evolutionary relationships and therefore on naming species. It is how this information is used that differs. Drs. Mueller and Dahlberg spoke in detail about IUCN red lists and the need for participation in the international conservation community. American mycologists are more concerned about defining habitat and elucidating ecological relationships because American conservation is based on an American social-historical understanding of nature (Cronon 1995). It is about ecosystem management and protecting wilderness. American fungal conservation is developing a similar focus by emphasizing the landscape and ecosystem scale in fungal research. European conservation is more closely tied to international accords like the Rio Convention or the IUCN. These systems, especially the IUCN red lists, emphasize the protection of individual species because they were established specifically to protect "warm and fuzzy" mammal species, often considered to be keystone species in their environments.

These strategies are also affected by how citizens are perceived by scientists and managers in relation to the environment. In contrast to the mycophilic history of many European countries, mushroom hunting and eating has been popularized in the U.S. only since the 1980s. American mycologists, unlike their European counterparts, are not readily aware of any level of widespread traditional harvesting in the U.S. Rather, they tend to perceive hunters primarily as amateurs, recreationalists, or commercial hunters. This has direct effects on their conservation strategies because they are less likely to recognize the cultural significance and social value of mushroom hunting to local peoples throughout the U.S.

The CUSSTA program is clearly developing with a different focus. As outlined above, the imagery, the language, and the emphasis in this government program is on economic development. Through the regulation of harvesting and sales, and simultaneous mycotourism development, this Spanish program goes well beyond the U.S. Forest Service in its view of fungi as commodities. It is *proactively* developing diverse market strategies centered around wild edible mushrooms, and using conservation and sustainability rhetoric as the backdrop. This seems almost anathema to conservation science: this neoliberal approach to fungi that places the market, rather than the preservation of the earth's biodiversity, at the center of conservation. However, biodiversity conservation has been critiqued for doing just that and not acknowledging it (Mansfield 2003; Heynen et al. 2007). In his paper about western riparian resource conflicts, Crifasi (2007) argues that "the production of nature through the naming of species… highlights how the taxonomic process of describing an animal is a power-laden endeavor with significant economic and social consequences" (p. 512). This implicates taxonomists in conservation politics in a way that those involved in ECCF and MSA activities did not openly discuss or recognize at the conferences.[22] Yet, economic sentiments pervaded these conferences as well, to some degree. The following quote, excerpted from a talk given at the EMA meeting sums up this position, and identifies two key ways in which mycologists hope to make inroads for fungi in conservation:

> "One of the important messages I aim to deliver today is *what is not seen does not exist*. *We mycologists [should be] speaking on equal terms, as people in charge, as those interested in animals or lesser plants*. And the other thing that we need to be aware of is that *fungi could be one of several players in the conservation business*. We need to phrase that in a way that's similar to other conservation organizations because the decision makers and politicians can't handle too many groups of organisms. They handle biodiversity, so *they need a comparable view of different groups of organisms*." Anders Dahlberg, (then) President of the Fungi Specialist Group of the IUCN. "Conservation of Macrofungi in Europe: Progress and Challenges." September 26, 2007; emphasis added).

From this quote, it becomes apparent that mycologists view fungi, and themselves, in a weaker position in relation to other biologists in larger conservation discourses. It is striking how aware mycologists are of their position vis-à-vis other biological sciences, and this was apparent at all the conferences. As specified at the October 2009 ECCF/UK/IUCN conference, a goal for fungal conservationists is to "become familiar with courses of political action used by conservationists" (Minter 2009). Integrating neoliberal economic and political policies is consistent with this goal. Perhaps because of this, while the WorldFungi conference may not have been the separate committee that David Minter and ECCF members might have developed themselves, they did support it.

[22] In the case of mycology, most mycologists are involved to some degree in taxonomy simply because they discover/name new species in their work very frequently.

Turning now to the second idea highlighted in the quote: fungi are at a disadvantage because they are often not visible. They are decidedly not cute or furry (in the "good" way). Mycologists often comment that although fungi are a massive and integral part of the forest, they do not garner the attention of those in charge or even of other scientists. Mycologists want to be on equal terms, and they have identified two main ways to do this: by becoming a "player in the conservation business," and by making fungi easily comparable to other organisms. This second idea positions scientists specifically as actors engaging in decisions about how to represent fungi to the world.

In his essay "Socializing Nature," Castree challenges us: "The question…up for discussion is a crucial and profound one: what kinds of nature – or more properly natures, in the plural – do we want for what kind of future?" (Castree 2001:19). I observed Anders Dahlberg present on ECCF activities and fungal conservation at the EMA meeting, WorldFungi and the MSA meeting. He started all of his presentations with similar sentiments: We need to ask ourselves, why do we want to conserve fungi? Is it necessary? What future do we want for ourselves? The lack of systematic data and the lack of scientific consensus consistently resulted in Dr. Dahlberg acknowledging the social nature of conservation. He called on mycologists to exercise their unique power *as scientists*, to build a more powerful discourse. This sentiment is echoed in his recent publication: "the quantitative focus on high species richness in mycological science should be replaced by a more qualitative and ecologically oriented consideration of the conservation value of species and guilds of fungi" (Dahlberg et al. 2009:12). This privileging of scientific knowledge is consistent with floral and faunal conservation discourse, and it is precisely the power of those discourses that European and American mycologists are drawing on to increase the legitimacy of their own endeavors. The WorldFungi conference also relied heavily on linking its socio-economic and regulatory aims to scientific claims for conservation.

This is not necessarily to the exclusion of the knowledge of others. There are some examples, at the national level, of strategies that have been developed to work with land owners, land managers, and harvesters. Collaborative work between amateurs and government scientists in the PNW is reviewed in detail in chapter 2 (McLain, Christensen, and Shannon 1998; Norvell 1995). Direct outreach in Scotland, led by mycologist Roy Watling, has focused on fungal awareness, research, management and conservation. At the Dawyck National Botanical Gardens there is a cryptogamic sanctuary and reserve. They have published a series of pamphlets for wide distribution to land managers, land owners, and mushroom hunters. These pamphlets have been developed for amateurs, commercial harvesters, land managers, land owners, and mycologists, by the "Scottish Wild Mushroom Forum, a group consisting of representatives of conservation organizations, landowners, public land owning bodies, mushroom buyers, and mushroom packers" (Dyke 2001:221).

The second example comes from Sweden, where they have developed an interactive mapping project, called "The Species Gateway," to map sitings of all species (animals, plants, and fungi) nationwide. Anyone in the country can upload to this database, and is encouraged to use it; scientists are required to use it. Similar interactive mapping projects exist in New Zealand and a few other countries (A. Dahlberg, personal communication 2007). These activities represent active engagement with a broad range of people interested and invested in fungi, although they are controlled by mycologists.

Mycologists are not trying to actively exclude laypeople, but these people were not present at the conferences I attended. The conferences are the domains of the experts, where their science is practiced, and their scientific practices are exchanged, debated, and legitimated. Anders Dahlberg has stated that he believes mycologists are the ones hindering fungal conservation because of their concerns over lack of data. At conference sessions, uncertainties are recognized, and there is a shared understanding that such uncertainties are a normal part of *doing* science. Moving outward from those moments, however, authoritative accounts of the physical environment and related economic processes are communicated to the outside world. Red lists, declarations, education campaigns, these tools present consensus and a decisive need for protection. In this discursive space it is not the active exclusion of laypeople, but *the indirect dismissal of the depth of their potential contributions*, that is being practiced. The second half of this dissertation explores why this is the case, what effects this is having, and what possibilities still exist for making space for others in the fungal conservation community.

Chapter 4: Unstable Ontologies and Situated Knowledges

4.1: Introduction: Situating Knowledge

In this chapter I seek to further understand fungal conservation by asking: when harvesters, managers, and mycologists talk about conserving morels, what do they think they are talking about? The epistemic constructions of fungi outlined in the second chapter assume a firm ontology: morels exist as individual natural objects. An apolitical understanding of morels differentiates them from other fungi by focusing exclusively on biological characteristics for the process of naming. This makes particular framings related to strategies for protection and economic practice possible. As I explore in this chapter, however, the process of naming is in fact neither apolitical nor stable.

Approaching morels as constituted by how they exist in the environment *and* how different stakeholders understand them, brings cultural practices and discourse to the foreground as subjects of analysis. By deconstructing the social processes of demarcation and naming within each stakeholder group, it becomes clear that the groups have different epistemological constructions of morels. 'Denaturalizing' the morels positions them as “social products arising in particular contexts and serving specific social or ecological ends that ought to be questioned" (Castree 2001:13). Scientists understand and categorize morels specifically in relation to other fungi, and based on observations that are only available through the technology of molecular biology. As I explored in the last chapter about the debate over membership in the *Lactarius* genus, the current state of mycology means that in situ observations and gross, or even microscopic, morphological characteristics are no longer sufficient ways to know fungi. Harvesters, in contrast, categorize morels solely based on observations in the environment. For harvesters, morels exist visually as individual objects, physically as food, and emotionally as a representation of spring and connection to family and place. Harvesters are not concerned with morels' relationship with other fungi or with the environment, beyond identifying environmental clues to signal morel locations. Managers have developed the least unique morel ontology, but their epistemology may be the most influential on the landscape. Through management practices, nature is constantly being reconstituted. How morels, and other fungi are understood to exist biologically, ecologically, economically, and culturally directly informs management practice, and those practices in turn affect these processes.

Stakeholders' differing epistemologies of morels are the basis for their morel discourses and conservation practices. Braun paraphrases a relevant passage from Derrida (1976), "there is no place *outside* such cultural practices from which nature can be objectively known. Even when our relation to nature seems most immediate, it is profoundly shaped by the narratives, knowledges, and technologies that enable experience" (Braun 2002:15). As I explain in the next section of this chapter, the narratives through which each group constitutes the identities of the morels fundamentally informs the ontological position of that group. These narratives are strongly shaped by performative limits and boundaries, the mechanisms of knowledge transfer, and available technologies. Exploring these cultural, social, and political practices is the process of "socializing the morel," moving away from naturalized narratives that silence alternative understandings (Slater 2001).

Critical geographers engaging in scholarship to socialize the natural "insist that states and bureaucracies, [as well as] their ecocentric critics must all acknowledge nature's sociality from the very start, if adequate measures are to be developed over everything from deforestation to the patenting of life forms" (Castree 2001:18). This research includes work from science and technology studies meant to socialize the process and practice of science (Latour 1988; Whatmore 2002) and a theoretical reframing of Nature as socially constructed, which often takes the form of critiquing apolitical approaches to Nature (Braun 2002; Castree 2001; Haraway 1991). I utilize the social construction of nature critique to conceptualize morels as subjects of discourse, and to demonstrate the ways in which models of fungal conservation become differentiated. This is significant for two reasons. The first is to show that there are indeed multiple models of fungal conservation. Second, once the models are differentiated, hierarchical power relationships among models become more apparent.

Castree (2001) outlines three components of the concept of "social nature." The first is how we know nature/morels. If we understand morels as socially constructed, it follows that there is no singular objective knowledge of morels, only particular, socially constituted, *partial* knowledges. Produced out of a series of social interactions over time, knowledge about morels is a social product, an expression of social power relations with material effects. Understanding how each group has historically constituted its understanding of morels becomes the foundation for each group's emerging model of fungal conservation (Haraway 1991).

Second, claims about nature are discursively mediated, they are discourses of nature. Castree (2001) points out that different individuals or groups use different discourses to make sense of the same nature. These discourses do not reveal or hide the truths of nature but, rather, create their own truths. For example, an understanding of fungi as organisms identified based on their DNA leads to a very different truth than that of fungi as free food from the wild. Neither of these positions is inherently more valuable or valid than another, but they have their own set of consequences, and are perceived, appropriated, and wielded quite differently.

Finally, societies engage in physically reconstituting nature, 'producing' nature for specific purposes, whether industrial, scientific or wilderness. Morels are affected through peoples' understanding of them and interactions with them. In section 4.2, these different ontologies and resultant epistemologies are explored for each of the three stakeholder groups. Acknowledging the sociality of morel ontologies reveals alternative ecologically relevant knowledge. It presents an opportunity for ethical engagement with the processes of knowledge formation: "The question it opens up for discussion is a crucial and profound one: what kinds of nature – or more properly natures, in the plural – do we want for what kind of future?" (Castree 2001:19). This sentiment, also present in the conclusion of chapter 3, is pushed further in this chapter to consider the very foundation of these relationships.

What are the epistemological implications of acknowledging that stakeholders' concepts of morels are socially constructed and historically situated (Demeritt 2001)? What do stakeholders want their future relationships with morels to be, and consequently, what do they see as the greatest threats to those possibilities? Section 4.3 explores this question by reviewing participants' answers to the question "what do you think are the top three threats to mushrooms or fungi today?" The answers suggest the ways in which morel discourses are informed by meta-narratives of environmental degradation and conservation, which are also abstract or spatially and temporally bounded.

In section 4.4, I explore the articulations of power that are revealed by a more in-depth analysis of morel discourses. By viewing knowledge as partial, shifts in power among the different models are made possible because no single model represents the absolute truth. I conclude with a discussion of the ways in which the adoption of differing morel ontologies results in different epistemologies due to scalar politics.

4.2: What Are You Talking About? Seeing Ontological Difference

"Only partial perspective promises objective vision." (Haraway, 1991:190)

In this dissertation I focus specifically on the processes and practices of fungal conservation. As such, this chapter continues to address one of the overarching research questions: how do scientific and managerial theories and practices differ from lay or traditional theories and practices? This section explores how the theories differ in terms of the foundations of their ecological knowledge. I use biological and ecological concepts as my entry point for this discussion of morel ontology and epistemology because it is on that basis that scientific epistemologies are privileged in the institutionalization of fungal conservation discourse (chapter 3). Other entry points to a discussion of how these theories differ, such as social networks or commodity chains, may lead to a different emphasis. This remains an intentional decision on my part because it is the social and cultural dimensions *of the biological and ecological* that I am interested in exploring.

The Scientist's Morels

Morel habitat is highly variable based on species and region, and since the mycologists come from different regions and countries, there was no consensus on habitat or vegetative associates. These observations reflect the natural history of each mycologist's region. PNW mycologists highlighted the role of disturbance in creating morel habitat. Morels are well known to fruit after large wildfires (Pilz et al. 2007). The Deschutes and Ochoco National Forests (popular morel hunting areas), for example, are comprised of short-interval, fire adapted ecosystems with fire return intervals of 0 – 50 years (D. Pilz, personal communication 2007). European mycologists identified a wide range of potential habitats, including burned areas, apple orchards, grasslands, sand dunes, and both broad-leaved trees (preferably *Quercus* and *Corylus*) and firs (*A. alba*). They also associate morel fruiting with disturbed habitats, and acknowledge the high level of historical and current disturbance, due to land use, throughout Europe.

Morels exhibit a wide variety of forms and their taxonomy continues to challenge mycologists. The use of genetic analysis has maintained *Morchella* as a distinct genus, but the number of species within the genus remains unclear. Some estimates suggest that there are only 30-40 species worldwide (S0708), whereas up to 196 species and subspecies are officially listed in Index Fungorum (Pilz et al. 2007). As a result, mycologists recognize that the species level taxonomy is unresolved, and so know morels broadly as a genus and in terms of habitat and life strategy.

Morels are classified as ascomycetes, fungi that produce their spores inside an internal sack called an ascus. In technical terms this means that morels are not true mushrooms. That distinction belongs to select genera within the phyla Basidiomycota. True mushrooms typically have caps and their spores are produced on basidia cells, as opposed to inside the asci. Most other edible fungi are basidiomycetes. With the exception of the two *Morchella* specialists, scientist-participants had primarily a broad understanding of the genus as ascomycetes, and of its relative phylogenetic position in the family Pezizales. When I asked them to name specific species within the genus, some mycologists referred me to *Morchella* experts, or lamented the lack of "good keys" to identify specific morel species. Only one European mycologist specifically identified three species by name (*M. esculenta*, *M. conica*, and *M. elata*); the other three Europeans either did not identify morels by name, or fell back on the lack of scientific consensus. The American mycologists, who have worked more specifically on this genus, did name specific species, but were very aware of the unsatisfactory state of complete knowledge about American morels:

> To date the species have not been well delineated in morels. A lot of our names for morels, scientific names, are borrowed from Europe and we quite likely have different species here, even though they look similar. All the different species of morels that we do have in North America have not been named or described or even collected. (S0706)

This American mycologist highlights the fact that morphology is no longer sufficient for species classification. Now, more than ever, cladistics and taxonomy are based on principles of evolutionary biology, so determining individual species begins with understanding their reproduction. Dispersal of sexual cells is a major way that fungi reproduce, but to understand the full range of morel reproduction, and the resultant issues it raises for mycologists, requires a more thorough understanding of morels at the cellular level; Pilz addresses this question in some detail:

> Understanding how morel (Ascomycete) reproduction differs from that of most other edible (Basidiomycete) fungi requires a cursory explanation of fungal genetics. … It has not yet been determined how many different chromosomes *Morchella* has. Each chromosome in the set is different, that is, it has different genes coded along its length than the other chromosomes in the set. *In a haploid condition (for instance a sexual spore), each cell nucleus has only one copy of each chromosome in the set.* These nuclei are referred to as haploid nuclei. Diploid nuclei have two copies of each chromosome. …

Animals and plants are diploid throughout their entire lives because two sets of homologous chromosomes pair up into a diploid nucleus during fertilization. Many fungi, by contrast, can grow for periods of time with only one haploid nucleus (or multiple copies of the same haploid nucleus) per cell. This situation is common when sexual spores germinate and grow for a while in search of other haploid hyphae that are compatible for mating. *Fungi do not have genders in the sense of different male and female features, but they do have mating types that must be compatible.*

Among Basidiomycetes, a haploid hypha of one mating type typically finds and fuses (anastomoses) with another haploid hypha with compatible mating-type genes. The two compatible haploid nuclei from these fused hyphae just pair up in each cell of the newly formed mycelium without combining to form the single diploid nucleus usually observed in plants and animals. These fungal hyphae are called dikaryotic (Chang and Miles 2004:58). A karyon is a nucleus containing DNA, so a dikaryon is an organism having two nuclei per cell. In this case, however, the nuclei are haploid, consist of compatible mating types, and are paired. Such cells have the full genetic complement needed to sexually reproduce through the DNA-swapping and chromosome-halving process called meiosis, but the paired haploid nuclei in each cell do not actually fuse for this process until immediately before meiosis begins in the sporocarp.

The nuclear state of a typical morel mycelium, however, is different than many of the mushroom-producing fungi in the Basidiomycetes. Morel hyphal cells have long been observed to have many nuclei per cell. This is called a multikaryotic or multinucleate condition. Recent genetic analysis suggests that, like many Ascomycetes, these are not just multiple copies of the same haploid nuclei, but that *many different haploid nuclei co-exist unpaired in the typical morel mycelium. Because the nuclei differ, this is called a hetero-karyotic condition. Morels might also be capable of the highly unusual feat of haploid meiosis. In mammals, the equivalent would be a haploid female growing from an unfertilized egg and then mating with herself to produce offspring. …*

Morel hyphae anastomose readily and frequently (Volk and Leonard 1989a, 1990). The result of these frequent fusions among morel hyphae is a heterokaryotic mycelium; *that is, many different haploid nuclei coexist in the same hyphae and mycelium* (Arkan 1992, Volk and Leonard 1989a). *Although heterokaryosis is common in some groups of fungi, it is not common among the fungi that produce most edible mushrooms such as chanterelles, matsutake, or boletes. …*

Additionally, defining a morel "individual" and its spatial extent in the soil is problematic. For instance, many mushrooms that are classified as Basidiomycetes (such as chanterelles, matsutake, and boletes) form distinct dikaryotic mycelial colonies that can be considered individuals. The structural tissues of all the mushrooms arising from such discrete colonies are genetically identical, so the spatial extent of the colonies can be roughly mapped by analyzing the DNA of their sporocarps. *Because morels are formed by heterokaryotic mycelia, no two sporocarps need be alike. Indeed, the mycelium that produces the morel is more like a diverse genetic colony than an individual. Even morels*

> *fruiting side by side often appear genetically distinct, and thus are likely composed of different combinations of the multiple haploid nuclei that exist in the mycelium from which they fruit.* Therefore the extent of mycelial colonies can only be very roughly mapped by the presence of morels, and if such "patches" of fruiting bodies are in close proximity, it would be difficult to discern whether they are connected and share some nuclei. (Pilz et al. 2007:32-37; emphasis added)

Throughout the academic discipline of biology, understanding of species and of organisms is based on concepts of sex (male, female, hermaphrodite), sexual and asexual reproduction, and the individual. Typically, organisms that scientists understand as without sex do not "mate." The heterokaryotic condition and the ability to perform haploid meiosis are highly unusual, *even* for macrofungi. The last paragraph above is especially significant in understanding the mycologist's current ontology of morels. Before even attempting to define a group (species), one must be able to identify and count the individuals in that group, for comparison with individuals from another group. For boletes (a wild edible basidiomycete), if two mycologists are out in the woods together and one points to three boletes growing near each other and says, "There are three *Boletus edulis*," the other mycologist says: "Let's take them back to the lab and we'll confirm how many individuals we have here." For morels, if two mycologists who are versed in morel physiology and genetics are out in the woods together and one points to three morels growing near by each other and says: "There are three *Morchella esculenta*," the other mycologist says, "Well, we could try to determine how many individuals there are in the lab, but we can't be sure."

The end result of all the detailed, nano-scale, genetically based descriptions of morels is that within this framework, identifying an individual is extremely difficult, and essentially impossible in the field. Mycologists work around this by understanding morels not as "unique or distinct dikaryotic individuals," but as "populations of nuclei or genes."

Therefore, "studies of breeding and population genetics can still be conducted because these rely on similarities in gene ratios among samples (percent similarity of genes), not on unique dikaryotic individuals" (Pilz 2007:49). In other words, scientific knowledge advances on the ontological foundation of a morel as a population of nuclei or genes, rather than as an individual. Ultimately, ecological research operates at the genus level of classification, while biological research operates at the nano-scale of life.

The Harvester's Morels

Local ecological knowledge (LEK) is defined as an experientially gained understanding of the environment (Emery 2001), and MAR harvesters' understanding of morels clearly falls within these guidelines. It has developed and been communicated over time and in place. Morel hunting signals the arrival of spring in the area. Dominantly a male activity (although the sample did include 16 women), morel hunting and hunting spots are typically passed down from grandfathers, fathers, and uncles to younger family members. As a result of this intergenerational process, morel LEK is grounded in both individual experience and that of prior generations.

With slight intra-regional variations, up to six types of morels are identified in the MAR. They are differentiated based on simple morphological characteristics such as color, size, and pore tightness. How closely these types of morels conform to internationally recognized species is neither of concern nor of interest to most harvesters. Participants from West Virginia and northwestern Maryland identify three types of morels: black, white, and cappy. Residents of north-central Maryland often identify five: black, gray, yellow, cappy, and poplar. It is unclear whether the white and the gray are the same type of mushroom with different local names, or if the names represent two distinct types. These classifications form the basis of the “folk taxonomy” of MAR morels. Overall, harvesters identify five to six types of morels (Figure 6): black (a), cappy (b), white and/or gray (c), yellow (d), and poplar (Figure 7).

Figure 6: Mid-Atlantic Morels (from top left clockwise): A: black morel, B: cappy, C: gray morel, D: yellow morels. (photos taken by author, various dates).

Poplar mushrooms, the most elusive in the area, are variously described as white or gray, with irregular annual fruiting, with the pores opening up when they are still small in size, and fruiting specifically around tulip poplars.

There is a range of additional ecological information that contributes to the folk taxonomy of each species including soil type, soil moisture, elevation, aspect, and vegetative associations. Overall, ideal soil for morels in the mid-Atlantic is described as dark, loamy, rich, black, and fertile, often with a thick organic layer. One participant specified limestone soil as a good substrate. Contraindicated soils are high in clay, slate, and shale and are reddish in color. Black morels often grow alongside stones, although overly rocky areas are avoided. Suitable soil moisture is neither extremely mesic nor extremely xeric. Blacks are found at higher elevations more frequently than whites; while whites and yellows are found more frequently at lower elevations, but may also occur at higher locations where conditions are favorable. In the mountains, eastern and southern aspects are widely known to be early season habitat for morels. Northern and western aspects produce toward the end of the season, if at all.

Figure 7: Poplar Mushrooms. Note the pore structure and pore alignment in comparison to the yellow morels in Figure 6. (Photo taken by author, May 2009).

Four tree species – American elm (*Ulmus americana* L.), tulip poplar (*Liriodendron tulipifera* L.), white ash (*Fraxinus americana* L.), and apple cultivars (*Malus pumila* Mill.) – are sought out as good indicators of potential morel presence. In conjunction with the right soil, stands over 40 years old dominated by poplar, ash, and elm are ideal habitat for morels. Understory species cited as indicators of potential morel habitat include spicebush (*Lindera benzoin* (L.) Blume), mayapple (*Podophyllum peltatum* L.), jack-in-the-pulpit, (*Arisaema triphyllum* (L.) Schott), ferns, and poison ivy (*Toxicodendron radicans* (L.) Kuntze). Several people state that morels are rarely found near white pines, in fields, or in areas with dense undergrowth.

Participants observe clear associations between tree species and morel type. Yellow morels occasionally fruit near living elm trees but do so most abundantly soon after a tree dies. Historically, old apple orchards have also been favored sites to hunt for yellow morels. Several participants report that morels fruit most abundantly at an apple tree the first year after it has died. Due to the decline of elms since the arrival of Dutch elm disease and the widespread development of orchard land, participants report shifting their focus for hunting yellows from elms and apples to ash. Participants report that morels will not fruit near tulip poplar or ash trees once they have died.

These ecological data are relatively stable because the harvester ontology of mid-Atlantic morels is stable. Consequently, harvesters are well positioned to comment on the effects of environmental changes on morel populations. These may include erosion, siltation due to flooding (at CHOH especially), and damage to or destruction of vegetative associates due to disease, insects, wildlife, timbering, or clear-cutting. For example, several harvesters pointed out that the increase in wild turkey populations due to changing wildlife regulations has had negative effects on morel populations because turkeys scratch around morels for insects to eat. Through long-term observations, harvesters know these are not rake marks, and their observations are consistent with wildlife records (Long 2007).[23]

The Manager's Morels

Managers are aware of both the SEK and the LEK of morels, and they occupy a difficult position in trying to resolve these understandings into a consistent epistemology for ecosystem-oriented decision making. As a group, they know about morels less by choice and more out of obligation. Where harvesters have specifically chosen to know morels, and mycologists can appreciate and discuss morels directly or through association with their other fungal knowledge, managers have come to know morels primarily out of need within the larger context of their work. This does not mean that individual managers have not grown to appreciate morels, or even become hunters themselves. It means that managers' ontology of morels is primarily a utilitarian one, a mix between what they have learned from local harvesters, what they glean from books and workshops, and what they learn directly from scientists. This is true both in the MAR and the PNW, the two regions where the managers who participated in this study work and live.

Morels are highlighted because of their social value, and as a result managers know morels as biological objects that have become resources. They are significant specifically because harvesters are extracting them for either economic or cultural reasons from the domains that managers manage. Morels are known as a source of

[23] A more detailed discussion of disturbance and related ecological management issues can be found in Barron and Emery 2009.

concern because of the potential harm that the harvesting of them may bring about to the broader ecosystem. All of this is set within an institutional framework that centers around the idea of morels as a natural resource that needs attention and protection, but one that remains relatively insignificant compared to wildlife or trees.

It is precisely this institutional framework that drives managers' roles in knowledge production. PNW and MAR managers have facilitated the creation, accumulation and utilization of new knowledge at a rate accelerated by their own institutional timelines for morel management and conservation. Managers have depended on the scientific and social scientific data they have commissioned for assessments and to devise management plans. PNW managers made numerous references to the biophysical and the social scientists they have worked with to better understand morel biology and ecology, harvesting pressures, harvesting techniques, and other social conditions around harvesting:

> M0706: I've been working with [nearby scientists] for a lot of years. They were the credibility, I'm the manager. I do the policy, but when it came to credibility I needed their signature.

MAR managers often referenced the ecological study and the social science study, expectantly awaiting the results in order to move forward with their management decisions responsibly and in a way that was defensible:

> M0703: [Until recently], we didn't have any [interaction with mycologists], it was lacking, I wasn't satisfied.
> ESB: Ok. And, so as far as I'm aware there's this study, there's the [ecological] study, and then there's been the fungal survey. Is that everything?
> M0703: No, [our other biologist] is in touch with another person through USDA I believe, looking at some of the fungi or related organisms.
> --------------------------------
> M0704: Yeah, and I think hopefully some of these recommendations [for morel harvesting activities] are going to be based on, what [the ecological study] finds.
> -------------------------------

> ESB: Can you explain to me how the morels reproduce and how they grow?
> M0705: Well, that's why we're doing this study between CATO, here, and C&O Canal, where they've actually been trying to do studies to find out, you know, hey, is it disturbed or not?
> ESB: The ecological study?
> M0705: Exactly.

The first step in the process of resource management is identification and assessment of the resource. Most NCR manager-participants had attended workshops organized by the researchers working on the ecology study, to teach them some mycology basics and assist in identification of common species. Perhaps because of this and their own initiative, some managers made reference to the species in their parks as *M. elata*, *M. esculenta*, and *M. semilibera*. But more commonly, managers specified up to three of the following types: yellow, white, black, cappy, true and false.[24] They had a general understanding of morel habitat and phenology, and of trees to look for to find morels, but not of specific vegetative associations or the role of disturbance in the case of the eastern managers. For example, east coast managers said, "morels come up around poplar trees," but not "black morels are the first to come up and they come up most commonly around poplar trees." Instead, managers' understanding of morels, expressed in their interviews, focused specifically on the human interface: harvesting and extraction methods, overharvesting, concerns of possible decline.

MAR managers who did comment on habitat drew from their personal experiences as hunters and from their observations of harvesters' hunting practices within the parks. They looked for morels around tulip poplars, dead elms, and ash. One manager who had been working in the same park for 35 years had an understanding of morel habitat that was similar to harvesters. He specified good habitat as: south facing slopes

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[24] The last two types, true and false, were specifically delimited by PNW managers only.

early in season, deep moist soils, just outside riparian zones, around [tulip] poplar trees in the understory of forested areas, and [specific locations in the park and the area]. In the PNW the focus was on burn site morels, coniferous tree species (pine, Douglas Fir, Western Larch), and cottonwoods. West coast managers also regularly referred me to regional publications produced by the Pacific Northwest Research Station (USFS). Overall, the managers understood and broadly defined morels in relationship to their human use, and as valuable parts of an ecosystem that is itself representative of a larger discourse of the environment as a protected space.

This epistemological positioning of morels directly in relation to the larger ecosystem is closely tied to their potential conservation value. This is problematized by the often conflicting U.S. land management and conservation concepts of stewardship and control. The NPS, like the Forest Service discussed in chapter 3, is specifically tasked with balancing science and recreation. Without the strong commodity extraction component (present in the PNW), NCR managers were concerned for the ecosystem primarily in terms of plant and animal species:

> ESB: Right. So, what would you consider the top three threats to fungi today?
>
> M0703: What we don't know about them. All the other things that are going on in our forest. Gypsy moth (*Lymantria dispar*), white-tailed deer, hemlock wooly adelgid (*Adeleges tsugae*), no fire, you know, overall forest management. And maybe the long sustained harvest of morels in the past, and there's nothing we can do about that.

Above, I asked an MAR manager about threats to mushrooms, and he responded with the top three threats to the forest and to ecosystem integrity in the Catoctin range. This does not signal lack of concern about morels. As he pointed out, we need more knowledge about them, but he was clearly focused on threats to the forest trees that he deemed more significant, more dire, or at the very least that he was more aware of. Managers answered consistently that it is unknown whether morels have any specific ecosystem value as a genus, other than the generic fungal role of decomposition. Their primary concern is how to spatially manage the larger ecosystems for which they are responsible.

4.3: Material Consequences of Situating Morel Discourses

How morels are seen to exist in the environment, what they are, and what they mean to the participants is directly informed by each person's experience of learning and knowing morels, and to how central a role the *Morchella* genus plays in each person's fungal interests. Epistemological distinctions inform and are informed by these ontological differences. The results have direct material consequences on perceptions of threats and interventions to protect morels. This section begins with a brief review of the epistemology of each group based on the last section, before transitioning into additional findings relevant for the development of the conservation models.

Researchers continue to revise species distinctions based on both genetic analysis and morphological descriptions (Arnolds 1989c). Most North American morels have been given the names of European species, although likely they are distinct (Dewsbury and Moncalvo 2007). Hence few, if any, North American morels presently have scientific names that meet the standards of the International Code of Botanical Nomenclature (D. Pilz, personal communication, 2008). This bothered some scientist-participants whose research focused on morels, but the majority were relatively undisturbed since in their view, the *Morchella* genus is neither rare nor declining in their regions.

In contrast to these ongoing taxonomic debates, harvesters' understanding of morel types is sufficient for their practices and has therefore stabilized. A harvester knows the types of morels that occur in his/her area, when they occur, and how to find them. When new information about morels is encountered, it is understood within the existing typology. What morels are is defined by these spatial and performative limits. These place-based understandings allow harvesters to report confidently on specific threats to morels and possible mitigations for morel conservation. Questions of how to manage and conserve morels, and what may be threatening them, are most specific when they are spatially and temporally limited. Responses to those questions may be similarly more effective when they are developed within these spatial and performative limits, positioning harvesters at the heart of effective management and conservation. Managers are similarly spatially constrained, but view people on the landscape as the primary threat to fungi and consistently voiced concerns related to two mainstays of modern environmentalism: the tragedy of the commons concept (Hardin 1968) and overpopulation (Ehrlich and Holdren 1971). In contrast, scientists' approach to threats to morels and necessary action for conservation is relatively abstract and focused on broad anthropogenic causes (see chapter 2).[25] The material effects of these different epistemologies for fungal conservation are revealed through a closer examination of the answer to the following question posed in the interviews in 2007 and 2008: "What do you think are the top three threats to mushrooms/fungi?" The results are reported in Table 4.

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[25] In chapter 2, causes and actions are described in detail. In this section it is the underlying epistemology that drives those actions that is discussed.

Table 4: Threats to fungi by stakeholder group (N_H = 29, N_M = 7, N_S = 8). Top three threats, by group, are in bold.

	Stakeholder Group (in percentages)		
Threats to Fungi	**Harvesters**	**Managers**	**Scientists**
Development	**52**	14	25
Global Climate Change/Weather	**41**	**57**	**38**
Habitat Destruction	7	N/A	**100**
Habitat Disturbance	**24**	29	25
Ignorance	17	**57**	13
Modern Land Management Practices	14	29	13
Pollution	14	29	**75**
Increase in people harvesting/competition	10	14	N/A
Overharvesting	14	**43**	N/A
Overpopulation	3	14	N/A

All the categories in the table are based on definitions for anthropogenic disturbance as defined by Arnolds (1989c) or by the participants themselves based on responses. After the answers were tallied, similar answers were combined. For example, of the eight scientists who completed the interview, one answered nitrogen deposition, one answered acid rain, and four answered pollution. I combined these answers into one category, pollution, for a total of 6. These tallies were then converted into percentages for comparison across groups. Development specifically relates to the conversion of open space into housing and businesses, general processes of urbanization and posting of private land to discourage trespassing.[26] "Global climate change" and "weather" are clearly not the same concept, but were combined into one category here because participants, in this specific context, spoke of changes in the weather as a major threat to fungi. How these changes may or may not be related to the processes of global climate change is debatable, but clearly the effects of "changing weather" were widespread.

[26] Posting is included in this development category because it was the strong sentiment of a majority of harvesters that it was urban people that had relocated to the area that were posting their property with "no trespassing" signs. These signs signify development for harvesters.

Arnolds (1989c) defines habitat destruction as the irreversible conversion of actual or potential fungal habitat due to such factors as: town-building, industry sites, development of infrastructure, dumps and landfills, removal of sand, gravel, clay, limestone and peat. Habitat disturbance is defined as drastic transformation of landscape, habitat and/or plant communities by anthropogenic factors such as the affect of timber production and harvesting, clear cutting, silvicultural practices, tree pathogens and wildlife. Ignorance includes "poor harvesting techniques" and "lack of appreciation for fungi." Modern land management practices were named specifically as such by scientists and managers, and also include comments about "invasive species." Pollution is discussed above, and also included comments by harvesters on fungicides in the soil. "Increase in people harvesting/competition" refers to comments made that morels are threatened by an overall increase in the number of people hunting for them, leading to increased competition for the resource. This is distinct from comments on overharvesting, which is the direct over-utilization of the resource. Overpopulation is a broader idea that there are too many people using resources in an area or on the planet as a whole, and it is damaging the environment and mushrooms as a result. These last three categories are not necessarily any more different than "global warming" and "weather," or "modern land management practices" and invasive species. I have made a conscious decision here to maintain them because it draws attention to the fact that mycologists consistently did not rank anything related to harvesting as a major threat to fungi. Also, 43% of managers actually specified "overharvesting" as a major concern, again highlighting their focus on concerns of resource extraction.

Several interesting points emerge from a close examination of this table. Overall, scientists consider the top three threats to fungi to be habitat destruction (100%), pollution (75%), and global climate change (38%). Harvesters consider development (52%), weather/global climate change (41%), and habitat disturbance (24%) to be the three main threats to mushrooms. Managers' top three threats are global climate change (57%), ignorance (57%), and overharvesting (43%). Even from this cursory examination, harvesters and scientists agree that relatively broad anthropogenic disturbances are threatening fungi; managers are concerned about the negative actions of individuals on the landscape.

It is notable that all three groups prioritized changes in weather or climate as a threat to fungi. What participants are referencing when they say "global warming" or "global climate change" or more simply "weather" are not always the same thing, but there is a consistent observation among many participants that changes in weather and climate are strongly negatively affecting mushrooms and other fungi. Apart from this one area of relative congruence, the other threats and how to mitigate them, are consistent with each group's ontological framing of the fungi. These types of divergences are often frustrating and puzzling for conservation scientists and land managers, because of their beliefs about knowledge and how natural systems are understood. Examining morel ontologies yields insight into diverging models of fungal conservation specifically because it challenges the idea of a single, universal way to understand and relate to the surrounding environment. Extant epistemologies become distinguishable at a fundamental level.

Like the very foundation of their knowledge of morels, harvesters' two other top ranking threats to mushrooms are based on direct observation. Over time, they have observed specific changes in morel fruiting patterns in relation to changing weather patterns. They have observed trusted morel spots turned into housing developments. They have observed turkeys scratching at soil and disrupting the mycelia, and blow-downs and tree pathogens disturbing morel habitat and vegetative associates.

Participants believe that changing weather conditions are the most significant determinant of morel seasons. Ideal weather conditions are described as daytime temperatures in the 70s, paired with overnight temperatures in the 50s, in combination with rain on soils already moist from the melting of a good snow pack. Interviewees note that such conditions occur only every few years and without exception express concern that they are becoming less frequent than in the past.

> H0720: The changing weather, are we going to get the [right] weather in the middle of the summer, or is our top day [in the spring] going to be 70 degrees? what's it gonna be like in twenty years? I'd say weather, weather changes is about the biggest threat to ‘em I would think.

The timing of the mid-Atlantic morel season also has changed, according to participants. Several older mushroom hunters believe that the trend of the last several years has been toward an earlier season onset, perhaps by as much as two weeks. In the past, the season typically began in earnest around the second week of April and lasted approximately one month. Records kept by one man for almost 30 years indicate that previously the most productive point in the season occurred around April 28th. His notes suggest the high point of the season now occurs closer to April 20th. The end of the season similarly appears to have advanced. One man in his 50s indicates, "I always hunted big mushrooms the last week of May. Now they're over by 15th, 18th of May."

Historically, the different types of morels have fruited sequentially over the course of a season, with blacks fruiting first, yellows last, and white and/or gray mushrooms in between. The relative timing of cappy fruiting is less clear as they are reported variously as fruiting after blacks, after grays/whites, and after yellows. Poplar mushrooms are a late season mushroom, fruiting irregularly after blacks have finished. In the past, typically no more than two types were found in a day. Some harvesters report that over the last five to ten years they have found blacks and whites together in western Maryland, and up to four types on the same day in central Maryland.

National Climate Data Center information is consistent with harvesters' observations of fluctuating weather patterns, and indicates that temperatures have increased in Maryland over the last three decades. Mean spring (March - May) temperatures have risen at a rate of 0.26 degrees Fahrenheit per decade (National Climatic Data Center 2009a), while mean winter (December - February) temperatures have increased at a rate of 0.32 degrees Fahrenheit per decade. Winter precipitation in the state has declined 0.44 inches per decade since 1970 (National Climatic Data Center 2009b).

The second major threat to mushrooms that harvesters have experienced is development, primarily in the form of the conversion of woodlands and apple orchards into residential and commercial properties. These conversions represent aspects of local land tenure that harvesters are well aware that they have no control over. This development may be due to population growth in the area. Indeed, the counties in which interviewees live have experienced rapid population growth ranging from seven percent to 30% in the period from 1990 to 2000 (CensusScope 2008). This rapid type of population growth suggests shifting populations, for example, urbanites moving to the country. The resultant housing sprawl has had a negative effect on the mushrooms. Many feel this is the most significant threat to morels: (in conversation) H0703: “I can't think of 3 things…” H0704: “Except for development, development, development” (Figure 8).

In the spring of 2009, despite the economic downturn, new housing developments were still going in around Thurmont, MD. I visited one with Doug (name changed; pictured below) when we went morel hunting near his home. Doug was very keen to go to this spot because this was an area that he used to go with his father when he first learned to walk, and he’s been going there ever since to hunt for mushrooms. He told me if you combined all the mushrooms he’s found in there “it would be way more than a truck bed full.” Last year (2008), a banner year for morels in the MAR, Doug collected at least nine gallons there with a friend. That day, we found 13 big blacks and two cappies.

As evidenced in the picture, this area was recently clear-cut to make way for a new housing development. Thirty-two acres were sold for approximately $240,000 in 2008, and building set to begin in the summer of 2009. Consequently, Doug felt that this was the last year there would be good morels, and that he would have access. His sadness as we approached the area was palpable: “this just looks like death and destruction.” I came up the slope behind him and saw the slash of what used to be tulip poplars 4’-5’ in diameter. We talked about it the whole time we were hunting, and lingered when we were done. Doug regretted not being able to buy the property himself. This was the most visible, visceral experience of development that I experienced during this project.

Figure 8: How development has affected MAR morel hunting (Photo taken by author, April 30, 2009).

Finally, harvesters have several direct observations about ecological changes that they see threatening morels. Loss of tree associates is frequently cited as the primary one. Yellow morels, in particular, may have declined due to the crash in the elm population. Several participants believe that the spray used to fight gypsy moth infestations kills morels. For example, in 2008, 3370 acres of CATO were sprayed with the bacterium *Bacillus thuringensis* (Btk). Pilz (personal communication, 2008) speculates that if there is an association between the use of Btk and reduced morel fruiting, it may be attributable to improvements in the health of host trees and not an antagonistic relationship between the bacteria and the fungi. Increasing populations of some wildlife species were also mentioned as a factor in decline. Several participants report frequently finding evidence of wild turkey scratching in places where they have found morels in the past. Dramatic increases in turkey populations over the past 30 years could be affecting morels and other fungi as turkeys scratching for insects may damage fruiting bodies and mycelia (Long 2007).

For harvesters, the question “what are the top three threats to mushrooms?” was very specific. In part this is due to language; morel hunters in the MAR call all morels “mushrooms.” Although many long-time hunters also collect a wild edible locally called “milkbrooks” or “milkplates,” the way this question was asked made it specific to only the genus *Morchella*. For mycologists, this question was almost so broad as to be meaningless.

Mycologists’ relationships with fungal species have developed quite often in the classroom, in the lab and the herbarium, and in a variety of outdoor settings all over the world. These experiences extend to large numbers of genera. They are based on, and create, knowledge that is not tied to place. This results in detailed, yet broad, knowledge of the biology of fungi. Concurrently, mycologists are keenly aware of how much they do not understand about the fungal kingdom, about individual genera, and about fungal habitat requirements. Therefore, scientist-participants answers to the top three threats question focused on more general threats to the environment as a whole, that they also know to be true for fungi. These threats all relate to major anthropogenic effects on ecosystems at all levels. They are at once very real concerns, and also totally abstract. However, this grave concern for the effects of human society on fungi did not carry over to individual interactions. Within the mycological community, harvesting is not generally considered a significant threat to edible species (Moore et al. 2001). No mycologists felt that overharvesting or increased competition due to greater numbers of harvesters in the woods were threats to fungi. Mycologists were just as apt to say, “It’s like picking apples off an apple tree,” as harvesters were, because they have a clear understanding of the biological function of the mushroom and also of the reproductive capacity of organisms.

This shifts the focus onto more diffuse threats such as large scale habitat destruction, climate change, and pollution. These significant threats to fungi are apparent both in the interviews and in scholarly publications (Arnolds 1991a). While harvesters experience development of specific sites, mycologists see a broader category of destruction: "Ah, so habitat destruction, I mean draining, development, changing farming methods. Those are three but basically they come under the same thing, I mean, come on," (S0709). In general, mycologists do not differentiate between a clear-cut and clear-cutting, unless a rare or a specific species that they are interested in is involved.

Similarly, climate change and pollution are ways in which human industry, policies and economies are damaging the natural environment at all levels of spatial scale.

For managers, after global warming, overharvesting and ignorance were the most reported threats to fungi. Direct actions of harvesters such as overharvesting, poor harvesting techniques, raking, trampling, and increased harvesting pressure were all seen as major threats to the resources that managers are trying to protect. This is consistent with a resource ontology that conceptualizes every resource in direct relationship to its ecosystem value and human use value. Managers' morel discourse is based on their responsibility to protect nature, specifically their little piece of it in the park where they work, and they are very concerned that they not fail: M0705: "It may not be as big as we think. But like anything else, people do it and after a while there's no more. Then everybody's like, aw, how'd we let 'em do that?"

In stark contrast with the other two groups, managers were not at all concerned with the idea of habitat destruction, or even with habitat disturbance. This may be in part because the fungi that they are most concerned with are growing in federally managed lands. In other words, managers' focus is on how to protect what is already, to some extent, protected from destruction. For tem, wild edible fungi exist in protected space, and they are presently a part of it that is less protected. They represent a breach in the system. Indeed, many national park personnel that I spoke with that are based in western parks like Olympic National Park (WA) or Glacier National Park (MT) were highly surprised that any national parks still allowed the collection of wild edible mushrooms. In the national parks in this study, it is illegal to hunt animals, pick flowers, collect firewood, collect pine cones, or even take home rocks. Yet, the freedom to pick berries and wild mushrooms has remained at both CATO and CHOH. It is worth noting that this collection of wild food does not extend to leaves like pokeweed (*Phytolacca Americana*), ramps (*Allium tricoccum*), or land cress (*Barbarea vulgaris*), all popular wild edibles in the area (Barron and Emery 2009). Managers' epistemology of the environment is fundamentally based on the act of protecting it from human-caused degradation, ironically, in part, for the recreational enjoyment of humans. This reinforces an ontology of morels that is not about the morel, but about its existence as a part of a carefully managed nature.

4.4: Conclusions

In this chapter I examined stakeholder knowledge, and demonstrated differentiated morel ontologies and epistemologies of the three primary stakeholder groups. The certainty with which participants feel they understand the biological and ecological contexts of mushrooms strongly influences what stakeholders perceive as threats to the organisms. These situated knowledges are socially constructed and are grounded in power relationships and scalar dynamics. Highlighting power and scale in the social construction of morel discourse, and understanding knowledge as partial, creates a theoretical opening for new relationships in constructing discourses of fungal conservation. Namely, the production of situated ecological knowledges occurring at multiple levels and scales among the different stakeholder groups has material effects on how that knowledge is used, and therefore on the emerging models of fungal conservation. These effects are explored below.

The asymmetrical nature of power has been shown to permeate most social structures and modes of production (Johnston et al. 2000:630). The poststructural turn in political ecology reoriented this conception of power towards subjugation of indigenous (and traditional and local) environmental knowledges in relation to scientific and state sanctioned environmental knowledge (Watts and Peet 2004). In this case study, participants' answers to the 'threats' question can be understood in terms of their current power to control and affect morel management and conservation. Harvesters have power in relation to other harvesters. Individual knowledge of particular sites is important vis-à-vis other harvesters competing for access. Those that have long established ties to the community and have lived and hunted mushrooms in the same areas their whole lives tend to have the best luck every season. They can access more private property, and importantly, they have access to the knowledge accumulated by other harvesters. H0706 and H0712, for example, are both members of the Mycological Association of Washington D.C. (MAW). Their hunting success rates were 25 – 50% and 1 – 25%, respectively.[27] In H0706's case, he attributed his success directly to the fact that he goes morel hunting with a local friend who has grown up doing it. Only three other harvesters ranked their trips as being successful less than 50% of the time. This is an important point because it signifies the fact that "harvesters" are not a uniform group. Local knowledge is itself diverse and dynamic, affected by social, political, and power relationships in a place (St. Martin et al. 2007; Martin 2003). The plurality within each stakeholder group is further demonstrated in chapter 6, and addressed in greater detail in chapter 7.

[27] Hunting success rate was defined to participants during the interview as their estimate of the percentage of hunting trips that they find even one mushroom when out morel hunting.

In relation to the other stakeholder groups, harvesters remain comparatively weak in their position. They have relatively little power over the land tenure at most of their morel sites on public or private lands. Their LEK has no influence on management or land tenure decisions. Development and urbanization, both of which are significant land tenure decisions being made by outsiders, threaten existing harvesting regulations and unspoken long time agreements like access rights to neighboring private property. These expressions of power are tied to entities that, for harvesters, are seemingly nebulous: "the government," "city people," or "big companies." Harvesters identify the power as being in these places, and do not see alternatives.

Managers have influence over the resources that exist within the park where they work, and perhaps in surrounding parks. For managers, affecting social behavior is faster and more acceptable than changes to environmental management. This is likely because ecosystem management legislation must be maintained according to specific parameters that managers and their superiors often have little control over. Managers feel comfortable with the repercussions of restricting harvesting, whereas they feel that they do not have enough data to be able to predict outcomes from ecological changes that may also benefit morels, or power to attempt them. Managers are empowered to constrain the actions of harvesters, but wait on the actions of scientists to move forward.

From their perspective, the most immediate power managers have is over the behaviors of visitors to parks. However, this power is somewhat theoretical. Although it was rumored in the spring of 2009 that someone had been ticketed for harvesting more than the daily limit at CATO, both park service personnel and harvesters are aware of the very limited law enforcement resources at both CATO and CHOH. The number of protection rangers is far below the number of harvesters, and experienced harvesters could easily evade law enforcement if they chose to. Ultimately, managers' actual power is minimal, even if their jurisdictional power is absolute. Their answers to the 'threats' question could be interpreted as tacit recognition of this fact. This may, in part, be why they turn to scientific evidence for support.

As evidenced in the last section, scientists generate increasingly detailed SEK that permeates management. Their ontology is broadly accepted and validated because it has the full power and authority of "science" supporting it. Genetic research on morels is resulting in somewhat paradoxical findings, however. While greatly adding to the overall understanding of *Morchella* in relation to other genera in the family Pezizales, understanding that *Morchella* are capable of haploid meiosis and may persist indefinitely as heterokaryotic mycelia makes determining parameters for species identification extremely difficult. This has the indirect result of prohibiting species level assessments, undermining measurements of abundance and distribution, and obscuring the nature of ecological relationships by destabilizing the very concept of the individual. At the same time, genetic analyses of several major genera that occur worldwide have shown that species that were once believed to have cosmopolitan distributions are in fact many different and unique species (Mueller et al. 2001). In other words, through genetic research, mycologists have determined that there are many more species than were previously acknowledged.

Morel experts in this study agreed that European species and North American species are probably distinct. Because all North American species have been identified taxonomically in relation to their European conspecifics, this means a dramatic restructuring of the entire genus will have to be undertaken, if and when mycologists determine that they are able to identify species with an acceptable degree of certainty. It is only once species are established that mycologists will be able to begin assessing abundance or address concerns of scarcity strictly using the scientific method.

Both because of these uncertainties, and because the majority of scientist-participants are not morel specialists, mycologists tend to fall back on diffuse, global explanations when assessing threats to morels. Habitat destruction, pollution, and global climate change are believed by many scientists to negatively affect the environment at all spatial and temporal levels, and are known to have negative consequences for other macro-fungi (Moore et al. 2001). They are "safe bets" for participants who may not feel appropriately well-versed to pin down their concerns. Scientists' impact is most directly felt by land managers, who use scientific research in national parks and national forests all over the country. In contrast, harvesters may choose to believe or agree with scientists' knowledge, or not. Still, since harvesters' actions are affected by managers' decisions, they are not exempt from the effects of the powerful scientific narrative.

Understanding all knowledge as partial and situated disrupts these asymmetrical power relationships. Yet the question remains, how can alternative knowledges be legitimated, institutionalized, and systematized without being co-opted or subsequently re-subjugated (Watts and Peet 2004)? Since the mid-1980s, there have been many case studies that suggest that traditional and local knowledge systems complement scientific knowledge (St. Martin 2007; Martin 2003). By demonstrating the social processes that inform stakeholders' ecological knowledges, the power relationships between those knowledges are disrupted. Re-casting what morel harvesters know as Local Ecological

Knowledge, and demonstrating ways that Scientific Ecological Knowledge continues to change and adapt, begins to build parity between the conservation practices of harvesters, managers and mycologists that was previously lacking.

Both SEK and LEK are being created, accumulated, and utilized at multiple levels and scales. Here I interpret scale as socially produced, but biophysically mediated, emergent hierarchies of space, time and knowledge (Neumann 2009). Levels are the ranges within scales that are identified for explanatory purposes. As the accepted parlance within geography, I maintain the use of the terms "scaled-up" and "scaled-down" to refer to movement within individual scales.

The interactions of differentiated levels within spatial and temporal scales are apparent in the ways that the participants conceptualize and understand morels in relation to other fungi and the surrounding habitat. Harvesters maintain very detailed knowledge specifically about morels that occur only in their area. As H0721 said: "I've never read a book on 'em. They're talking about mushrooms all over the United States. You gotta read about something from western Maryland." This deep knowledge is based on generations of harvesting practice, but it is also narrow and place specific. Managers, in contrast, are interested in morels in relation to the regional habitat overall. They emphasize a shallower knowledge that they hope is broader, and more applicable across space. For example, M0707 commented on a study he commissioned on ferns in Oregon. At the completion of the study, results and analysis were available for two specific sites within the state. However, he pushed the scientists involved to extrapolate these results for all of Washington and Oregon.

For their part, scientists attempt to document universal knowledge that is fundamentally true. As Demeritt explains "scientific knowledge is founded on several important philosophical suppositions about knowledge (epistemology) and existence (ontology): (1) the objects of the physical world exist independently of our knowledge of them, (2) those objects can be observed directly such that knowledge of the world can be tested empirically by immediate reference to how it actually is, and (3) truth is defined by correspondence between our ideas about the physical environment and how it actually is (correspondence theory of truth)" (Demeritt 2001:26). Insofar as mycologists operate within this framework, the information they discover about morels is only spatially and temporally bounded by the objects themselves. As knowledge, it exists as discourse until it is connected to those specific objects at a specific place and time.

The standard scientific epistemology, centered around the scientific method of hypothesis testing, results in the concurrent documentation of facts and the recognition of the partial truth of these facts. This methodology maintains a constant amount of uncertainty. However, through the influence of modernity and technology, the unstable ontology is given objectivity and a universal reach. The emergence of genetic research and technologies has significantly affected how scientists understand and conceptualize morels. The mycologists' ontology, predicated most recently on DNA analysis, is at once operating on the smallest levels and the largest levels of spatial and temporal scale. Because DNA is understood to be the key to evolutionary relationships, understanding species in terms of their DNA positions them relative to all other forms of eukaryotic life – a 1.4 billion year temporal scale.[28] This genetic understanding is universal throughout the species, so the spatial extent of the information ranges from the nano-scale of DNA

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[28] see chapter 1 for more detailed discussion of fungi relative to other Eukaryotes.

molecules to the spatial extent of the species. Although many mycologists embrace this new technology, they do so within the context of their scientific epistemology. Yet, because that knowledge is perceived as objective and universal, it is imbued with discursive power.

Scientific knowledges and local knowledges are created in relation to specific specimens, in specific places, and over set periods of time. But unlike local knowledge, scientific knowledge is not constrained by these conditions. It is unbounded, and it moves across levels in space and time, rendering it more powerful. Once a species is named by scientists, that name extends well beyond the place where that specimen was originally collected. For example, American morels are referenced with European names. These names are imbued with biological and ecological characteristics that were determined based on specimens from another continent. So part of the power of scientific knowledge is related to the ability of scientists to "'jump scales' to suit particular needs as a matter of expediency" (Campbell 2007:328). Only recently, as fungal biogeography has become more possible with genetic analysis, have these names been problematized. However, the power of the act of naming remains with the mycologists.

MAR harvester knowledge is an experiential ontology of the morel situated in place and practice. It is spatially and temporally fixed. It centers around a set of morel types that has remained consistent over several generations. From this stable ontology, questions of species, ecological relationships, abundance, and range can be determined as necessary. Decisions about potential threats to morels can be assessed. The ecological relationships do not necessarily apply to morels occurring outside of the MAR, but that is not of concern to harvesters.

Harvester knowledge develops within a set of performative and spatial limits that it is unable to transcend, rendering it less powerful and therefore less widely utilized and understood. The local names for morels that have been used for generations remain undisturbed by the genetic revolution. The suites of ecological knowledge attached to these names are maintained. The names are further confined to long-term traditional harvesters in the MAR. H0712 for example, hunting in the Washington D.C. area and a MAW member, referred to “blondes” not yellows. When speaking to mycologists at the EMA meeting in St. Petersburg in 2007, the first question I received after my presentation was: What are the species you refer to? I had called them by their local names, and pointed out that this was a conscious decision on my part to maintain connection to the origin of the knowledge. I was promptly informed that, without proper species identification, my findings could not be interpreted. In other words, the harvester names and associated knowledge were not valid or accepted in this forum. It’s validity remained bounded by community ties and spatial limits that did not extend to that moment or place.

The role of climate change, an issue of importance to all groups, is exemplary of the different scales at which harvester and mycologist knowledges are operating. Where harvesters specify very detailed observations they have made about changes in morel fruiting within a roughly 20 mile area, mycologists are documenting the effects of shifting climatic patterns on hundreds of species of fungi throughout the UK and other similarly expansive geographical areas (Gange et al. 2007). They draw broad conclusions like: “We predict that the projected rise of global temperatures by up to 4°C by 2100 will have drastic effects on fungal fruiting phenology. Because fruit bodies function as habitat and diet for many organisms, these changes may have profound side effects" (Kauserud et al. 2008:3813). This is in stark contrast to the specific observations reported in section 4.3 by harvesters in the MAR.

Gaventa (2006) distinguishes between power over decision making, power over who is involved in decision making and power in shaping what decisions are even questioned or considered. Bringing to light the power dynamics inherent in knowledge production about the morel is the foundation for understanding the different models of fungal conservation that are practiced by different groups of participants. Folk taxonomies and scientific taxonomies develop in different discursive spaces on different trajectories, and with different material consequences. Tension arises because these taxonomies operate with different spatial and performative limits specifically because of whose voices are recognized by the powerful as powerful. In the next chapter I explore how power over ideas affects the material practices of these three groups of stakeholders.

Stakeholders' conservation models are based on their ontological and epistemological constructions of fungi, materially constructed through practice. The practices in turn reify specific understandings of morels. I refer to this fundamental relationship between knowledge and practice simply as knowledge/practice. It is what underlies the definition of each stakeholder group. Indeed, the group identities are simply proxy names for this knowledge/practice. Though the analysis in this chapter, and that in the following chapter the depth of what these group identities really stands for becomes clearer. Furthermore, codifying and documenting traditional or local knowledge/practices and deconstructing scientific knowledge/practices have their own material effects. Exploring all ecological knowledge as discursive processes and products gives some parity to the stakeholder groups who are creating this knowledge because certain aspects of that knowledge, those seen as "natural" or “scientific,” are no longer given or taken for granted. This in turn has material effects for models of fungal conservation, once created, to be re-articulated in new sets of relationships. Group identities that are otherwise imbued with distinct power relative to each other are complicated and the hierarchy problematized.

Chapter 5: Practicing Fungal Conservation

5.1: Introduction: Knowledge/Practice

Whatmore (2006) argues that examining "nature-culture hybrids" by focusing on everyday activities allows us to go beyond a more narrow emphasis on knowledge production. This emphasis on practice does dual work by both uncovering the "epistemological 'habits' of scientific thinking" (Robbins and Bishop 2008:750) and illuminating otherwise hidden practices that form the basis of other knowledges. Articulating the "tacit skills…through which everyday life goes into the repertoire of knowledges" (Whatmore 2006:6) further differentiates and rounds out the stakeholder models of fungal conservation as they have thus far been developed. Indeed, the participants themselves have been categorized according to their practices vis-à-vis fungi. Harvesters *harvest* mushrooms, mycologists *study* them, and managers *manage* areas where they occur. Models of fungal conservation have been subsequently identified and differentiated based on these knowledge/practices.

This focus on practice is closely related to the post-structural and constructivist theoretical terrain addressed in chapter 4. In this chapter, it is also material practices that connect humans and the environment. An analytical focus on practice also incorporates social agency by reworking discourse itself into a type of practice (Whatmore 2006). "The notion that nature is socially constructed, rather than a pure entity external to society, forces us to take responsibility for *how* this remaking of nature occurs, in *whose* interests, and with *what* consequences (for people, plants, and animals [and fungi!] alike). It brings together ecology and social justice" (Braun, 2002:13, emphasis in the original).

If it is true that nature only truly becomes intelligible to us through our social practices, it follows that fungal conservation will also become more intelligible to us in this way.

Practices themselves are performative and spatially bounded. The practices discussed in this chapter are tangible. Therefore, a focus on practice means a focus also on the places where those practices occur. Indeed, as outlined in the first chapter, addressing the research questions resulted in working with harvesters in the MAR, with managers in the MAR and the PNW, and with mycologists in the PNW and in Europe. The knowledges and practices of participants are connected to these places, but in this study a focus on practice and knowledge does not pre-specify places of analysis. Rather, the grounded theory approach allows the research questions to drive the sites of inquiry. This theoretical approach overlaps somewhat with actor-network theory (ANT), "following" a path outwards from what is effecting fungal management and conservation policies in the mid-Atlantic region.[29] ANT specifies only that we "stay within the networks: thus we should never vacate the local…nor should we remain trapped in the local and the micro for the networks will undoubtedly travel far from those restricted realms. Instead…we should roam freely between these two extremes…to observe how the world is made" (Murdoch 1997:335). This is my approach to practice in the following section.

This is the third and final chapter based on the ethnographic data collected through interviews and participant observation. As such, it builds on the literature, data, and analyses in chapters 3 and 4. After a brief introductory section on practice, this chapter focuses on everyday and longer-term activities that are the social and cultural

[29] The act of following actors in order to elucidate links within networks requires that researchers do not identify levels of analysis in advance for study. Instead researchers observe actors and connections, and which connections are maintained, and which are not. (Latour 1987 in Murdoch 1997).

processes that underlie the stakeholder models of fungal conservation (section 5.2). In the final section of this chapter I summarize the findings of these three chapters by delineating models of fungal conservation.

5.2: Practices

Each of the three stakeholder groups in fungal conservation - mushroom harvesters, land managers, and mycologists - has specific reasons for its interest in mushrooms and what happens to them. Long-term mushroom harvesters have a stable morel ontology on which to base their management and conservation ideas and practices. They remain concerned with one species, morels, and one central theme, protecting the morel spores for the future. Managerial practices center around sustaining and protecting spatially bounded areas where morels may occur. Mycologists actively incorporate environmental crisis and conservation narratives into their practice of fungal conservation. They are concerned with fungal conservation both empirically and theoretically as it exists in policy and science; and its influence and relationship with other branches of conservation sciences. Their practice reflects this focus through the creation of policy documents such as red data lists and assessments of regional species diversity and ecology.

Harvesters' Fungal Conservation: Protecting the Spore

Harvesters, by very definition, actively engage with mushrooms through the practice of harvesting them. They use mushrooms for food, for self-renewal, to maintain and build social ties, and sometimes for income. They use morels, and a small handful of other species, in accordance with an experientially gained knowledge developed over time through practice.

Transcript data suggest that these practices and beliefs are based in the history of agricultural practices of the people that settled in the region as early as the eighteenth century. Harvesters have developed gathering, transport and disposal practices that respect and protect the spore, often called the seed, from one year's crop to the next. For example, when harvesting, long-term hunters commonly leave a few mushrooms.

> H0501: The old beliefs were you have to leave some to seed, because they claimed they germinate or whatever you want to call it, in a cycle.

Others gently shake the mushrooms after they pick them, to "put the spores in the air" (H0706). Another common practice is to pick small or old morels, crumble or tear them into small pieces, and throw these through the woods or into the air. This participant's explanation of this practice further underscores the influence of an agricultural mentality:

> H0721: Well, I figure if you had one piece, you're only going to get one piece back. If you break that one into five and scatter it, you might get five back.
> ESB: Like cutting up a potato and planting the pieces?
> H0721: Right.

Harvesting methods also focus on not disrupting the mycelium, and there is a widely held taboo against pulling up or extracting the "roots." Roots are protected by pinching, cutting or breaking the mushroom off at the base (Figure 9). When the base or some of the mycelia are collected, many people often cut or break the bottom part off and leave it where they found it.[30] When the base of the stem remains in the ground, it is often covered up with leaves to prevent others from seeing it and thereby revealing the potential location of morels to others in the future.

[30] This is a practice I also observed mycologists doing in the field.

Figure 9: Harvester Picking a Cappy at CATO

Once the morels are collected, they must be transported out of the woods. Although plastic bread bags traditionally were used to carry mushrooms out of the woods, very few harvesters still use them. Instead, many report using a plastic grocery or Wal-Mart bag. Paper bags, shirts, hats, bushel baskets, and wash-tubs are also sometimes used. In recent years the idea of using some sort of mesh bag in order to let the spores circulate has been popularized by newspapers, television, the internet, and word of mouth. Several harvesters have switched to at least periodically using some type of bag with holes, whether bags commercially marketed for mushroom collecting or something from the grocery store like an onion sack.

Harvesters report that the use of a mesh bag is not always positive, and sometimes leads to the drying out or tearing of the morels. Mycologists are doubtful about whether the use of these bags is actually helpful, since morels must be mature before they will release viable spores (S0706). Despite this lack of efficacy, and the potential negative effect on the mushrooms, harvesters say they are willing to do this in order to help sustain the morel population. The integration of the use of these mesh bags for transport represents an adaptive practice, and is also closely related to the long-standing idea of maintaining spore dispersal:

> We use those perforated bags, like onion bags, because my great-grandfather told my Dad, and I was there, he was like, 'well, you have to use those bags because it spreads the spores.' And my friend's grandfather and his dad, [they] told him the same thing. (H0510)

Spores are also considered in the processing of morels. For example, it is widely known throughout the MAR that the first step in processing morels at home is to soak them in salt water "to get the bugs and the critters out." Some harvesters transport that water back to the original site where they found the morels and dump it there to "re-seed" the site. Small brown spots cut out of the mushrooms, stem ends, or spoilt mushrooms are added to this disposal water as well. Others distribute these materials to areas they have identified as potential morel sites. Harvesters believe that these methods are rarely successful, but they continue them regardless.

Harvesters, like scientists, document their observations and practices. Record-keeping is most often in the form of photographs of prize finds. These photographs usually have dates printed or hand-written on them. In this way people are able to keep track of good years, and document the quantity and quality of morels in the region at key times. Four participants had written records of their morel hunting activities over the years. For two people, this consisted of writing down in a small calendar the total number and location of each day's find. Another kept a digital record of the best days' harvests and created a map of "hotspots" on his land for his children to use in the future. The fourth participant had extensive records dating back to 1979, in which he recorded daily totals and locations.

Many harvesters also carry out experiments. The most common experiment is to try to determine whether morels continue to grow, or not, once they have emerged. To measure growth, many harvesters report placing sticks next to morels, checking them regularly, and marking the height of the mushroom on the stick over a specific period of time (usually up to two weeks). Others have placed cups or coffee cans over a mushroom to assess whether it grows in the dark. These experiments have yielded mixed results, due to variations in methods, duration, and whether or not the harvester accounts for confounding factors. Most harvesters have found that morels do grow.[31]

These practices are all local practices that occur in the MAR. They are a part of everyday life around Catoctin Mountain and the town of Little Orleans.[32] The practices, and the knowledge that they are based on, are passed down over time and are held closely as part of a local identity that separates "mountain people" from "flatlanders." These practices are maintained over time because they form part of the collective identity of these communities in the past and the present. They also represent an approach to the local mushrooms that has been shown to be sustainable, and in combination with the LEK in Chapter 4, form the basis of the harvester model of fungal conservation.

Scientists' Fungal Conservation: Protecting Biodiversity

The conservation practices of managers and mycologists are more difficult to differentiate because they are mutually constitutive in many ways. This is apparent in the

[31] For more on this discussion see Appendix A in Barron and Emery 2009.
[32] These two locations represent epicenters of harvester-participants.

literature reviewed in chapter 2, and in the discussion of the ways in which managers support scientific research in chapter 4. However, I maintain this separation here for the sake of consistency and to emphasize other aspects of practice for each group.

The production of knowledge itself is a practice, and one that scientists, specifically, are understood to engage in (Latour 1988). Mycologists create knowledge specifically for fungal conservation through the creation of red data lists, especially in Europe.[33] Red lists have become increasingly important over the last few decades under the direction of the ECCF. National level lists in many eastern European countries especially, are created with the express purpose of inclusion in the pan-European list. Picking up on the issue of red data lists introduced in chapter 3, I present additional findings here from participant observation at the ECCF and the MSA meetings about the practice of creating these lists and the scientific dialogue and debate that they engender.

On July 26, 2009, I attended a workshop at the 2009 Botany and Mycology conference: "Evaluating Conservation Status of Fungi using IUCN Criteria," given by Anders Dahlberg. In addition to myself and Dr. Dahlberg, there were seven mycologists in attendance. Dr. Dahlberg is a past president of the ECCF, and remains a member of its executive committee. He has been influential in directing European fungal conservation activities, as well as those in his native Sweden. Since American mycologists, through the MSA, are mobilizing on fungal conservation, there has been increased interest in creating red data lists for fungi in the United States. Dr. Dahlberg was asked to give this workshop in order to demystify the process, demonstrate how these lists have been created in Sweden and elsewhere in Europe, and provide a forum for discussion of this tool in the

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[33] Red lists are a conservation tool of the IUCN. The IUCN is an international focal point for global biodiversity for governments and non-governmental organizations. See chapter 2 for more on the IUCN and red lists.

American context. What follows draws heavily from his presentation, and the ensuing discussion.

Dr. Dahlberg regularly begins his conversations on fungal conservation by asking why we need to even consider it. He puts the question directly to the group: “Is fungal conservation important, and why?” Here are some of the responses:

> “Fungal biodiversity is one of the main buffers our systems have, especially in the face of global climate change. We need to make connections about why it’s important to understand rarity, and identify rare species, and what are the effects of rarity.”
>
> “The public is interested in nature. That shows up in the media all the time. I want to share my passion for fungi with more people, and this is a way to do that.”
>
> “Conservation helps us understand biology because it drives interesting research questions.”
>
> “For overharvesting, we have to know population structure and fruiting or we’re just talking.”

Once the participants are satisfied that they have made the case for conservation, the discussion turns to how to make it happen, and to the power of the red list. Dr. Dahlberg makes several points over the course of his presentation (below). In reading through these points, note the level of interpretation and decision making that is inherent at each juncture.

> Red data lists (1) aim to evaluate the risk of extinction of species, (2) provide important information on biodiversity, and (3) are important tools for making nature priorities. It is important to note that assessing extinction risk and setting conservation priorities are two related but *different* processes. Therefore, red-listed species can be any of the following: (1) common but declining, (2) uncommon and declining, or (3) very unusual. All evaluated species (“not evaluated” is a large category of its own) fall into categories ranging from species of least concern (not red-listed) to regionally extinct (Figure 10). (Dahlberg 2009, presentation at Botany & Mycology conference, Snowbird, UT.)

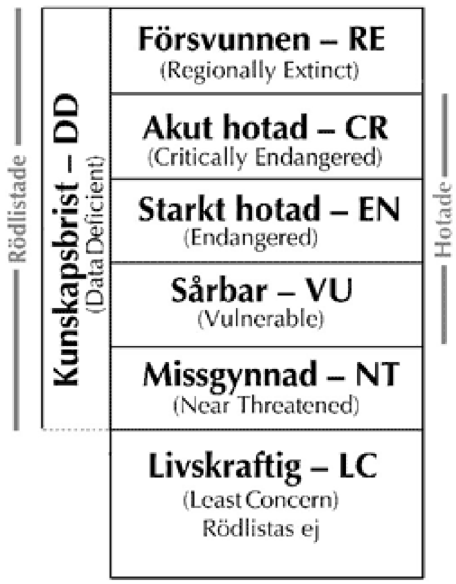

Figure 10: Red List Categories used in 2005 for Swedish species. Based on IUCN Red List Criteria (Swedish translations: Rödlistade = red listed; Hotade = threatened) (ArtDatabanken 2009).

Categories are meant for application at various spatial levels. They are based on IUCN Red List official criteria, but have never been tested for fungi. They represent the culmination of extensive ecological analyses to assess numbers of individuals present (abundance) across specific areas (range, habitat, distribution) over time by species. The mycologists recognize that this is problematic on several levels, and discussion on how to assess individuals over time, what defines habitat, and issues in fungal taxonomy (see chapters 3 & 4), are all raised during the workshop.

In comparison to attendees at the ECCF meeting in 2007, the American mycologists seem particularly concerned with the precision and accuracy of data available for these assessments. This makes going through the assessment process at the workshop, despite the fact that it is “just practice,” rather contentious as the group splits between those who are comfortable with the method and those who are not. Discussion centers around how much data is needed to make decisions about a species in terms of where it would fit in figure 10. Some present feel that only “hard” data is sufficient to make such decisions. The majority feel that anecdotal information is valuable, especially if that is the only data available.

For our test case, we eventually settle on *Bridgeoporus nobilissimus*, commonly called the Noble Polypore or the Fuzzy Sandozi. This species was considered in the Northwest Forest Plan, and listed in the Oregon Natural Heritage Plan, List 1: threatened or endangered throughout its range (Oregon Natural Heritage Program 2003). Over the course of 20 minutes, the group goes through the criteria on the handouts, and determines that the Noble Polypore is eligible for red listing. This is an exercise at the time, but given the amount of data known to be available for this species and the level of expertise in the room, it is fairly clear to everyone in the room that if and when a red list is created for the PNW, this species will be on it.

One of the reasons for the tension over the creation of red data lists in the United States is because of legislation. In Europe there is no link between red lists and policy or enforcement. There is one in the U.S. and Canada. While the red list is not synonymous with the Endangered Species Act, it foments similar tensions among interested parties. This debate makes mycologists uneasy, especially those from the PNW who have been involved in political battles: “The bottom line in the northwest is defending it in court and in the legal system. We need to have hard and fast, defendable numbers. Agencies and legal systems require hard data and definitions.”

In Europe, however, red lists are simply advisory guidelines created by scientists and provided to policy makers to do with what they will. It is, perhaps, precisely this lack of obvious political power that suggests to mycologists that they are practicing science, and not engaging in politics:

> The [ECCF members] are all scientists, but conservation is political; you're not doing conservation if there's no political element. The ECCF has behaved in a gentlemanly and scientific way, but they need to develop a political element if they want to get anything done because they need support from [the public]. (S0702)

By "political element" this mycologist is referring to the mobilization of civic voting power by members in an outside organization, such as the Audubon Society. He goes on to suggest that perhaps the political part might need to be a separate organization in order to maintain a clear line between science and advocacy. The intense political dimensions of the red lists remain unacknowledged.

The juxtaposition of science and advocacy was also apparent at the ECCF meeting in 2007.[34] Representatives from at least 14 member countries were present at the meeting. The ECCF has one or two bigger meetings each year for 2 – 3 days where they do the "heavy lifting." This was a public meeting essentially for the purpose of updating attendees on status reports from different countries. Official business included electing new officers, and an update on the 5th Planta Europa meeting. What follows is an excerpt from the official meeting minutes discussing the update:

> Claudia Perini reported about her participation in the 5th Planta Europa Conference on the conservation of wild plants and fungi. The main results of the workshops during the conference were further steps in developing a new European Strategy for plants and fungi, which were integrated with the CBD.[35] … Among highlighted items was ongoing importance of assessing species conservation status and producing Red Lists - which goes well together with [the ECCF's] plans to prepare a European Red List of macrofungi.

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[34] 17 September 2007 during the XV Congress of European Mycologists, in St. Petersburg, Russia

[35] CBD: *Convention on Biological Diversity* http://www.cbd.int/ as part of the Global Strategy for Plant Conservation (GSPC).

This excerpt suggests that ECCF mycologists see their creation of red data lists as appropriate scientific activity specifically because it aligns with other scientists' conservation practices.

The salient point is that for many European mycologists, practicing fungal conservation means creating red data lists, which are in fact both scientific *and* deeply political. American mycologists who have engaged in fungal conservation activities in the PNW are aware of this because their actions have been more closely related to political debates (the spotted owl and the NW Forest Plan). Furthermore, as government scientists in the PNW, their actions have often been in direct response to the needs of management in order to support decisions about access to and management of fungal resources.

Managers' Fungal Conservation: Protecting the Ecosystem

All seven managers in the study work in parks or areas where mushroom hunting is a popular activity. Some managers also actively engage with the mushrooms on their own terms; three of the seven land managers are active mushroom collectors. However as a group, managers' formal practice of fungal conservation is strongly influenced by their perceptions of nature and the environment, and by their institutional and structural positions. The result of this focus on the ecosystem is that one major way that managers practice fungal conservation is through the support and use of mycological research in their decisions on appropriate ecosystem management. The second significant conservation practice of managers is influence over the spatial domain in which the morels occur. Three aspects of managers' practice, enacting agency missions within agency guidelines and restrictions, supporting science, and managing the social dimensions of spatially bounded areas, are discussed below.

Both the NPS and the Forest Service are tasked with protecting nature and resources, and providing for the recreational enjoyment of citizens. The mission statement of the National Park Service is: "to conserve the scenery and natural and historic objects…and provide for the enjoyment of the same in such a manner… as will leave them unimpaired for the enjoyment of future generations." (*The National Park Service Organic Act* 1916), and the motto of the US Forest Service is: "Caring for the Land and Serving the People" (USFS 2004). These mottos express the tension within these federal agencies between conservation and preservation, protection and stewardship, society and nature. Managers' practice is the embodiment of this tension. They support and reinforce concepts of nature as separate from society, and of the federal government as the official body that regulates these relationships. Similar tensions were reflected in the managers' comments about their responsibilities towards fungi and visitors, like this one from the forest ranger in charge of special forest product management in the PNW region:

> Like I said before, everything we do is resource driven, but if we felt there was an issue and we needed to control it, we did. So we're protecting species, protecting an area, protecting something. Or, to make sure everybody gets a fair share, then we may have to do that. Sometimes people are upset about it, but for the most part we have kept all those options open, it's different from forest to forest. Now if the general public's happy with it, and one or two come in and bitch, I mean, it's democracy. We're not trying to make life harder for anybody, we're just trying to manage it and protect it for perpetuity. (M0707)

Enforcing these regulations and changes in management can be challenging. Both the NPS and the USFS are very large national agencies with hierarchical command structures. MAR managers at individual units are the field agents that deal with day-today operations of natural resources management at parks that do not have nationally high visibility. As one manager said, "Let's face it, it's no Glacier [National Park]." Staffs at NCR parks have also been cut back considerably, and this has created a great strain on resource managers in this region. One manager, for example, who has a Bachelor's degree in Forestry and Wildlife Management, describes his job this way:

> There's only two of us now on the staff. I deal mostly with animals and plants. He deals with water issues and things like that. We do research permits for scientists. I do fire management if we have any wildfires. I deal with some of the trails in the park and work with volunteers to do trail projects and maintenance projects…we had four people at one point, now we're down to two. We don't have specialists like a bigger park might. (M0701)

At a park like Yellowstone there are at least six *teams* of people working on these same resource issues, in addition to multiple teams of university researchers providing additional scientific support. M0701 does not have the training, or even the time, to specifically address fungal management unless it becomes a pressing issue over the responsibilities outlined above.

Managers also feel that they have limited access to resources that could potentially assist them in their work, such as regular communication with agency employees at other parks dealing with similar resource management issues:

> M0702: Right now with our deer Environmental Impact Statement, you know, Rocky Mountain [National Park] is going through some similar stuff…we get some information back and forth but only because people are going through almost extraordinary measures to find out what's going on and letting us know, it's not as if I'm talking to anyone from Rocky Mountain.
> ESB: Can you just email them?
> M0702: I could. We're letting the regional people handle it because they can fill in more than one park. And as far as all of the parks getting together for a conference on the deer problem, that's not really happening.

Actually, that is exactly what happens every other year at the George Wright Society Meeting, the biennial meeting for the "association of researchers, managers, administrators, educators, and other professionals who work on behalf of the scientific and heritage values of protected areas" (George Wright Society 2010). Based on my observations at these meetings in 2005 and 2007, very few park-based managers attend, despite an expressed desire to do so, because of funding cuts and time constraints. Instead, they rely on information from the meetings to be communicated to them by senior staff.

It is clear that in the case of fungal management, field managers are looking for guidance from regional level scientists and administrators, whose actions are influenced by the public, politicians, and the scholarly science community. Such diverse interests and influences make following the "one-third" rule, explained to me by one manager as trying to keep one third of the people happy one third of the time, challenging at best. However, despite these constraints, conditions, and challenges, managers do affect fungal conservation. This goes beyond the commissioning and application of scientific research. Precisely because fungi are parts of the ecosystems that managers are responsible for, other operational decisions that managers make have direct and indirect effects on fungi. This includes their decisions on access, on management of other parts of the ecosystem, and on how to work with law enforcement. These practices are illustrated below with examples from the morel study.

The first operational decision that directly affected morel hunting in the MAR came when parks started placing limits on the amounts of morels that could be harvested. None of the managers interviewed could recall when harvesting limits were first enacted in the MAR, or why the quantities for these limits were chosen as such. Comments from PNW managers suggest that limits may be chosen based on personal preferences or experiences of the person tasked with making the decision at the moment, and may be somewhat arbitrary. However, there was consensus that CHOH was one of the earliest regional parks to have a daily limit of ½ gallon per day per person. Different NPS units in the region have different regulations (Figure 11). When the morel study was commissioned, CATO did not have a specific limit on harvesting. In 2007, the limit was set at less than 1 gallon, and in 2008 it was set at ½ gallon.[36] State parks technically do not allow any harvesting, but in informal conversations with personnel, I was told that this rule is rarely enforced. In fact, most of these harvesting limits are rarely enforced because of limited personnel, and varying feelings about the regulations themselves prevail among park managers and law enforcement.

Catoctin Mountain Park: "The gathering in amounts of less than one gallon of mushrooms or berries for personal consumption per person per day is permitted." It goes on to specify ½ gallon per person per day is allowed for all mushrooms (Poole 2004:8). Note: this is a change from 2007, when it was "less than one gallon" and a further change from 2006, when it was "small amounts."

C&O Canal NHP: "Edible fruits, nuts, berries, and mushrooms may be gathered by hand for personal use or consumption. Commercial use is prohibited. Removal of fruits, nuts, berries, and mushrooms cannot disturb the remainder of the plant." Limit: ½ gallon per person per day. (Brandt 2006)

Rock Creek Park: "No fruits, nuts, berries, seeds, mushrooms or cut greenery may be gathered or collected for personal or business use or consumption in Rock Creek Park." (Rock Creek Park Superintendent Compendium 2008)

For all state parks in Maryland: Title 8, subtitle 7 section 6.13: 08.07.06.13:
B. In a State park an individual may not:
(1) Remove, disturb, damage, or destroy a plant, rock, mineral, or animal;
(2) Cut down, remove, or destroy a tree; or
(3) Feed, touch, tease, frighten, or intentionally disturb wildlife. (McDonough 2008)

Figure 11: Examples of varying state and federal regulations for mushroom collecting in the MAR (last updated August, 2008).

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[36] The final report for the morel study was submitted to the NPS in 2009. At that time the current limits on daily harvesting at CATO were still ½ gallon/person/day.

The commissioning of the morel studies (chapter 1), and the decision that, regardless of the results of the studies, any changes in management would be purely social in nature (Emery 2004), directly affected MAR morels and stakeholders. This pre-determined course of action suggests that changes in management were expected, and that the findings from both studies would support them. Managers' individual expectations were mixed, but they coalesced around the need for intervention:

> I think we need a management plan for morels. We need to know if collecting has an impact. If so, how to properly set up some sort of restrictions so that it will be sustainable in the future, and try to do it in a way that we get cooperation of the mushroom hunters. That it's not to be a "you can't do this anymore" situation. (M0501)

This manager is concerned for both the resource and the harvesters, but the question asked was, "Do you think the NPS needs a management plan for the mushrooms?" His response immediately focuses on the ways a management plan would restrict collecting in order to make mushroom harvesting sustainable. The expectation is that restricting access will benefit the mushrooms.

A second quote illustrates the division between nature and people that underlies ecosystem management, and therefore any potential morel management plan:

> ESB: Do you think, depending on what information you get from all this research, that mushrooms might need an active management program?
> M0701: They might, yeah, depending on what we have in the park. If we can get a feeling for the impacts, the unnatural impacts, you know, people collecting them and what not. If we could get some kind of [sense of that]. Enumerate that to someone, is it great, is it minimal?

This manager talks elsewhere in his interview about the need to first collect scientific data on the fungi of interest to better understand their environmental parameters, to "try to get a feeling for what's happening to them" in relation to other environmental processes; to find out: "[Are the morels] doing what [they're] supposed to do [in the ecosystem]?" Depending on these findings, the next step is to get in touch with the public, but the first step is to take a "scientific approach."

Managers often fall back on science as a way through this difficult terrain (chapter 3). All the managers have education and training in the biological sciences and similar orientations towards the environment. Science is a path both advocated by the agencies, and their agents:

> Fungi in general have a very important ecological role, and there may be some specific things that morels are important for that we know nothing about. And, since they are really important to a certain segment of our visiting public, it would be nice that they have them in the future, to be able to appreciate them as well. If we end up losing them [the morels] then [the harvesters] can't harvest them anymore. (M0703)

Managers strive to base their fungal management on science, underlined by their belief of an external-to-human natural world that must be protected. PNW managers, who have been working on this issue for decades, commented that "NTFP management is people management, plain and simple." But they still based their approach to people management on science-based understanding of the resource. The problem with MAR morels, for managers, is therefore that there are not sufficient scientific findings to support changes in management on those grounds.

In response to this lack of scientific information, in the final report for the morel study we offer alternative management ideas based on LEK. For example, we suggest the protection of morel associate saplings, and the maintenance of root systems of morel associates, such as elm, when they die and are slated for removal.[37] We also suggest designing scientific experiments based on LEK, and in coordination with harvesters.

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[37] Trees are removed at parks when they are deemed a hazard, meaning usually that they have fallen across a road or a path. We suggest rotating the tree or cutting the bole in such a way as to maintain the root system for morels (Barron and Emery 2009).

These proposals are premised on maintaining good relationships with local harvesters and local communities, both of which are important to managers. Because of the emphasis on the social aspects of morel management, we make recommendations for social dimensions of morel management as well (Barron and Emery 2009).

An underlying premise of national park land management is that parks are areas where specialists, with expert knowledge, determine the balance between nature and society. Inside the boundaries of national parks, nature takes priority. As is evident in the comments of M0501 and others, managers are not excluding people out of disrespect or malice. If they restrict access it is because they see their actions as protecting nature from what is unnatural, from humans. Ironically, they do this specifically for the future of the earth and the humans that live on it. Finding the balance in this relationship, while unapologetically prioritizing these parcels of nature as much as possible, is at the heart of managers' practices of fungal conservation.

5.3: Practicing Scholarship

Knowledge does not, according to a poststructural perspective, exist independently of the people who created it – knowledges are partial and geographically and temporally located. (Hay 2005:257).

In a dissertation so focused on the situatedness of knowledges and the positionality of experts, it would be remiss for me not to consider at least a few of the ways in which I have influenced this research, and the knowledge created within it. Of course, the most obvious part of this consideration is the fact that I directed the research. Under the direction of my advisors, I created the interview questions, I asked the interview questions, I analyzed the interview data, and I wrote about it. My standpoint is clear throughout: I believe that all the stakeholders identified in this dissertation have contributions to make to fungal conservation. Some of those contributions are more widely acknowledged and praised, others are not. Ultimately my goal is to produce knowledge that has an equalizing effect between scientific and traditional/local ecological knowledge.

In this section, I explore the experience of doing this research by considering harvester comments on my participation in the morel project, and my engagement with managers and mycologists. In the process of coding and analyzing the interview data for this research, I eventually developed a code called "embedded me." These were comments in which the participants referred specifically to me as a researcher and as an authority figure, referenced my identity, tested my knowledge of mushroom hunting or of mushrooms, or expressed appreciation of my efforts.

Several harvester-participants made comments that acknowledged me as an authority figure. The tone of these comments, and their intentions, varied considerably. Eight people specifically considered the research I was conducting as a way that information would be collected and discovered about why morels were declining in their area. They looked forward to finding out what was happening to the mushrooms and they wanted to help me, the "mushroom scientist," the "professional," figure it out. They were pleased that I had sought them out for their ideas and opinions, but comments such as, "well, you probably know all this already," were common. My authority was not always taken for granted, however. I was, at times, asked specific questions meant to test my knowledge of mushrooms both inside and outside the MAR.

Some participants were unsure how the information I was collecting was going to be used, and this made them suspicious of me. They felt specifically that I was responsible for getting them the results. Over time, as I learned more about MAR morels, as I met more people, as I hunted for and ate morels myself, I became more established as a credible, trustworthy outsider. I received a nickname locally as, “the mushroom girl,” and regularly had to identify myself as such before people would remember who I was. This transformation included several key points in harvester-participants’ eyes. One was that I was actually there:

> H0720: Well, it's like what you're doing now. I'll use you as an example. Simple fact is you’re in college and you're studying all this, and you're getting ready to write up a big report about it for the government, for your college or whatever, but you're out here also, doing it. You've evidently been out hunting mushrooms and eating mushrooms so you know, and that just makes it more real to the other person because you've actually experienced it…You'll see two sides of it.

H0720 mentions the fact that I have actually eaten mushrooms, and most of the harvester-participants did ask me if I had eaten them, and then also whether I liked them or not. They would press me to try to describe the taste, and on where I gotten the ones I had eaten:

> Husband of H0722: Did you find anymore, after [you went with us], did you go anymore?
> E: Yeah, I went two more times after that with other people, we did ok.
> H0722: She's not going to tell you [where she went]!
> E: Well, I'm kind of concerned about the time. I can tell you all about it later but I want to get through everything so.
> Husband of H0722: She's got the fever.

Through my engagement with both harvesters and with morels, I earned peoples’ trust and respect to the extent that I was taken mushroom hunting on several occasions, and continue to be welcomed back. An important part of maintaining this trust is following through on commitments to participants to distribute information. Accordingly, copies of the final report were mailed, to all those who requested them, in May, 2010.

The final report is a publication of the National Park Service, the employees of which made up the bulk of the managers interviewed for the fungal conservation project. Because the morel project was a cooperative agreement with the NPS and the USFS, I assumed managers would understand me to be an ally. This was not the case right away. Managers were not familiar with the ethnographic methods I employed, and some were suspicious of the social science study overall. They also tested me in the interviews. They tested me on my scientific ecological knowledge, my research methodologies, and eventually on how I arrived at my conclusions. Over time, I think they did come to see me as an ally, and Dr. Emery and I received positive feedback on the final report. In stark contrast, managers in the PNW were very familiar with social science research and a bit wary as well. They felt that they understood why I was there, and what I might do with the information they provided. Their experiences made them careful about what opinions they shared, and how they expressed them.

For the mycologists, I was a novelty. I heard the phrase, "your research is so novel," more times than I can remember. This group also seemed to have the clearest and most fixed concept of my identity in relation to them. They were very excited that I was interested in fungal conservation, and talked to me freely. Some were interested in my comments and my findings; others easily dismissed them. For many of these senior scientists (mostly white men), I was a younger white woman and a graduate student, and that influenced how they viewed my work. I was a social scientist, which was novel, and often not quite understood. The exceptions to this rule were the Europeans who were much more familiar with geography because it is a more widely acknowledged and understood discipline in Europe. In general, mycologists were very excited that there was interest, "outside" interest, in fungal conservation, but they did not quite know what to make of it, or of me. I often got the sense that I was welcome, but also that the novelty of it all translated into not being taken seriously.

Acknowledging the choices that I made through the process of this research, and my relationships with stakeholders, is the process of writing-IN to the research (Hay 2005). This process begins to acknowledge my positionality, my individuality, and my creativity in the research process.

5.4: Delineating Models of Fungal Conservation

Participants in this research were selected originally for their experiences with morel mushrooms in the mid-Atlantic, and subsequently for their experiences with morels and fungal conservation. Harvesters have a deep understanding of the types of morels occurring in their region. Over time they have established a series of practices that help them to know morels, and to protect them. Managers similarly know the morels that occur in the areas in which they work, although in a more shallow way. Their practices are shaped strongly by guidelines from above, but are also very much affected by each manager's everyday experiences and activities. Because scientists were not specifically selected for inclusion in the study based on their work on morels, as a group they had the least site specific detailed knowledge of the genus. However, their practices shape a broad approach to fungal conservation based on abstract concepts that are important for conservation. For mycologists, the applications of concepts like generation time and population size are as applicable to morels as they are to any other fungi.

The practices outlined here do not represent the sum of all the individual practices of each participant in regards to fungal conservation. A "rationalistic approach to knowledge is essentially an individualistic one…[but] the embeddedness into practice view stresses the collective, the individual as being part of an epistemic community" (Ibert 2007:105). Rather, they emphasize the dominant knowledge and practices of each group in relation to their ecological and biological knowledge, how it is practiced, transmitted, documented, and influenced by outside forces.

In chapters 4 and 5 these experiences have been re-cast through the lens of knowledge/practice. I have argued that models of fungal conservation are determined by the social processes that produce and are produced by these situated knowledges and practices. In exploring these social processes, stakeholders are grouped specifically by the nature of their practice vis-à-vis fungi, and the knowledge that practice produces. Taken together, this knowledge/practice becomes a significant way to understand differentiated models of fungal conservation.

While all the stakeholder groups see morels as potential objects of conservation, how that conservation takes form differs substantially between groups. The emerging models of fungal conservation consequently form around these epistemic communities. Stakeholders, and their models of fungal conservation, are defined in relation to their knowledges and positions of power: those that control the morel conservation discourse with scientific knowledge, those that control access to morels with state power, and those that have/control local ecological knowledge and an historical claim on morels.

Therefore, "models of fungal conservation" emerge and solidify along a priori stakeholder group lines because the groups are defined by material expressions of their knowledge/practice.

Scientists base their model of fungal conservation on what they understand as objective, universal knowledge of fungi. As this knowledge is accumulated, it is articulated with other existing knowledge about the environment, the biosphere, and the ecosystem. The correspondence theory of truth suggests that those that are more educated about fungi and these various systems, the experts, will have more accurate ideas about nature and how to protect it because they have a better understanding of reality through the accumulation of knowledge.[38] Scientists know that fungi are negatively affected by anthropogenic changes to the environment at multiple spatial scales. Their model of conservation, therefore, emphasizes mobilizing against pollution, habitat destruction, and global climate change at multiple scales. They recognize that they must reach a broader public, and decision makers, if they are to affect changes in these areas. They practice the continuing accumulation of knowledge to further these aims, and are increasingly mobilizing using established political tools of conservation such as IUCN red data lists.

Managers base their model of fungal conservation on their knowledge of the history of, and their personal experiences with, other types of resource extraction. The dominant narrative of resource extraction in the U.S. is one of over-exploitation defined by the tragedy of the commons (Hardin 1968). It is clear that this narrative has been applied to morels and other wild edible fungi, as many managers know morels specifically because of their extraction as a resource. This narrative is further underscored

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[38] "Truth is defined by correspondence between our ideas about the physical environment and how it actually is (correspondence theory of truth)" (Demeritt 2001:26). For more on this see section 4.4 on the discussion of scientists' knowledge.

by managers' primary concerns about barriers to effective conservation: climate change, ignorance, and overharvesting (chapter 4). These last two represent the causes and effects within the tragedy of the commons narrative.

MAR managers are aware of the local significance of morel mushrooms, and as a group they support this cultural practice, yet for most that does not fundamentally change the primary goals of ecosystem management. Their approach to fungal conservation is embedded within this goal. It is expressed differently at different parks depending on available resources, access to scientists and scientific data, and managers' experiences and length of time in their position at each park. PNW managers have had greater human and financial resources to address the extraction of wild edible fungi, and this has in turn given them greater access to scientists and scientific findings. Based on research findings, and their additional years of experience with morel harvesters, PNW managers emphasize a more nuanced "people management" that constitutes the bulk of their fungal conservation practices.

Harvesters base their morel conservation on accumulated experiential knowledge augmented by continuing observations and information. They maintain a stable ontology of the morel that rests on collective agreement and experience. They base their knowledge of morels on detailed, specific, long-term observations. This has resulted in a harvester model of morel conservation that is in place in the MAR through a series of harvester practices that aim to leave the mycelium undisturbed, spores available for "seed," and others to be redistributed. For harvesters, this shifts the emphasis for conservation interventions onto larger anthropogenic disturbances to morel habitat such as those brought on specifically by development, by all types of habitat disturbance, and through the effects of changing weather patterns and climatic trends.

In recognizing particular and specific embodiments of knowledge/practice, the objective moment of naming these models is a moment of opening rather than closing because it includes the recognition of different ideas, rather than the discovery of a single truth. Similarly, a focus on the knowledge processes and material practice of all three groups demystifies science because everyone is the expert of their own practice. All the practices can be understood as everyday activities, and also as political and social endeavors with material consequences across space and through time.

Up to this point, the examination of this emerging discourse has focused on social spaces dominated by specific stakeholder groups, such as mycological conferences. It has emphasized stakeholders' biological and ecological knowledge and practice in relation to these groups from an historical and situated perspective. The next chapter takes a decidedly different approach to the examination of stakeholders in fungal conservation. The a priori stakeholder groups are left behind, and analysis is based on a holistic view of each individual in relation to the primary issues of morel management and conservation. This analysis is tied most strongly to a specific place, the MAR. The second part of chapter 6 also connects the knowledge/practice analysis of chapters 4 and 5 to a specific place through the integration of harvester and scientist knowledge/practice to examine morel habitat in the MAR.

Chapter 6: Quantifying Models of Fungal Conservation

6.1: Introduction

The Man and the Biosphere (MAB) study conducted in the PNW established a key precedent in the study of fungal management and conservation by defining discrete “stakeholder” groups (user, manager, scientist) (McLain, Jones, and Liegel 1998). This structural approach has many advantages. It facilitates abstraction and explanation that may otherwise be overlooked. Furthermore, it is straightforward and widely understood. Almost all interactions between humans and other species in protected areas, especially in the United States, are classified and commonly understood within these three categories. The groups have epistemological utility because they are experiential. There are comparable threads of knowledge and practice, such as how wild mushrooms are understood, or what is done with them. However, the knowledge and practice ascribed to each group is often assumed to be performatively bounded, with beliefs and political positions of individuals based solely on their group membership. The categories lose utility and become problematic when they transition from experiential and expansive to definitive and restrictive.

Alternatively, the relationships between people and fungi remain expansive when viewed through ontology and epistemology. In the preceding chapters on discourse, knowledge and practice, I use the categories because they bring explanatory power to the discursive formation of fungal conservation, and to the complexity and diversity of experience within and among the three groups. However, using the categories to define how each individual feels about political and social issues like conservation, harvesting restrictions, access, is where and experiential title may become an oversimplified label. For example, two harvesters may both have learned about morels from their fathers, but that does not mean that they will share an opinion about how they should be managed or who should have access to them. Likewise, two scientists may both think about morels in terms of their phylogenetic relationship with other fungi, but that is not indicative of how they think is the best way to protect them. In other words, case should be taken to not conflate the positionality of the individual with that of her/his group.

This chapter then, turns from the ontological and epistemological complexities of the last two chapters, to how the social and political issues are immediately confronted by individuals in fungal management and conservation, primarily in a American context. This is done through the use of Q method and an ecological field study design based on input from harvesters. In chapters 4 and 5, I suggest models of fungal conservation based on ecological knowledges that are organized by stakeholder group membership. In section 6.2, through Q method, each participant is considered individually, and then their group membership is discussed in light of the results. The findings complicate the models of fungal conservation posited in section 5.4, and suggest new, thematic typologies for models of fungal conservation. In section 6.3, I present the findings from an ecological field study designed to integrate methods of knowledge production, and therefore models of fungal conservation. The results of statistical concur with harvester observations on differences between morel and non-morel habitat at Catoctin Mountain Park. In the final section, I discuss the use of these quantitative methods in a dissertation that up to this point has been decidedly qualitative.

6.2: Complicating Models of Fungal Conservation: Q Method

Methods

The purpose of using Q method was to examine perspectives on the protection and preservation of fungi, with a focus on morel mushrooms as the case study. As with the phrasing of the interview questions, statements were selected to provide a variety of claims relevant to fungal conservation within the following subjects areas: ecology, biology, conservation, management, and harvesting practices and effects. A major difference between these two methods is that in the interview process, the researcher shapes the interview by asking the questions, and directing the interview. It is the interviewer that may decide to emphasize certain themes in the discussion or not, and these interactions between the interviewer and the participant affect the responses. In Q method, the themes and the positions expressed on the cards are presented equally to each participant. Of course, in both cases it is the interviewer who has created the questions and statements. The difference occurs at the moment of interaction. In the Q method it is the participant, who in sorting the cards, decides on her or his own which themes (s)he feels the most strongly about and wants to emphasize. This subtle difference can have significant implications. For example, when asked directly, "What type of land management policies do you think work the best – when trained professionals make decisions, or when professionals and local residents work together to make decisions, or a different way that I have not mentioned?" every manager responded that they believed it was better when professionals and locals worked together to make decisions. However, as I discuss below, this is not the sentiment that was expressed by managers in their Q sorts.

A total of 48 statements were created for the concourse (Appendix E).[39] The concourse of statements was compiled using quotes from the 2005 oral histories, excerpts selected from National Park Service and Forest Service websites dealing with fungal management, and the formal fungal conservation literature. The differences of opinion represented within the statements about these issues are the underlying logics around which the Q analysis takes its shape (P. Robbins, personal communication 2010). Within Q Method parlance, this approach is called a “hybrid structured deductive sample,” because it contains some interview data and some formal literature, compiled to promote theory testing by incorporating hypothetical considerations into the sample (McKeown and Thomas 1988).

The concourse was developed based on a priori hypothetical and theoretical considerations that represent a tacit hypothesis about the nature of the different relationships between stakeholders and mushrooms, namely that the stakeholder groups have different beliefs about fungal conservation that are reflected in comments and published texts. All the quotes were paraphrased to make them similar in length, no more than two sentences or four lines on the note card (Figure 12). Effort was made to put the statements in a similar voice, without losing their statements’ original meaning. Two examples give a sense of this process. The following quote from H0501: “There is no such thing as overharvesting because you can’t find all the mushrooms that are out there to begin with” was kept verbatim because it is concise (Figure 12). In contrast: “It is fair to say that, apart from those at a very few sites, the precise range of species of fungi present in any one area and their relative abundance or scarcity is usually unknown and

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[39] “Concourse” is the term used in Brown (1980) to describe the “population of statements” selected for the sample.

therefore conservation is meaningless" (Watling 2003:81) was re-written as: "Because the precise ranges of species of fungi present in most areas and how many there are is usually unknown, conservation of mushrooms is meaningless." Because of the specificity of words and phrases such as "relative abundance" and "scarcity" in an academic context, these words were removed.

18. There is no such thing as overharvesting because you can't find all the mushrooms that are out there to begin with.

Figure 12: Example statement card used in Q Sorting by participants.

Participants were asked to sort the 48 cards in response to the following instruction statement: "The following statements represent a range of ideas and opinions about what might be influencing the sustainability of mushrooms and other fungi. Consider these statements while thinking about the protection and preservation of mushrooms or whatever fungi you are most concerned about. Sort the statements according to those with which you most agree (+4) to those with which you most disagree (-4)." Like the concourse statements, the instruction statement was developed with attention to accessibility and vocabulary selection. The word, 'conservation' was specifically avoided because of its political implications in the U.S. context. Additionally, the word 'sustainability' was pre-tested with a non-random selection of approximately 10 people at a church coffee hour in Frederick, MD.[40] Based on this rapid, informal

[40] This "quick and dirty" assessment of vocabulary was conducted because these methods were finalized in the field.

assessment I determined that a general meaning of sustainability, whether something can, will or should continue in the long-term, was understood by enough of a cross-section of area residents to include it in the study design.

Participants were instructed to first sort the cards into three general piles: “agree or feel good about,” “not sure,” and “don’t agree or don’t feel good about.” From there, they were asked to further sort them on a scale from +4 to -4 as follows: +4 ranking (strongly agree; 2 cards); +3 (3); +2 (6); +1 (8); 0 (indifferent, 10); -1 (8); -2 (6); -3 (3); -4 (strongly disagree, 2).

In accordance with the method, participants were required to sort statements into a normalized distribution. Critics of the forced distribution argue that this approach distorts the participant’s true opinions, or that it is less authentic than if the participant were allowed to sort the cards in a free form way. Proponents downplay this concern: “The key point made in defense of normal distribution is that it forces participants to contemplate the Q statements in a thoughtful way” (Webler at al. 2009:19). Like Webler et al., my position was to force the normalized distribution, but to talk through the process of sorting with participants if they had comments. Participants were also given an opportunity to write comments on the back of the Q sort data form. Furthermore, since the statements on the cards were in the same subject areas as the questions asked during the interviews, participants had several opportunities to engage with similar concepts and express their ideas.

Analysis

Q method is a quantitative approach that utilizes factor analysis. Two types of factor analysis are typically used in Q, the centroid method and Principal Components Analysis (PCA). I chose to use PCA because I am more familiar with that technique. However, in Q, factor analysis is one part of the analytical process and additional steps are required to relate the results of the analysis back to the statements for interpretation. This makes it different from how PCA is used in wildlife ecology. Webler et al. describe the analytical process of Q:

> Factor analysis is a mathematical technique that reveals underlying explanations for patterns in a large set of data. In the case of Q method, the factor analysis identifies patterns among the Q sorts. The analysis produces some number of "factors," which are particular arrangements of the Q statements. Factors actually are Q sorts. These are called "idealized sorts" since they are produced by the analysis, not a participant. They are also called "social perspectives" because they comprise many people's subjective expressions. The job of the analyst is to read the idealized Q sorts and write a narrative describing each one, that is, to compose the social perspectives (Webler, Danielson, and Tuler 2009:25).

A free software, PQMethod, is available from Peter Schmolck specifically to perform Q analysis (Schmolck 2002). PQMethod is a DOS program based on the work and guidelines of Steven Brown, a leader in Q Method (Brown 1980). The software guides the user through the various steps of the factor analysis, the rotation, and the final Q analysis that correlates the factors to the statements using a z-score test statistic. In this case the z-scores represent factor loadings that have been weighted based on the number of participants' sorts that were used to compile the "idealized sort." Then, because factors are composed of varying numbers of sorts, the weighted factor loadings are relativized so that factors can be directly compared using the resultant z-scores. In the final output from PQMethod the z-scores are also converted back into the original sorting values so one set of the final outputs are "idealized sorts," representing these composite sorts, now displayed in the -4 to +4 scale.

The software only allows statements up to 60 characters, so for my analysis I manually abbreviated all the statements before importing them into PQMethod. Sorts were entered using the participant codes as ID tags. Once the raw sort data were entered, the program displayed the final sort, the mean and standard deviation (which should both be 0 in accordance with the normal distribution), and checked for any errors. If any number was entered more than once, or not at all, the program displayed a message and led me through the steps to fix it. This process of data checking during data entry, and the mechanism for data entry that allows for direct reading of the data form, insured minimal data entry errors.

As stated above, I chose to perform a PCA. There were 44 variables in this analysis (i.e. participants that completed the Q sort). PCA works using eigenanalysis (a technique from matrix algebra) to reduce redundancy in the data set (McGarigal, Cushman, and Stafford 2000). In this case, sorts that are more similar are combined into idealized sorts to create the factors. These idealized sorts are grouped separately from the other sorts based on the total variance in all the data. The second factor is orthogonal to the first and explains the next greatest variance, and so on until all the variance in the data is explained. What this means is that the idealized sort represented by factor 1 is the most different from all the other sorts, factor 2 is the second most different, and so on (i.e., the participants' sorts represented by the first idealized sort varied the most from the other participants and so on).

Eigenvalues represent the variance explained by the corresponding principal component, or factor (McGarigal, Cushman, and Stafford 2000). In this analysis the eigenvalues represented the extent of the difference between the sorts that were used to compile the various factors. Important outputs of PCA in ecology, "eigenvalues and total variance are relatively meaningless in Q-technique studies" (Brown 1980:233). For example, in ecology the eigenvalues are one mechanism used to determine how many factors to interpret. This technique is not as commonly used in Q method because the emphasis is not necessarily on the variance explained by each factor, but rather on the perspectives and logics underlying as many factors as one chooses to interpret. Although it reports all the eigenvalues, PQMethod only generates eight factors. I performed a varimax rotation on the first four factors, which attempts to rotate the factors for a simpler solution. These four factors had similarly high numbers of defining variables, and each explains 12-15% of the variance in the total data set (Table 5).

There are various criteria used to determine how many factors to interpret in each study. I decided to interpret the first four factors based on the greater number of statistically significant loadings used in the creation of these factors. Also, after the first four factors, the eigenvalues begin to level off (this is the scree plot method, see McGarigal, Cushman, and Stafford 2000). The percent variance explained by each additional factor also levels off, suggesting that the major differences are explained in the first three or four factors. Indeed, according to these criteria I could have also chosen to not interpret the fourth factor, but I did so because this factor showed some particularly interesting results (see below). Therefore, four factors were retained in the final solution and interpreted (Table 5). They explain 53% of the total variance.

Table 5: Factor Characteristics

Factors ("idealized sorts")	1	2	3	4
Number of defining variables	11	16	14	12
Explained variance (%)	12	13	15	13
Eigenvalues	12.5340	5.0522	3.9397	1.9677
Average relative coefficient	0.800	0.800	0.800	0.800
Composite reliability	0.978	0.985	0.982	0.980
Standard error of factor scores	0.149	0.124	0.132	0.143

After the PCA was completed, the next process in the Q analysis was to "flag" those sorts that loaded highly (positively or negatively) on the four factors. Flagged sorts are then used to create the weighted averages that result in the z-scores. This step relates the results of the PCA back to the statements. Following Weber, Danielson, and Tuler (2009), I flagged all loadings greater than ABS(2.58 / √N), or greater than +/-0.388 (Appendix F). In cases where a participant loaded significantly on more than one factor, the highest loading was selected to define group membership. There were three exceptions to this general rule for flagging. Both H0701 and H0712 did not have any loadings greater than +/- 0.388. However, because I was interested in associating all the participants with factors, I tagged their greatest loading, both of which were almost significant: 0.3792 for H0701 on factor 4, and 0.3873 for H0712 on factor 1 (only 0.004 higher than her loading on factor 4). Finally, H0730 loaded at 0.3995 on factor 1, but loaded much more significantly on factor 2 (0.4749) and so was tagged only on that factor. The last step was to produce the final analysis. This generated 67 pages of results for interpretation.[41]

In essence, the Q method uses a different mechanism to explore the same themes as the interview questions, but at a different social scale. Up to this point in the dissertation I have been building an argument based primarily on the data from the interviews, namely that models of fungal conservation diverge along stakeholder group lines of harvesters, managers and scientists. Using Q as an alternative method of data collection and analysis on the same subject areas, to some extent, tests that theory. If group membership accurately represents individual's positions, and models of fungal conservation are formed along these divisions, then group members should cluster by factor, and also in ordination space.

Interpretation

Statements that have high negative and positive z-scores are related to each other and used to interpret the meaning of each factor. Once the factors are correlated to the statements, they take on representational meaning independent of which sorts have been compiled to create them. They represent expressions of the relationships between the claims and internal logics that are present within the statements. The interpretive task is one of constructing and explaining a narrative based on the internal logic that is inherent within the statements that make up that factor. The statement in figure 12, for example, is about harvesting practices, but it also represents a specific approach to, or logic about, mushroom harvesting. If you are the type of person that believes that mushrooms are being overharvested (inverse of statement 18), you are probably less likely to think that

[41] See Webler, Danielson and Tuler 2009 for explanation of these outputs.

the future of fungal conservation is fairly rosy (statement 35). It is this process of identifying the logics that hold the statements for each factor together that is the first major step in the interpretation. Once these narratives are created, then they are related back to the participants. How the ideas/logics are tied to one another for each individual participant gives perspective on the participant's relation to different aspects of fungal conservation and to each other within and between groups. The first step is the interpretation of the individual factors. The following interpretations are based on statements that ranked +4, +3, -3, and -4 on each factor.

Factor 1: This perspective is based in a universal understanding of fungal ecology with four aspects. There is a strong sentiment that all fungi are equally important (opposite of 40), and that they need to be considered in terms of their relationships with other parts of the environment (39).[42] This importance is underscored by a strong belief that most conifer trees could not live without fungi (7). At the same time, there is agreement that the presence and abundance of certain fungi may change during forest development (43), so changes in abundance are not directly related to management and conservation concerns. This has consequences for management. For example, adherents to this perspective do not agree that timbering or prescribed burning would necessarily increase morel mushrooms (42).

Complementing this ecological knowledge is a secondary theme that focuses on the importance of conservation, and how to bring it about. A core part of this perspective is that, despite the lack of data on species range and abundance, conservation is

[42] The numbers in parentheses represent the number of the statement that expresses this sentiment. "Opposite of N" means that the sentiment written here is the opposite of that expressed in statement N, in this case of statement 40. This type of interpretation occurs based on whether the statement fell onto the negative or positive side of the distribution in conjunction with the overall interpretation of the factor.

meaningful (34), and should focus on the *places* where fungi occur (17). Mycologists have a lot of work to do in this regard, in terms of educating the public, government management agencies, and other biologists (37). At the same time, those who hold this perspective agree that morel hunters are selective in determining which mushrooms to collect (opposite of 25), and that protecting an area should not require prohibiting mushroom collecting entirely (opposite of 15).

The underlying logic of this perspective is that it is important to work to conserve fungi and that mycologists need to be major proponents of this work. This work is meaningful because of the significance of fungi for their own sake and for that of the environment as a whole. As such, fungal conservation should focus on the protection of places, rather than single species management or the prohibiting of harvesting or collecting wild mushrooms.

- ♦ Key themes: Fungal ecology and conservation
- ♦ Social Perspective: Based on scientific epistemology, the protection and preservation of fungi is meaningful for fungi and for the environment, accomplished through place-based conservation, led by mycologists, and does not interfere with local harvesting practices.
- ♦ Defining group members:[43] S0703 – S0707, S0710, S0711, R.M., M0706, H0712

Factor 2: The social perspective represented by factor 2 is based on a clear understanding of MAR morels: that they fruit under specific temperature and precipitation conditions that occur in the MAR (2), in association with ash and elms (1), and that it takes a combination of factors for mushroom fruiting to occur (41). Closely

[43] The sorts of the participants listed here had significant loadings on the factor (greater than ABS (2.58/√N)), and were therefore the sorts that were used to generate the factor.

tied to this knowledge is a belief that morels are declining due to inconsistent weather (9), rather than because of high deer populations (opposite of 32). There is also a strong sentiment that one of the best ways to protect morels or increase morel abundance is to protect associated tree species (1) from such disturbances as fire or timbering (opposite of 42).

A secondary theme here is related to harvesting practices. This theme has four aspects: that mushroom hunting is a tradition (1), that it does not generate any income (opposite of 47), that it should be allowed (opposite of 15), and that it is an activity that occurs throughout the forest, not just near roads or paths (opposite of 44).

Combined, these two themes represent a strong logic that mushroom hunting is a personally significant activity that requires a specialized knowledge and skill set, and that it should be allowed. At the same time, there is a belief that mushrooms are declining, and opinions about why this may be occurring and what to do about it.

- ♦ Key themes: MAR-specific morel ecology and harvesting practices
- ♦ Social perspective: Based on experientially gained detailed knowledge of localized morel phenology and ecology, there is a belief that mushrooms are declining due to inconsistent weather, and that mushrooms and their tree associates need protection from disturbance.
- ♦ Defining group members: H0704, H0706, H0708, H0711, H0714, H0718, H0719, H0720, H0725-H0730

<u>Factor 3</u>: This perspective has two major themes. The first of these is of the importance of fungi to the ecosystem as a whole. Given the lack of knowledge about species' reproductive biology (30), range, and abundance (34), the core belief in this

perspective is that fungi need to be primarily considered in terms of their relationships with other parts of the environment (39). Because of the complexity of these relationships, disruption to any part of the ecosystem will affect the entire system (45), so there is strong agreement that the best way to protect fungi is through protection of the natural communities and the environment overall (22). There is strong agreement that mycologists have a lot of work to do in this respect (37).

The other major theme represented on this factor is about harvesting practices and the effects of harvesting. There is a strong sentiment that harvesting is not a critical component of harvesters' economic livelihoods (opposite 47). Furthermore, adherents to this perspective agree that it is likely that mushrooms are being overharvested (opposite 18), and that this practice is damaging the land (opposite 11). Accordingly, the future of fungal conservation is grim specifically because people that harvest wild mushrooms are not interested in conservation (opposite 35).

These two themes represent a logic emphasizing ecosystem management and environmental protection through the exclusion of harvesting practices by a public that is either uninformed of the effects of its actions, or uninterested in those effects. It should be noted that this is the only factor that is bi-polar. In other words, it had a significant negative loading, representing a participant whose perspective disagreed strongly with this factor. He believes that mushrooms are not being overharvested, that there is bio-ecological information about morels, and that they are important to conserve for their own sake. Being at the negative pole of this perspective also suggests that this participant has ambivalence about the need for scientific education about morels.

- Key themes: Role of fungi in the ecosystem and harvesting practices

- ♦ Social Perspective: Fungi should be protected because they play a key role in the ecosystem, and mycologists should be leading this work. A major part of these efforts should focus on the cessation of all harvesting, which is damaging the mushrooms and the environment.
- ♦ Defining group members: S0701, S0702, M0701 – M0705, H0702, H0709, H0715, H0717. Counter-indicated: H0718

<u>Factor 4</u>: In this social perspective there is equal weight given to the themes of biology/ecology and rights of access. While acknowledging that there is a lot that remains unknown about the biology of edible mushrooms (30), there is agreement that morels come out under specific temperatures and precipitation (2), and that it takes a combination of factors for mushroom fruiting to occur (41). Closely related to this knowledge about fruiting is knowledge about where mushrooms will fruit, and that a lot of mushroom collecting does not occur near a path or pre-made track (opposite of 44). Finally, there is recognition that decreases in morel abundance are not related to increases in deer populations throughout the northeastern U.S. (opposite of 32).

This perspective has a secondary theme regarding mushroom harvesting. There is agreement that mushroom harvesting is a long standing practice, a tradition (3), and that restricting or controlling access to mushrooms should not be attempted. This opinion is based on the belief that picking does not harm mushrooms or the surrounding area (8 and opposite of 15), so closing off parks to mushroom hunting (10) should not be attempted. Furthermore, the NPS should not create a management plan for wild mushrooms (28).

- ♦ Key themes: MAR-based ecological knowledge about mushrooms and access

- Social perspective: Public access to mushrooms should be maintained based on the rights of access established over time by those people who exhibit LEK. Any attempts at government interference with these practices is decidedly unwelcome.
- Defining group members: H0701, H0703, H0707, H0710, H0713, H0716, H0721-23

Comparing and contrasting the social perspectives

It is notable that many of the statements that contribute to the poles of the factors are similar amongst factors. In interpretation however, it is the relationships among the statements, and the emerging logic of those sets of relationships, that is of interest rather than simply the statements themselves. This is an important point because otherwise it seems like there are more points of consensus between the factors than may in fact exist.

Social perspectives 1, 2, and 4 are all premised on ecological knowledge of morels or whatever fungi the participant was most concerned about. The bio-ecologically themed statements in the concourse ranged from those that specifically referenced MAR morels, to those that were about fungi in forest ecosystems and about fungi in general. The social perspective of factor 1 drew heavily on scientific ecological knowledge of fungi, whereas the perspectives of factors 2 and 4 relied primarily on local ecological knowledge of morels in the mid-Atlantic region. The relationships between the factors can also be displayed spatially, although only two at a time. I present three biplots here of factor loadings in ordination space to explore the relationship between selected pairs of factors more thoroughly.

The first of these graphs is of factor 1 vs. factor 2 (Figure 13). These two are selected for presentation because they represent the first and the second most different social perspectives. The relationship between these factors is also interesting because they are representative of a SEK-based perspective vs. an LEK-based perspective.

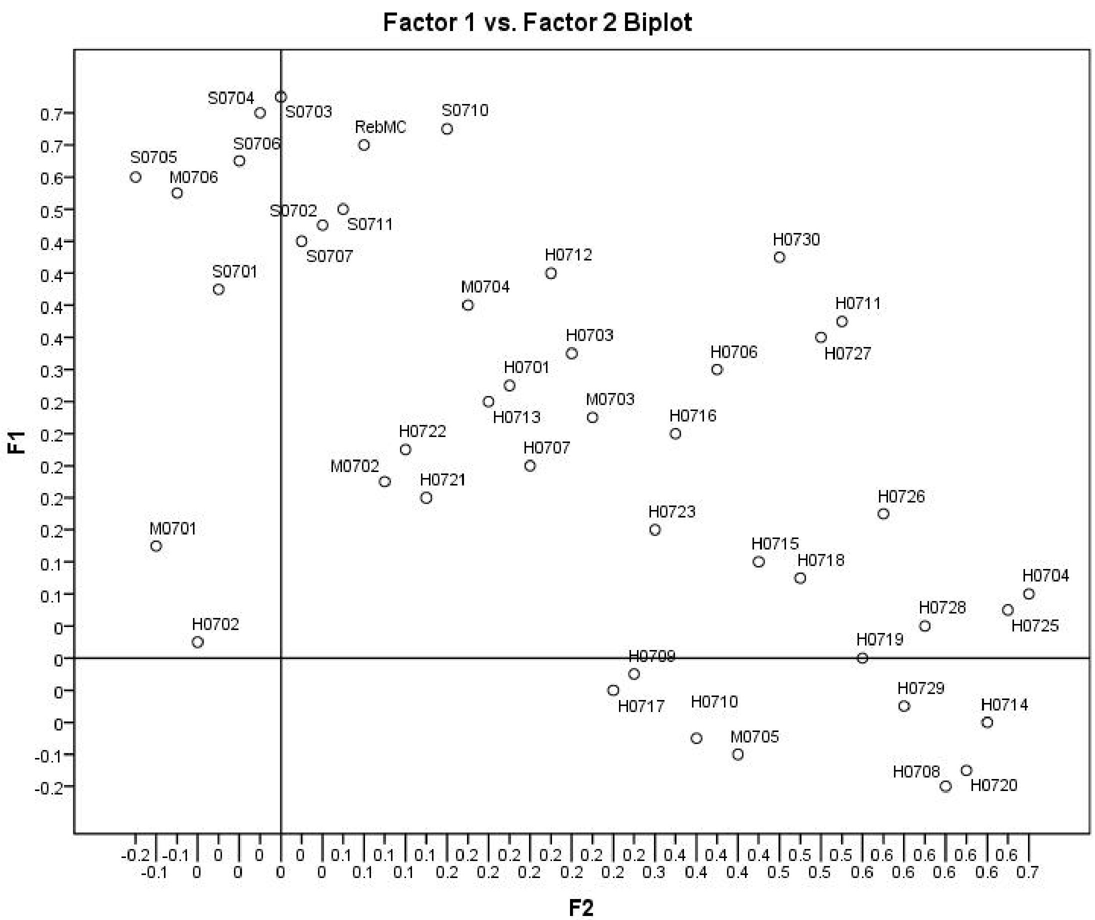

Figure 13: Factor 1 vs. Factor 2

Stakeholders represented by factor 1 are concerned primarily with place-based conservation because of the broad bio-ecological significance of fungi. The sorts of the majority of the scientists (S0703 – S0707, S0710, S0711), the manager from the PNW (M0706), and a harvester who is a young woman living in the D.C. area and a MAW member (H0712), all loaded significantly on factor 1. RM, a social scientist working and living in the Pacific Northwest, also loaded significantly on this factor. Although she was originally included in the analysis as a sort of "test control," it is interesting to note that her sort is aligned closely with the sorts of scientists she has worked with over the last several years (McLain 1996; Pilz et al. 2007). Participants who compose the social perspective represented by Factor 2 are concerned about declines in mushrooms, for the mushrooms' own sake. However, this concern is premised on local ecological knowledge of morels in the MAR. Similar concerns are represented by these two social perspectives for habitat protection and the importance of fungal conservation, and both of these positions are also supportive of local mushroom harvesting activities. In contrast to factor 1, however, which represents stakeholders from different groups, factor 2 is populated entirely by harvesters.

The similarities and differences are apparent when viewed in a biplot graph of ordination space (Figure 13). Many observations can be made from these graphs, including how tightly the defining group members of each factor cluster and the spread of the original stakeholder groups (H, M, S). Of special interest in figure 13 is the spread of the managers, whose sorts, except for M0706, do not define either of these factors. They are broadly distributed throughout ordination space, suggesting that their positions range widely in relation to the perspectives expressed by these factors.

Factors 2 and 4 are populated entirely by harvesters, and both express social perspectives based on MAR bio-ecological knowledge (Figure 14). Notably, they diverge from one another on the social behavior that is informed and suggested by that knowledge. Where on factor 2 there is acknowledgement of a decline in mushrooms and strong feelings about what to do about it, the emphasis on factor 4 is on maintaining access. This is an especially interesting finding because it elucidates an underlying logic that was not previously apparent, differences between harvesters. In other words, harvesters that feel strongly about access, feel less strongly about whether or not morels are declining, and what to do about it. This does not mean that they do not have opinions about it, and in fact based on the interview data, many of the harvesters who loaded significantly onto Factor 4 do also believe that morels are declining. However, they feel more strongly about access and government regulations than they do about the decline.

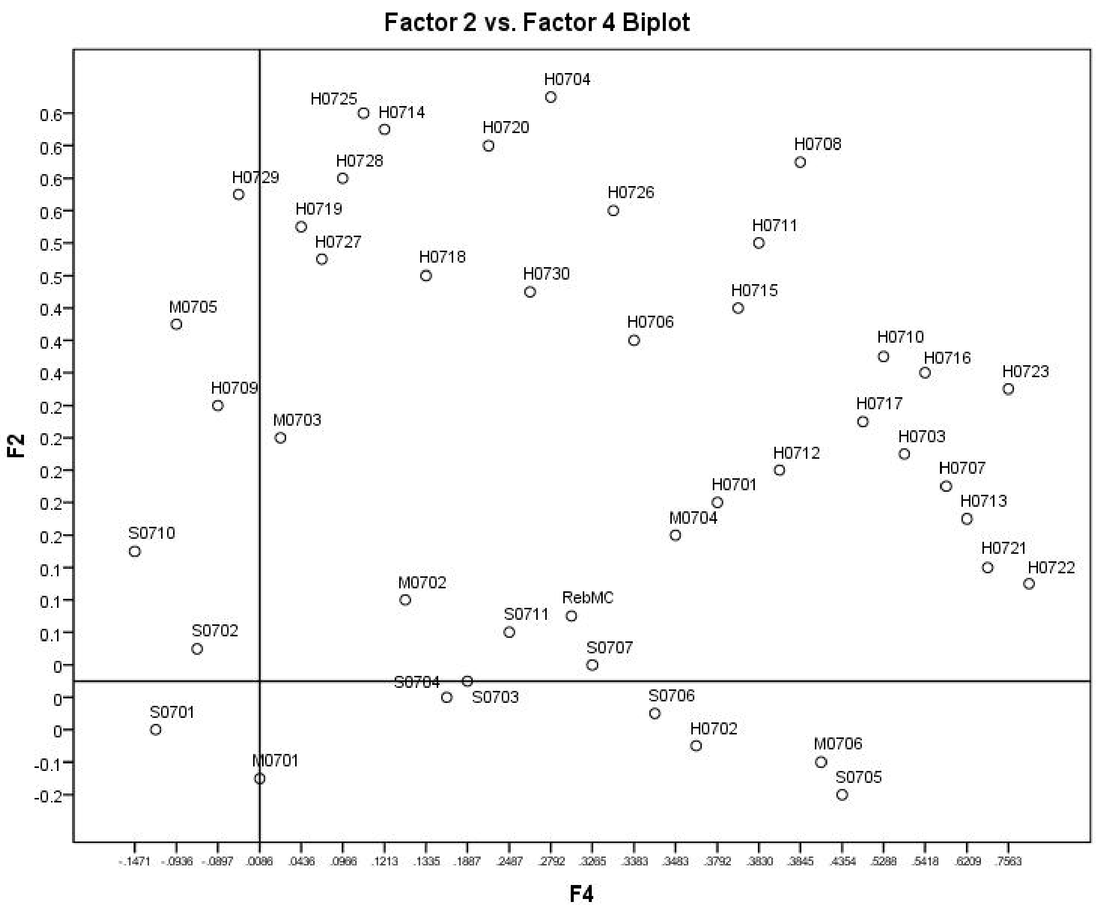

Figure 14: Factor 2 vs. Factor 4

Similarly, harvesters that feel strongly about the decline are fairly broadly distributed in how they feel about access. Participants H0729, H0727, H0728, H0714, and H0708 all answered in their interviews that they thought that restricted access was the best way to protect the mushrooms. Except in the case of H0708, this is consistent with their positions in Figure 14. Participants H0719, H0725, H0718, H0730, H0726, and H0711 all answered that they felt that mushrooms should remain open access. These participants are fairly well distributed on Factor 4. So while factors 2 and 4 do represent a divergence in the level of agreement of harvesters with these issues, it seems that most harvesters whose sorts defined these two factors have similar feelings overall. It is the feelings they chose to highlight in the Q sort that vary.

The mores striking observation from this biplot, then is the similarity of the harvesters in contrast to the managers and the scientists, who all occur below the diagonal (i.e., on the lower left). H0702 and H709 are the only two harvesters that occur mixed in with these other two groups. These two harvesters are both originally from outside of the core areas of long-term harvesters (Thurmont, Sabillasville, Little Orleans origins). M0704 on the other hand, seems positioned in the middle of this diagonal division. She is an avid morel hunter whose long-term partner is originally from the area, and so is connected to the place and the local ecological knowledge of mushrooms through him.

Of the four perspectives, factor 3 is the least based on bio-ecological knowledge about mushrooms. Like factor 1, factor 3 represents the sorts of participants from all three groups. In this case they are: two British mycologists, all the managers from the MAR, and a group of harvesters, three out of four of whom have settled in their current county of residence for less than 20 years. As the two factors that display members of all three stakeholder groups, these two are the final pair to be further explored graphically. Factor 3 is the only factor that had a significant loading of strong disagreement. In this case, it is the sort of a harvester in Frederick County who has lived in the same house his whole life and hunted for morels in the surrounding woods since he could walk. Interestingly, the next most negative sort (not significant) on this factor was the PNW manager.

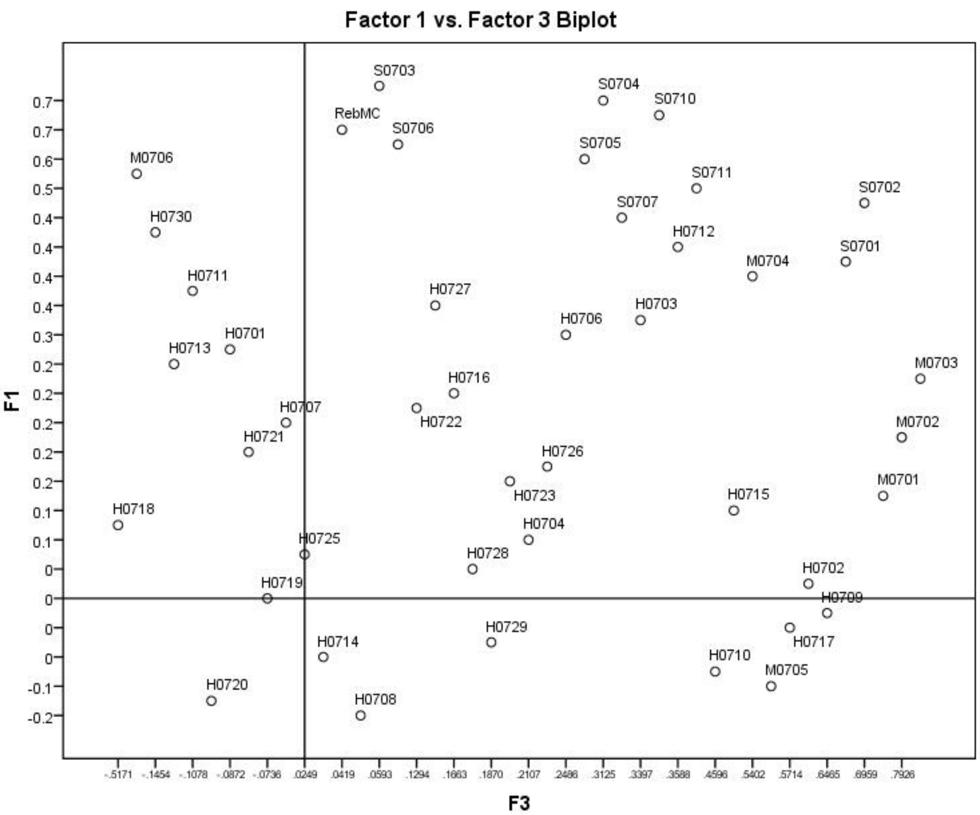

Figure 15: Factor 1 vs. Factor 3

These two factors are interesting to examine spatially specifically because they share an emphasis on ecosystem conservation and protection, however they diverge on the question of how to accomplish this and differ on the reasons for doing so. Both factors 1 and 3 stress the importance of mycologists in educating the public, the government, and other scientists about the significance of fungi (Figure 15). However, they diverge in meaning fairly strongly after that. In contrast to factor 1, where the emphasis is on the protection of fungi for their own significance and secondarily for ecosystems, factor 3 is focused solely on the role of fungi in ecosystems. While factor 1 is relatively unconcerned with the effects of harvesting, an underlying belief that mushrooms are being overharvested takes on heightened significance on factor 3 because of the potential of this activity to harm the environment.

In Figure 15, like in figures 13 and 14, the participants whose sorts loaded significantly on the factors are at the most positive ends of the X and Y axes. In both cases these sorts are widely distributed along the opposing factor. For example, M0706, a manager in the PNW, feels the most strongly about issues represented on factor 1. His social perspective is that the conservation and preservation of fungi is meaningful for the sake of fungi and for the environment, but that this should not prohibit local harvesting. This perspective is supported by his position on factor 3, where he is strongly against the exclusionary ecosystem protection advocated by that factor. At the other end of the spectrum is a small group of scientists (S0704, S0705, and S0707 from the PNW; and S0710 and S0711 from Europe) and H0712, who are more in agreement with the factor 3 social perspective. S0701 and S0702, whose sorts are significant on factor 3, also load highly on factor 1, while the harvesters represented by factor 3 have low or even negative loadings on factor 1. This is consistent with opinions on fungal conservation that are closely related to ecological knowledges discussed in chapters 4 and 5.

With the exception of the factor 4 group in Figure 14, in all three biplots the defining group members are spread out over a fairly wide area. This suggests that within each group, the defining members do range in opinion both in terms of that factor, and also in terms of the second factor in each graph. Indeed, factors 2 & 4, and factors 1 & 3, are fairly highly correlated with each other, suggesting the social perspectives they represent are similar in some respects (Table 6).

Table 6: Correlations between Factor Scores

Factors	1	2	3	4
1	1.000	0.2606	0.5414	0.5867
2	--	1.000	0.3305	0.5646
3	--	--	1.000	0.4091
4	--	--	--	1.000

Webler et al. (2009) point out that in cases where two factors agree on many issues, it is their points of disagreement that may be of particular interest. For example, factors 1 and 3 agree on the importance of fungi in ecosystems and on the need for place based conservation, but they diverge strongly on issues of human use and harvesting. Everyone that participated in this study is interested in fungi in some capacity, so it is not surprising that themes of conservation and fungi in ecosystems would both emerge consistently as key themes with stakeholders. Harvesting is more controversial, creating a tension point among stakeholder groups and therefore between factors. Similarly, factors 2 and 4 are both based on MAR LEK, but one uses this information to inform opinions about declines in morels, while the other uses it to justify rights of access to morels.

Another interesting aspect of the figures to examine is where the non-defining group members fall in ordination space. Again focusing on M0706, he loaded negatively on factor 3 (Figure 15) suggesting that he is against exclusionary management. He also loaded negatively on factor 2, suggesting that he does not feel strongly about MAR LEK (which is consistent with his PNW location). He also loaded significantly and positively

(0.4156) on factor 4, suggesting that he strongly supports local rights of access (Figure 14). This assessment is consistent with his interview. What is interesting, then, is that based on data from the Q analysis, his model of fungal conservation is not consistent with the “manager” model that I have developed in chapters 4 and 5. Instead he is more closely aligned here with factor 1, and also factor 4, which represents various aspects of the scientist and harvester models respectively.

Based on this analysis the original models delineated based on stakeholder group membership do not adequately represent all possible individual “models of fungal conservation.” The social perspectives brought to the fore by the Q analysis suggest that for some, alternative, issue-based models are more representative of individuals than those based on their structural position as a harvester, manager or mycologist. These alternative models focus on themes that I introduced in the concourse of statements, but which the participants drew out and emphasized on their own. These new models are: inclusionary biodiversity conservation (IBC), localized conservation (LC), exclusionary ecosystem management and protection (EEM), and LEK-informed rights of access (LEKA) (Figure 16).

Factor 1: Inclusionary Biodiversity Conservation (IBC)
Key themes: Fungal ecology and conservation
Social Perspective: Based on scientific epistemology, the protection and preservation of fungi is meaningful for fungi and for the environment; accomplished through place-based conservation; and led by mycologists. It does not interfere with local harvesting practices.
Defining group members: S0703 - S0707, S0710, S0711, R.M., M0706, H0712

Factor 2: Localized Conservation (LC)
Key themes: MAR-specific morel ecology and harvesting practices
Social perspective: Based on detailed, experientially gained knowledge of localized morel phenology and ecology, mushrooms are declining due to inconsistent weather, and/or climate change. Mushrooms and their tree associates need protection from disturbance.
Defining group members: H0704, H0706, H0708, H0711, H0714, H0718, H0719, H0720, H0725-H0730

Factor 3: Exclusionary Ecosystem Management and Protection (EEM)
Key themes: Role of fungi in the ecosystem and harvesting practices
Social Perspective: Fungi should be protected because they play a key role in the ecosystem, and mycologists should be leading this work. This includes the cessation of all harvesting, which is damaging the mushrooms and the environment.
Defining group members: S0701, S0702, M0701 – M0705, H0702, H0709, H0715, H0717. Counter-indicated: H0718

Factor 4: LEK-informed rights of access (LEKA)
Key themes: MAR-based ecological knowledge about mushrooms and access
Social perspective: Public access to mushrooms should be maintained based on the rights of access established over time by those people who exhibit LEK. Any attempts at government interference with these practices is decidedly unwelcome.
Defining group members: H0701, H0703, H0707, H0710, H0713, H0716, H0721 - 23

Figure 16: Summary of Factors for Revised Models of Fungal Conservation.

There is clearly overlap between these new models and the stakeholder group models. The majority of scientists fall into the IBC model, and the two that do not are closely aligned with the majority of managers, who fall into the EEM model. Given the diverse places of origin and experiences of participants, it is not surprising that the groups of scientists and managers break across models. Based on the factor loadings and represented by their positions in ordination space, members of each of these groups also feel strongly about issues represented by the other models as well. For example, S0705, a retired mycologist in the PNW, also strongly agrees with the LEKA model. M0704 agrees with both the LC and the LEKA models (Figure 14). M0706 is the only manager to “break away” from the other managers, who are all defining members on factor 3. M0707, the other PNW manager, did not complete the Q-sort and is therefore not included in this analysis. The other managers are all located in the mid-Atlantic, and thus have much less experience in managing mushroom harvesting activities. This perhaps explains why their positions are more strongly informed, at this point, by the tenets of the agency for which they work.

Harvesters are both the largest group of participants, and the most diverse in terms of their opinions about fungal conservation. The first major division among the harvesters distinguishes between those that have local ecological knowledge and those that do not. As addressed in the factor description above, H0712 is a bit anomalous in this study in several respects. Most significantly, she does not hunt morels in central or western Maryland, and only moved to the area recently. As an MAW member and based on her childhood experiences, she has a great interest in morels and other fungi, but at this point her perspective is primarily informed by books and websites. H0702 and H0717 are also originally not from the study area, and either do not hunt or have not successfully found morels in the area. As a result, it is not surprising that their position on fungal conservation would not be strongly related to LEK.

H0715 is another anomaly, being within the EEM model. He is a lifelong resident of Frederick County, and a successful morel hunter who hunts on public and private lands. According to the methodology I outlined above, he was aligned with factor 3 because that was his highest significant factor loading (0.4938). However, his sort also had a significant loading on factor 2 and was almost significant on factor 4 (0.4392 and 0.3822, respectively). Webler, Danielson, and Tuler (2009) label people that load on multiple factors as "confounders." These people have truly hybrid views on the subject at hand. In the case of H0715, his interview adds context to his position vis-à-vis these new models. H0715 is married to H0714, who is well represented by the LC model (0.617 on factor 2).

Their interview took place together in their home. They both believe that morels are declining in the Catoctin area, and they both support restricted access. In their interview, H0714 advocated for more public education about morels based on her opinion that the general public does not know what morels are, and uses bad practices such as raking and "stomping around." They are strongly opposed to further development in the area, and have gone so far as to put part of their land into a conservation easement to prohibit the sale of the property to a land developer, and limit the number of structures that can be put there to one home. They are suspicious of outsiders, and feel negatively about the National Park Service. H0715 is especially so because part of his family's property was claimed through eminent domain in the 1930s to make the original Catoctin Recreational Demonstration Area. In summary, H0715 is a long-term morel harvester with LEK, he agrees that morels are declining and feels strongly about habitat and ecosystem protection, *and* he also feels that that people like himself should be allowed access to morels without government interference.

Like H0715, H0718 loaded significantly on two factors. As stated above, his sort is most strongly aligned against the social perspective of factor 3 (-0.5171), but he is also significantly aligned with factor 2 (0.4782). This is interesting because, based on his interview, I would have placed this participant strongly on factor 2 or perhaps on factor 4. However, I would not have accurately assessed the strength of his opinion against the position of the EEM model.

The examples of both H0715 and H0718 represent the strengths and weaknesses of using Q method. In the case of H0715, relying solely on the Q method limits understanding of this person's complex perspective. Without the additional interview data it is difficult to understand why this participant would feel strongly supportive of a social perspective that is based on ecosystem management that is exclusionary of harvesters. However, reflecting back on the statements that inform this position on factor 3, they represent an opinion that mushrooms are being overharvested, that this practice is damaging the land, and that the future of fungal conservation is grim. These opinions are consistent with this harvester's belief that there are too many uninformed people in the woods, and that land needs to be protected from outsiders and from development.[44] In the case of H0718, the Q method elucidated the strength of his opinions about this same factor, which I did not uncover in the interview data. Here, this harvester's social perspective was actually complicated through this additional analysis.

The use of the Q method in this study specifically addressed sets of issues related to morel decline in the MAR, and to the need for fungal conservation. It connected the more theoretical, group identity models developed in chapter 4 and 5 to these specific questions as experienced by individuals, with mixed results. The models of fungal conservation that emerged from the Q analysis are all based in ecological knowledge, which demonstrates the centrality of epistemology and ontology to these issues.

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[44] Webler Danielson, and Tuler (2009) suggest taking extensive notes during the Q sorting process in order to deal with this issue, although that brings into question how much interaction and discussion the participant and researcher are having during the sorting process.

However, these results also emphasize the plurality of knowledges, experiences and opinions that inform decision making moments.

6.3: Integrating the Models of Fungal Conservation

The thematic models of fungal conservation explained here do overlap considerably with the stakeholder models outlined previously. In general, most of the scientists are aligned with the model centered on biodiversity conservation, managers are aligned with the model centered on ecosystem protection, and harvesters are aligned with the two models centered on local ecological knowledge. The Q analysis provided the foundation for naming these models based on the social perspectives they represent, and also complicated them by showing that not all stakeholders are strictly or most strongly aligned with a model based on the a priori assignment of them to groups commonly understood to differ on issues of conservation and management. In this section my goal is to relate these models to the discussion of knowledge and practice in chapter 4 and 5 and ask a specific question: what is the ecological profile of morel habitat at Catoctin Mountain Park? Scientists and managers approach this question using a suite of quantitative techniques designed to be objective, accurate, and precise. This approach is based on the scientific method of hypothesis testing, which focuses on the ability to determine whether something specific, rather than something random, is occurring, and then attempts to explain the difference. By contrast, as outlined in chapter four, local harvesters already have the knowledge to answer this question, and an ecological profile of MAR morel habitat based on LEK was delineated in section 4.2. However, these data would be described within the scientific community as “anecdotal” or “biased.”

Following this line of reasoning to its logical conclusion, models of fungal conservation based on LEK are also dismissed because of their anecdotal and biased origins.

I designed a hybrid ecological habitat assessment to collect baseline ecological data on morels in the MAR based on already existing local ecological knowledge. The study essentially examined the LEK in a scientific, quantitative format. It is considered a descriptive study due to the small number of sites and plots. My secondary goal with this study design was to address the bias against LEK. Harvesters have a wealth of ecological knowledge about the genus *Morchella* as it occurs in central and western Maryland specifically. Yet, managers and scientists repeatedly discounted the value of local knowledge to me for the above reasons. Because of this scientific bias, there is a misconception that little to nothing is known about *Morchella* in the MAR. Some of the findings presented here are redundant with those in chapter four. They are included here because of their specific relevance to the results in this section.

Sites were selected in Catoctin Mountain Park based on harvesters' knowledge of the area. One hundred meter square ($100m^2$) plots were located using a stratified random design, with A plots in an area where morels were consistently found, and B plots placed a minimum of 50 meters away in an area where morels were not found by harvesters. Site evaluations included the following variables: overstory stem density, understory stem density, percent ground cover ($1m^2$ nested plot), litter depth, and canopy cover. Five sites of two plots each were located throughout Catoctin Mountain Park for a total of 10 plots. These were sampled in July and August of 2007. Morels were not present at this time. To locate the plots, once in the general area selected by the harvester, I randomly selected a direction based on the time on our watches, and tossed a roll of flagging over my head.

The location of the plot center was determined in this way.[45] This qualifies as stratified random sampling because the researcher does maintain specific selection criteria for the location of the plot, but the specific location is selected "randomly."

On average, plots where morels were consistently found (A plots) had greater vegetative ground cover, less litter, thinner overstory, less canopy cover, and much denser understory, primarily owing to thick patches of spicebush (*Lindera benzoin*) (Table 7). Collectively, these results suggest that morels are occurring in younger stands or areas of regeneration.

Table 7: Results from Analysis of Variance (ANOVA) of difference between A plots and B plots. P-values in bold italics are significant at the 0.05 level.[46]

	Overstory (#stems/100m²)	**Understory** (#stems/100m²)	**Ground Cover** (% cover/1m²)	**Canopy Cover** (%)	**Litter depth** (cm)
Mean of A plots	3.20	58.00	19.00	70.47	3.11
Mean of B plots	7.40	2.00	2.40	77.19	4.95
P-value	0.0578	0.0784	***0.0282***	0.1739	0.1334

This is consistent with interview data in which harvesters discussed morel ecology for all types/species of morels, including associations with specific tree, shrub and ground cover species, the seasonality of morel fruiting by species/type, and the effect of specific climatic conditions on fruiting (see section 4.2).

Trends observed in the ecological study were consistent with harvester knowledge of morel habitat. Percent ground cover varied significantly between A plots and B plots.

[45] Using a face watch to determine random direction is a common technique in ecological field work to establish randomness in the field.

[46] A p-value is the probability of obtaining a result at least as extreme as the one that was observed, assuming the null hypothesis is true. The lower the p-value, the less likely the result. In this case the null hypothesis is that A plots and B plots are the same. Although this is now changing, the traditional way of using this test statistic is that if it is less than 0.05 or 0.01 the findings are considered significant or very significant, respectively, and the null hypothesis is rejected, the plots are actually different.

This is an interesting finding in relation to morel biology and habitat, and one that is supported by the literature. Pilz et al. (2007) specifically discuss the presence and occurrence of mycelial muffs on ground cover species. These specialized structures are made up of mycelium rather than mycorrhizae, the structures fungi more commonly use in nutrient exchange with plants. Buscot and Roux (1987) found that these muffs are connected to morel fruiting bodies and that they disappear as the morels mature, perhaps providing extra nutrients to help mushrooms reach maturity. Lakhanpal et al. (1991) found morel muffs on several small herbaceous species such as strawberries, grasses, and ferns. In the current study, the species of ground cover were not identified. This would be a potential next step in future research on morels in the area.

Differences in overstory and understory stem density were not significant at the 0.05 level, most likely due to sample size. Additional plots would be required to further examine differences in overstory and understory stem density, which are variables of particular interest. Joint results from both the ecological plots and the interviews highlight a key association between morels and overstory species. The interviews and the site evaluations showed a close relationship between morels and healthy tulip poplar (*Liriodendron tulipifera*), a finding unique to the mid-Atlantic region.

Overall, the data suggest that morels at Catoctin Mountain Park may fruit more abundantly in younger stands or areas with regeneration. Harvester observations of morels in this ecosystem support the theory that associations between morels and plants are a crucial component of a perennial life strategy for this genus in stable ecosystems, and that relationships may vary depending on the taxa of both partners (Buscot 1992; Wipf et al. 1997). By comparing specific components of harvester knowledge with site evaluations of local morel habitat, the habitat study shows that long-term ecological observations of harvesters can contribute critically to understanding the habitat associations, fruiting, and sustainability of morels in the mid-Atlantic U.S.

6.4: Conclusions

Quantitative methods are often associated with positivist epistemologies and deductive approaches. "The hypothetico-deductive method, in the spirit of Euclidean geometry and Cartesian space, focuses on scientific practice as a product rather than as a process" (Poon 2005:766). In comparison to the other chapters in this dissertation, this chapter is highly quantitative, but I suggest that these methods are abductive rather than deductive. Poon explains an abductive approach this way:

> The abductive method begins with consequences and then searches for reasons and explanations (Pierce, 1955). In abduction, the aim is to try and find the best explanation among several plausible or even competing explanations; and the emphasis is not on the amount or volume of data but the relative importance of the data…Given its emphasis on knowledge discovery in knowledge production, abduction that admits qualitative reasoning allows geographers to focus on the human as an active rather than passive agent in the problem-solving process (Poon 2005:767).

Poon actually suggests Q method as a "postnormal" methodology that uses this abductive approach. He suggests that a particular view of positivism has become prevalent in human geography, regularly associating positivism with exclusivity and power. His intention seems to be a defense of quantitative methods and logical positivism, which by definition do not operate under the tenets of the above critiques. He advocates for a methodological and theoretical pluralism that does not so roundly denounce positivist approaches, specifically because they facilitate communication with policy-makers who are often trained in positivist or physical science traditions. The quantitative methods used in this chapter are used specifically in these ways, to both facilitate knowledge discovery through the use of Q method, and apply a theoretical pluralism to the documentation of LEK so that it may be communicated to those unfamiliar with post-positivist and post-structural approaches. Furthermore, as I explain below, the findings from using these methods have challenged my own a priori assumptions and essentialisms.

Local ecological knowledge, like science, is partial (Ticktin and Johns 2002). More recent approaches to local knowledge understand it also as being multiple and embedded within socio-cultural discourses in similar ways as scientific knowledge. Highlighting local ecological knowledge of NTFPs, examining its relevance to conservation and regulations, and how it articulates with specialized environmental knowledge has been one strategy used by researchers to demonstrate the importance of local people in resource management and conservation (Robbins 2000; Berkes 2008; Berkes and Turner 2006; Davidson-Hunt 2006).

Q method provides a quantitative, multi-dimensional way to examine the relationships between people and natural resources vis-à-vis specific issues. A list of environmental statements is used to generate and uncover human-environment relationships. In Q analysis the patterns between the variables across individual people are analyzed. Because the subject is the independent variable in the analysis and the sorts are the dependent variables, the method examines the traits of a single person holistically rather than matching traits across individuals. "Q analysis dovetails with the interpretive and cultural turn in geographic theory and is a powerful tool for anti-essentialist approaches to subjectivity and for constructivist inquiries into categories of nature, urban form, and scientific activity" (Robbins and Krueger 2000:636). In this study, the use of Q method provided a tool to holistically examine the positionality of each person's ecological knowledge of wild edible mushrooms *in relation to* issues of access, harvesting practices and effects, management, and conservation on U.S. federal lands. It drew out ways in which this ecological knowledge is mutually constitutive with issues of access and harvesting.

This rigorous analysis made me examine my own categorization of stakeholders in accordance with their primary practices, and problematized the labels: "scientist," "manager," and "harvester." While there is some awareness that not all the people in these groups have the same positions, in practice both in scholarship and policy-making, the tendency is to rely on these default categories, this dissertation being a case in point. This Q analysis suggests that exploring alternative categories organized around issues and social perspectives is also appropriate and useful, especially when there is a specific set of questions and issues being discussed. My findings, for example, suggest that in future studies on NTFP gathering it may be more useful to organize stakeholder groups at the outset based on their opinions on key issues such as access, harvesting, or ecological knowledge.

Q method provides a bridge between the qualitative interviews and the quantitative ecological research. It is meaningful that both the IBC and the EEM models of fungal conservation emphasize the role of mycologists in accumulating new knowledge about fungi and also in educating the public about that knowledge.[47] In the idealized sort of the LC model this statement was ranked 0 (indifferent), in the LEKA

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[47] The statement that this sentiment is based on, statement 37, is: "Mycologists have a lot of work to do in educating the public, government management agencies, and other biologists about fungal conservation."

model it was ranked +1 (slightly agree). People who have these social perspectives are much less concerned with the role of scientists in the sustainability and conservation of wild mushrooms, perhaps because their opinions about fungal conservation are based on existing LEK. Yet this knowledge remains disconnected from mycologists, government management agencies, and others. Some harvesters prefer this, others are more willing or may actively choose to engage in decision making. The objective of the ecological study, then, can be interpreted in two ways. The first, à la Poon, would be to see it as a way to "re-package" the LEK using quantitative methods more acceptable to, and readily understood by, scientists and managers. The second is as a test of the validity of the LEK. Either way, the goal is the same: to build connections between existing models of fungal conservation using methods that are understood and acceptable to multiple parties.

While Poon is actively advocating for a theoretical and methodological pluralism, it is clear that he does so in the defense of positivist approaches. He is sensitive to pressures for quantitative geographers to "do narrative" and recognize intersubjectivity. He is critical of the reflexive turn in human geography because of the level of uncertainty that it brings to the foreground. This is a debate that surrounds critical and post-structural perspectives on discourse and knowledge that I employ elsewhere in this dissertation. In the next and final chapter, I use this reflexive approach to examine my own use of mixed methodologies in this research. The quantitative analyses of this chapter and the qualitative analyses from the previous chapters are brought together to explain emerging models of fungal conservation based on knowledge, practice, power, stakeholder identity, positionality, and the pragmatic applications of this work.

Chapter 7: Conclusions: Models of Fungal Conservation, Interrupted

7.1: Models, Scales, and Knowledge/Practice

This research project began with a small scale, applied study of morel mushroom harvesting in two American national parks. The basic focus of that study was to find out more about the experiences of “visitor-harvesters” and make practical suggestions for morel mushroom management for these parks. In the course of examining the claims of morel decline, a set of larger issues has emerged: a need for an explicit focus on fungal conservation writ large; the role of different actors in that project; the emergence of different conservation models in different regions; the distinctive nature of fungi as a resource; and the current conceptualizations of fungi as biological organisms. In sum, a major new front in the complex human and environmental dimensions of biodiversity conservation has opened.

This dissertation began with a few basic questions: What is fungal conservation? Where did it come from? Who is involved? From this, I have developed a complex narrative that has engaged with the institutionalization of fungal conservation, with the stakeholders in this discourse, and with challenges in current conceptualizations of both the resources themselves and in how we essentialize human-environment interactions through assumptions about identity.

Fungi are not widely known. Their conservation remains marginalized. Unlike the intensive and expansive use of plants or animals, small scale human use of fungi has been viewed by scientists for a long time simply as “everyday practice” in many parts of the world, and resource managers have long been unaware or unconcerned with these activities. These everyday practices began to take on new meaning in the 1980s, when mycologists in Europe and the U.S. first began to focus on the conservation of fungi.

Conservation discourses are predicated on historical factors. This is especially apparent in the U.S. context. One hundred years of forestry and management in the U.S. emphasized fortress conservation in national parks, management decisions based on scientific research, and sustainable resource extraction from national forests. All of these management and conservation strategies have been variously applied to wild edible fungi since the 1980s. In contrast to the European focus on scarcity, American fungal conservation therefore has its roots jointly in the commodification and extraction of wild edible mushrooms, and the role of fungi in ecosystem function. These issues are brought together through the social and ecological valuing of individual species.

Fungal conservation is further affected by global conservation discourses that emphasize the need to document and describe all life, and the relationships among different lifeforms (Encyclopedia of Life 2009; Maddison and Maddison 1996; Maddison and Schulz 2007; GenBank 2010). Fungal conservation, like floral and faunal conservation, is predicated on widespread acceptance of the veracity of these epistemologies. These lines of research support specific global conservation discourses that emphasize conservation "solutions" such as: (1) mycotourism, to appreciate the diversity of life in situ; (2) sustainability through regulation, to control the uses of species; and (3) specific types of capital investment where species based conservation and biodiversity are tacit commodities. These are forms of conservation that create unstable conditions such as the simultaneous protection of nature from individual people, and the promotion of large scale extraction through commercial harvesting.

These discursive spaces where decisions are made about fungal conservation and management are not accessible to harvesters and laypeople, and as a result their potential contributions are often dismissed. Through the presentation of the knowledges, practices, and beliefs of the stakeholder groups, I explore what possibilities exist for making space for others in fungal conservation discourses and in the application of that discourse. This begins with the systematic deconstruction of morel ontologies and epistemologies of each group.

A scientific theory or model of morel conservation is theoretically predicated on an objective and scientific knowledge of morels. However, even within this epistemological framework, my analysis shows that mycologists do not have a critical amount of knowledge about *Morchella* on which to base species-centric conservation strategies. In contrast, harvesters have detailed, place specific, morel typologies that could be used for morel conservation. Harvester fungal conservation does not recommend mycotourism, regulation, or capital investment. In fact, most harvesters report that a central element of their conservation strategy is secrecy. This is not a component of the science of conservation biology. In fact, the emphasis on distribution of SEK is a directly opposite strategy.

Knowledge and knowledge production are materially grounded by a focus on practice. These two constructs, knowledge and practice, are in fact mutually constitutive to such an extent that it is difficult to conceptualize them separately. Raffestin (2007) quotes Veyne: “There are no knowledges without practices: ‘Practice is not some mysterious agency, some substratum of history, some hidden engine: it is what people do (the word says just what it means) (Veyne 1978: 211, Veyne 1997:153).” This is especially apparent in this dissertation and in natural resources discourses more broadly, where stakeholders are named in relation to the environment based on their type of practice.

In the nascent field of fungal conservation, a primary practice of scientists is the naming of new species. This is an ultimate act of knowledge production in biology, and in the quest to demonstrate biodiversity for conservation. Mycologists literally cannot name new species as quickly as they are being "discovered" because of the increasing prevalence of the phylogenetic species concept and the related technologies that make that species concept possible. The very definition of LEK, experientially developed knowledge about the environment, demonstrates this connection between knowledge and practice as well. Based on the term power/knowledge (Foucault 1980), I use the term knowledge/practice to describe this relationship, its process, products and effects.

Knowledge/practice has spatial and temporal dimensions, and these are apparent in the distinct ways that each group practices its model of fungal conservation. Long-term harvesters in the MAR have a set of harvesting practices that center on protecting the spores of morels for the future. These practices rest on the stable typologies developed for blacks, whites/grays, yellows, cappies, and poplar mushrooms. This knowledge/practice is supported by social structures and processes that emphasize tradition and earned rights of access. MAR harvesters recognize a long history of harvesting in their area; many have a strong desire to see this tradition passed on to their children and grandchildren. Around Catoctin, people tell stories about how morels were part of the subsistence lifestyles of their families that settled on the mountain. No one is aware of who first started to hunt the mushrooms, or how those people originally learned about them, but they make sure to teach their children as soon as they are able to walk in the woods. It is also significant that many MAR harvesters only collect morels. They are unconcerned with other species that occur in the region, and with morels that occur outside the region. Many feel a sense of ownership of the morels in their area, and some feel resentment towards outsiders, such as harvesters coming down from Pennsylvania. These knowledge/practices are spatially bounded in place and are long-standing. In sum, MAR morel harvesters maintain "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 2008:7).

Land managers operate at the spatial scale of the park where they work, and of the region where that park is situated. These are legally bounded spaces (CATO, NCR) that most often do not match up with spaces of nature, described by scientists variously as habitats, watersheds, or ecosystems. Managers negotiate between these legal and naturalized boundaries as they attempt to both protect nature, and maintain positive relationships with the public. In order to negotiate these boundaries, managers work closely with scientific information, and sometimes with scientists. As conservation practitioners, they are responsible for the pragmatic use of scientific knowledge. This creates a series of decision making moments (practices) about the applicability and generalizability of that knowledge.

Managers' decisions and actions are informed by social structures and processes in the same way that harvesters' practices are. America's national parks are protected spaces where the needs of non-human life are supposed to be privileged over those of people specifically because outside of parks it is so often the opposite. This is the mission that NPS managers carry with them in their minds as they make decisions. MAR managers hear anecdotal stories of declines in wild mushrooms that are consistent with their environmental training, and they are specifically tasked with stopping and trying to reverse that decline. In contrast, PNW managers in this study work with the USFS or with state land management agencies. As the basis for their management decisions, managers in the PNW have funded the most extensive ecological and social research on wild edible mushrooms in the U.S., and perhaps in the world. Yet they emphasize their actions regarding mushroom harvesting as "people management." The regional variations in historical use, and the different missions of the NPS and USFS inform and differentiate these manager knowledge/practices.

Manager practices are united by widespread agreement that they rely as much as possible on science in all of their long-term and day-to-day decision making. It is the application of that SEK to specific places that provides managers with a spatialized authority. Although heavily constrained by outside forces of discourse and policy, managers maintain this authority in their practices. They are the ones that operationalize certain knowledge/practices into policy and regulation. They are the ones that make choices to privilege SEK over LEK, or not to. They are the ones that decide on the spatial and temporal scales of the application of the knowledge/practices of the other two groups.

Intense scholarly inquiry and analysis on power/knowledge requires the domain of the experts to be a prime area of inquiry for exploring the production and the practice of knowledge. Mitchell (2002) explores the relationship between expert knowledge and practice through the building of the Aswan Dam. He points out that the engineering projects that were part of this larger project formed the science that supported it, and that it was through day to day practice that solutions were found for problems that scientists did not previously have answers for. The interplay among science, technology, and practice are also apparent throughout forestry in the 20^{th} century (Agrawal 2005; Braun 2002; Willems-Braun 1997; Kosek 2006). These same dynamics are visible in fungal conservation. Mycologists have a variety of practices that are actively contributing to and creating fungal conservation discourses. They name species. They define qualities of fungal organisms necessary for conservation policy, like generation time or habitat requirements. Because conservation is species based, this has intense political ramifications (Crifasi 2007). They are in the process of creating agendas for popularizing fungal conservation, which they hope will change the face of conservation worldwide. They engage with other biologists in conversations about conservation as they attempt to dismantle global "Flora and Faunaism" and bring about the period of "the Flora, the Fauna, and the Fungi."

The creation of red lists, for mycologists, is the ultimate practice that unifies these other practices. Red lists are where science meets advocacy. If red lists are created and accepted by policy and decision makers, this legitimates mycology and mycological research at the global level in a significant way. From the perspective of the mycologists in this study, that is the direction that they are most dedicated to moving towards. However, red lists are composed of species, and it is the spatial and temporal dimensions of the species concept that complicate expert knowledge/practices in conservation. Individual species, once named, are biophysically constrained by their determined range, and a set of life characteristics such as how they eat, what they eat, how and whom they reproduce with and other various aspects of their "population." But the species concept is a social construct, one which mycologists know is shifting and changing. They are attempting to put names to millions of unknown species, yet they do not agree on the concept of an individual; they do not agree on the concept of generation time. In short, mycologists are finding that fundamental concepts in biology are not working for fungi.

Understanding the naming of species as discovering a truth about the non-human world, and disseminating that truth, specifically positions biologists as the decision makers in the race to protect and secure biodiversity. Mycology, and fungal conservation, are fundamentally changing because new technologies have enabled mycologists to "discover" and name more species than ever before. The phylogenetics and cladistics of almost all known species are shifting. These practices of knowledge creation and knowledge disruption are visible through an examination of mycology in a way that they are not in other domains of conservation, making fungal conservation the best realm in which to examine and explore the effects of the concept of "species" in conservation discourses, and related technologies that are driving scientific inquiry.

These knowledge/practices culminate for each group in a broad, identity based model of fungal conservation. To know someone as a scientist, land manager, or local harvester, is to understand their knowledge/practice approach to fungal conservation. This, however, does not specify how they will act in certain situations. Four, not three, models of fungal conservation emerged from the Q analysis focused on the MAR morel decline. Two of these models represented the social perspectives solely of mushroom harvesters, but the other two demonstrated social perspectives of members of all three groups. In other words, the opinions of individuals were not always consistent with their group identity when faced with a specific fungal conservation dilemma. This is an important finding for understanding the human dimensions of natural resource management and conservation efforts, and how we theorize stakeholder engagement.

7.2: Knowledge, Power, and Naming

There is now a significant body of scholarship that challenges the hierarchical relationships power among stakeholder groups in natural resources, and the knowledge truth regimes they rest on, through critical examination of the social constructions of nature and of knowledge(s) (Castree and Braun 2001; Demeritt 2001, 1998; Willems-Braun 1997; Haraway 1991). Related scholarship explicitly emphasizes the value and significance of local and traditional ecological knowledge, and its articulation with scientific ecological knowledge (Davidson-Hunt 2006; Richards 1997; Berkes 2008; Berkes, Colding, and Folke 2000). Futhermore, there are many case studies suggesting how LEK can complement SEK (Lykke 2000; Martin and Lemon 2001; Lynch, Jones, and McLain 2004).

LEK itself is represented and perceived in different ways. Sometimes it is seen as primitive and unscientific. Alternatively, in a populist view of LEK "the real value of local knowledge is rediscovered and the special epistemological status of 'scientific' knowledge is challenged" (Martin 2003:59). Finally, more recent work on LEK applies critical analysis to this seemingly uniform other: "Scoones and Thompson (1994) argue for a more sophisticated analysis in which the community is itself differentiated, with multiple knowledge formations arising around differences in experience…expected due to individual contexts such as power, class and gender" (Martin 2003:59).

All three of these approaches to LEK are encountered within the course of this dissertation specifically because of my a priori determination of the relevant stakeholder groups, and my methodology. Like the marine turtle conservation experts that Campbell describes (2002), mycologists have respect for amateur mycologists and mushroom hunters, but they often view lay knowledge as unscientific. That knowledge gains credibility and scientific value by being processed and interpreted by scientists. At the same time, they couch their own arguments in scientific terms, and downplay the role of other values that may influence their decision-making and their views. In contrast, when reflecting on the views of others, they might comment on how personal experiences and motivations create others' opinions. Through this process of othering non-scientific ecological knowledge, "science remains the privileged language of the interviewed experts" (Campbell 2002:1243), and scientific ecological knowledge remains dominant.

Ultimately, mycologists exercise power in fungal conservation by creating, and therefore controlling, the discourse (Gaventa 1982). They perpetuate specific discursive structures that privilege a particular type of knowledge (SEK) over other knowledge claims (LEK). That special status is challenged by showing places and processes of social marginalization, and then by explaining the production, use, and application of both of these types of knowledge (Hay 2005). This alters the relationship between SEK and LEK in fungal conservation by giving voice to "resource users" and raising awareness of the processes and effects of a fungal conservation discourse predicated on SEK.

However, this analysis resulted in models of fungal conservation developed around a binary of ecological knowledge. Where do land managers fit in this knowledge binary? At issue is that managers' model of fungal conservation is only secondarily based on ecological knowledge. It is primarily based on political power and historical events in land management that give government agents a spatialized power over natural resources. In fact, all the models of fungal conservation are affected by ecological, political, social and economic issues. To group mycologists and harvesters together based solely on their "group" ecological knowledge removes emphasis from these other dimensions, essentializing these positions and reifying the SEK:LEK binary. Members of the three stakeholder groups, in actuality, have differentiated, multiple knowledge formations arising from differences in experiences. This becomes more apparent when a specific dilemma is addressed.

The Q analysis in the sixth chapter examined the research participants' perspectives on ecological knowledges, access, harvesting activities, and fungal conservation, focused on a specific place, genus, type of bounded space, and sets of harvesting practices. The statements used to address these issues were selected from the comments of harvesters, from NPS and USFS websites, and from the academic literature on fungal conservation (Appendix E). The tacit hypothesis embedded in the statement selection for this method was that participants would group together in the final analysis because they would agree most strongly with the statements from their own group. Ultimately, this was not the case. Instead, the four alternative models that emerged problematized the knowledge/practice identity models, and presented a more nuanced analysis of LEK by showing that it can inform different positions on fungal conservation.

These new models are thematically oriented rather than identity oriented. They are: inclusionary biodiversity conservation (IBC), localized conservation (LC), exclusionary ecosystem management and protection (EEM), and LEK-informed rights of access (LEKA) (Figure 16). The social perspectives of harvesters contributed to all four of these models. The LC model and the LEKA model are both informed strongly by LEK, but how that LEK informs individual beliefs on conservation differs. In the LC model, LEK has shaped a common belief among harvesters that morels are in danger, and that there are specific practices that will work locally to help local morels recover. In the case of the LEKA model, local harvesters still signify the importance of LEK for their decision making, but here it drives strong feelings about historical rights of access based on insider knowledge and practices. These models show points of difference in what is otherwise interpreted as a homogeneous group in natural resource management and conservation. The strength of agreement (in terms of the loadings, Appendix F) of these two models, underscored by the agreement of some harvesters with the IBC and EEM models, shows that to understand harvesters simply in terms of their LEK is overly simplistic. Both SEK and LEK are dynamic and fragmented, influenced by socio-political discourses, and by spatial and temporal dimensions.

There are many different ways to consider stakeholders in natural resource issues, all of which share one common approach: they categorize people into groups based on a priori assumptions about positionality on issues vis-à-vis their practices. The Man and the Biosphere (MAB) mushroom study is a good example of this. The authors sought out stakeholders from three groups: scientists, land managers, and forest users, because of agreement that the promotion of sustainable human and natural communities necessitated the active involvement of multiple groups of stakeholders, identified based on their structural positions (McLain, Jones, and Liegel 1998). I have argued in this dissertation that these groups are fundamentally, by definition, about knowledge/practice. What is missing from this categorization is an appreciation of the personal experiences and of the historical dimensions that also contribute fundamentally to these epistemic communities. When experience, what might be considered the culmination of knowledge/practice at any one moment, is subsumed under these group concepts, the individual may become essentialized in terms of their group identity. This is also true in the case of the growing use of the SEK:LEK binary.

When people are categorized and labeled in terms of their knowledge/practice, as scientists, managers, and harvesters, additional assumptions are often made based on these labels. There are intense relationships of power/knowledge that are conveyed by these structural positions. Understanding TEK and LEK as complementary to SEK, even when seeing it as differentiated and situated, reifies these power relationships and an SEK:LEK binary. The alternative models of fungal conservation that emerged from the Q analysis highlighted the significant influences that political, social, and economic experience can have on specific events and concerns.

I offer one very practical example of how this information may be useful in the MAR. In the future, the NPS may wish to convene a working group to further discuss harvesting regulations for morels in NCR parks. Based on current practices, this working group may be made up of two mycologists, two managers, and two harvesters with the assumption that this would represent “diverse stakeholders” and therefore a diversity of opinions on harvesting regulations. However, the results from the Q analysis indicate that this may not be the case. Rather than selecting members for this working group solely based on knowledge/practice identities, individuals might be queried in advance on their opinions on a variety of relevant issues. In this way, stakeholders who are for and against harvesting regulations could be brought together for discussion. This example suggests one way that findings from this study may be operationalized. The next section includes several additional suggestions.

7.3: Political Ecology, Policy and Praxis

Above, I suggest that the categorization of stakeholders as scientists, managers or resource users oversimplifies both the groups and the individuals that populate them. However, like Kendrick's use of "the fifth kingdom" to refer to a functional group of organisms that populate three kingdoms, I remain reliant on these widely known referents. Indeed, throughout work in the human dimensions of natural resource management, stakeholders are categorized as scientists, managers, and users. Future research stemming from this work should address how to move past these categorizations for the reasons discussed herein. However, in the meantime, the following insights rely on the broad understanding that these names currently offer. In deference to my argument, I refer to these group names in quotes for the remaining pages.

The first contribution of this dissertation, stemming from the event ethnography at three mycological conferences, has been to demonstrate that there are people who have vested interest and devotion to fungal resources who are not present in decision making forums. Bringing "managers" and "harvesters" more actively into the creation of fungal conservation agendas and discourses by inviting them to mycological conservation conferences would change this. This would in turn have material effects, as "managers" and "harvesters" are given opportunities to express their concerns and interests, rather than having those interests assumed.

In other instances, when "non-experts" are involved in discussion, it is at times clear that they are not given power to affect change. My experience of presenting "harvester" LEK at the EMA meeting, and immediately having its legitimacy challenged and negated is a striking example of how real power is difficult to negotiate. More broadly, a recent review of the inclusion of LEK in ecological and conservation research suggests that despite consideration, LEK-based publications and scholarship remain marginalized (Brook and McLachlan 2008). LEK is acknowledged, it is praised, it is seen as necessary, but it is denied authority and power. As long as "resource users" are strictly associated with LEK, they are denied authority and power as well. Furthermore, a strict focus on the identity of each group based on the type of ecological knowledge that it exhibits, rather than a more complex analysis of the relationships between those knowledges and their constitutive practices, remains a rather theoretical approach to conservation. The research emphasis in much of the emerging social-ecological systems and sustainability literature on LEK as a product to be quantified and distributed is exemplary of this shallow approach (Carpenter et al. 2009; Steffen 2009).

Supporting the reconciliation of essentialisms and the breaking of binaries with in-depth analysis and empirical data does disrupt naturalized hegemonies, and these disruptions do make openings for new beginnings in scholarly and non-academic work that may filter down to actual lived experiences. However, more active engagement with the pragmatic applications of research is also necessary. These opportunities present their own challenges, namely, how can we maintain the depth and richness of case study research, but scale these findings up to engage with regional and global issues such as climate change and conservation? Scaling up and generalizing are inherently reductionist, and so the burden of the researcher becomes how much (s)he is willing to generalize, for what purpose, and around what central theme. In the case of this research project, active engagement with policy and decision makers was in place from the beginning, setting the tone for this engagement.

Because of its practical roots in the morel study, this research has had one very tangible, policy oriented publication, the morel study final report. This report has been published by the NPS and is now being distributed to all of the research participants who requested it, to libraries and public offices in the MAR, and to USFS offices across the country. It describes the LEK that was documented in the MAR, and discusses social dimensions of harvesting such as relationships between “managers” and “harvesters,” and opinions about harvesting. It also has practical suggestions for future management (Barron and Emery 2009).

This report exemplifies active engagement with conservation practitioners. The overall tone is inclusive of “harvesters” and “managers,” and suggests specific mechanisms for education and outreach such as pamphlets, and visitor center displays about morel ecology and biology. There is a small section on participatory research. This report is specifically written to communicate with managers and the public. It does not overtly challenge essentialisms or binaries, but hopefully it does not reify them either. To the extent that it may, I would suggest respectful and progressive engagement requires compromises and patience.

Political ecologists attempt to engage with natural resource management and environmental conservation discourses by identifying underlying ecological, cultural and political processes that profoundly affect social processes, but that are often disregarded or unrecognized at critical moments. This can include critiques of policy, but also the development of new evidence-based policy and ideally, the creation of new entry points for action.

Making contributions from these types of scholarship can therefore take many guises. It is about being critical in selective places, and about passing on the political ecological perspective in teaching. It is also about choosing when to be explicit and self-conscious about allusions to power, and when to be more covert in order to speak truth to power in the name of progressive outcomes (Bebbington, Peluso, and Mearns 2010).

7.4: Future Geographical Research on Fungal Conservation

A theoretical shift within the field of ecology since the 1980s has provided new incentive for human geographers to re-engage with ecologists working to integrate disturbance, spatial scale and heterogeneity into non-equilibrium ecology. The integration of empirical evidence documented through this type of ecological work with detailed ethnographic research, can provide significant new insights into conservation (Zimmerer 1994). This dissertation contributes to political ecology by exploring the creation of the new discourse of fungal conservation as grounded in the biophysical realities of specific organisms (morels), but with special attention to the discursive dimensions of knowledge, practice, and power that are elemental to specific approaches to this discourse.

Finding a balance between poststructural and grounded biophysical approaches to conservation is challenging and at times seems even antithetical. Yet, this is the crux of political ecological research. In this dissertation I have employed both of these approaches because for me it is most useful to examine the same question in many different ways. The comparison of the results of the qualitative and quantitative analyses are then also available for critical reflection. As a geographer studying the human-environment, it is through the use of a mixed methods approach that I think the most valuable information becomes available for analysis and decision making. My suggestions for future directions in geographical research on fungal conservation are based on this epistemology. As such, they reflect very different lines of inquiry that arise from this work.

First, additional data on MAR morel habitat are available from the current study. Among these data are the results from the environmental questionnaires on perceived ideal and poor morel habitat that were collected for a spatial analysis. The purpose of the spatial analysis was to utilize available knowledge to develop a deeper understanding of potential morel habitat and ecology in the mid-Atlantic region by examining perceived ideal habitat for morels. Currently there is no data on this, and although there is information about morel habitat and ecology in the Pacific Northwest, the mid-Atlantic is a different ecosystem in which morels are known to behave differently.

During the interviews, participants were asked to select the five variables that were the most significant indicators of morel mushroom presence, and also the five least significant. For each assessment, the lists were compiled within the three groups and all together as one group, and the variables most frequently cited in each of these four tallies were to be displayed spatially using GIS overlay analysis to determine areas where the variables co-exist. Once compiled, the maps would illustrate the convergences and divergences of opinion about where morels are expected to occur and not occur, not where they actually do occur. Once updated vegetation maps are available for CATO and possibly for CHOH, these analyses will be more feasible. The maps create a tangible, understandable format for knowledge sharing between stakeholders, which can inform management decisions and also provide an avenue for further examination of the effectiveness of knowledge transfer as a foundation for participatory discourse formation.

The results from this analysis would provide spatially explicit information about potential morel habitat in the MAR. Upon their completion, the maps would be reviewed with the harvesters to gain insight into their interpretation of the results and their feedback on my interpretation of the results. This “ethnographic ground-truthing” by harvesters provides historical depth and vital new information on ecosystem dynamics.

The second set of data for future analysis includes extensive records of morel fruiting over a 29-year period from the greater Catoctin area (“the H29data”). These data show fluctuations in morel fruiting and an overall downward trend in fruiting at local sites over a 29-year period. As referenced in chapter 2, recent research has established specific links between a changing climate and the changing phenology of large groups of fungi at specific sites in the United Kingdom and in Norway (Gange et al. 2007; Kauserud et al. 2008). It is unknown whether trends observed from northern Europe can be generalized across the planet, as predictions based on one kind of habitat may not hold up in other areas. Correlating the H29 data to temperature would be a first step in determining if phenological changes are also occurring in the mid-Atlantic region of the U.S., where the peak of the morel mushroom season has advanced one to two weeks. The interview data also support this hypothesis. Based on findings from these additional analyses, this approach may be scaled up to include other popular fungal species and other U.S. regions.

The collection and use of these data, supported by scientific data and techniques, will contribute to a conservation-focused American mycological research agenda. However, to use these records effectively folk taxonomies and scientific taxonomies must be reconciled. This work will entail developing a model for the "matching" of species concepts (types) by working with "amateurs" to collect fresh specimens of a variety of target species, and using genetic data to barcode the specimens and compare them to species currently recognized within scientific taxonomy (Pringle, Moncalvo, and Vilgalys 2000; Pilz et al. 2007). Working with "harvester communities" to identify data that could be used to determine how North American fungi are affected by global change, includes more stakeholders in the creation and development of management strategies and conservation decisions more comprehensively than they have been in the past. This proposed research develops a practical model for this alternative framework for conservation biology in two ways. First, it utilizes "harvester" records to provide historical data that are otherwise not available because in the past "harvesters" have not been considered by mycologists. This remains an important distinction moving forward, since mycologists are very aware of and actively work with "amateurs" from mycological societies, but not with local harvesting communities, per se. Second, it involves "harvesters," and the data they have collected, in the development of conservation strategies for individual fungal species of outstanding social and economic value.

These data will provide new and critically needed information about whether and how fungi are shifting phenologies in response to changes in temperature and rainfall, by correlating historical records of fruiting with historical data on climate. The phenology of an individual species reflects diverse aspects of its life history and reproductive strategy, and data on phenologies will give us basic information about the changing ecology of target species. For example, preliminary evidence suggests that the different morel species that previously fruited in sequence are now fruiting simultaneously (Barron and Emery 2009). Simultaneous fruiting may have multiple impacts on morel biology. First, the species that once used temporal partitioning to divide local niche space may now compete for the carbon and the other resources needed for reproduction. Second, simultaneous fruiting may facilitate hybridization among the germinating spores of species that used to be reproductively isolated. Finally, the carbon budget of plants symbiotically associated with mycorrhizal species may be influenced by the increased need for resources during a few, concentrated weeks, a heretofore unconsidered concern of the changing climate for plant ecology. Similar data on the shifting phenologies of other genera will provide similar insights about their ecology. Results from this type of integrated research have practical, economic, and scientific value. “Scientists,” “managers,” and “harvesters” would all be interested in these findings.

My second set of suggestions is based on the social-theoretical aspects of this dissertation, arising specifically out of my focus on morel harvesters in the mid-Atlantic. Specifically, I propose new directions in how we theorize the relationship between SEK and T/LEK.

Understanding nature through scientific inquiry is a central component of dominant American culture. However, conventional sciences like biology and ecology remain abstract because they seek to extrapolate universal understanding and rules across space, place, and time. Since the 1980s, the term "traditional ecological knowledge" (TEK) has come into widespread use as a way to discuss "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 2008:7). In contrast to the seemingly universal reach of SEK, TEK is in part defined by spatial, temporal and performative limits. While the term indigenous ecological knowledge (IEK) is restricted to indigenous peoples, TEK may be applied more broadly, although in practice the two are often equated with each other. The term LEK is sometimes used because it is the least controversial, but it does not connote the temporal dimensions, cumulative cultural transmission, or connection to place inherent in TEK (Berkes 2008).

Findings in this dissertation suggest that there are long-standing communities with a depth of knowledge about local species and environmental processes that go unnoticed specifically because they do not fit into established categories of holders of ecological knowledge. For example, in addition to the MAR morel hunters, gatherers and traders of products like piñon pine nuts in New Mexico (R. McLain, personal communication 2009), salal in Washington (Ballard and Huntsinger 2006), or morel mushrooms in Oregon (McLain, Christensen, and Shannon 1998) have documented long-term place-based ecological knowledge. They remain marginalized because of the scientific: indigenous binary that has emerged in perceptions of ecological knowledge. This binary can be dismantled by acknowledging the plurality of knowledge practices that exist. J.K. Gibson-Graham has shown the plurality of economic activities, outside of and beyond capitalism, in the diverse economy (Gibson-Graham 1996, 2008). What I am suggesting is a similar recognition of the plurality of ecological knowledges, outside of science, in a diverse ecology.

Re-framing these cultures of nature in terms of their situated knowledges and examining those knowledges in terms of how they are created, constructed, and practiced acknowledges the sociality of nature. It presents an opportunity for ethical engagement with the processes of knowledge formation by asking: "what kinds of nature – or more properly natures,…do we want for what kind of future?" (Castree 2001:19). This question should not be restricted to those who may claim membership in scientific or traditional communities. Examining this problem through the lens of diverse ecologies broadens the field of what constitutes ecological knowledge and who can create and maintain it.

How TEK is defined, and whom this definition continues to include or exclude from decision-making merits careful examination. The growing literature on IEK/TEK/LEK suggests that it may contribute significantly to helping us address current and emerging environmental challenges, but in what ways? Uncovering the diversity of ecological knowledges begins to create an upwelling of actors whose voices are increasingly difficult to ignore. This includes long-standing communities of gatherers, who may not be considered Native, but who have local and regional insights into environmental processes that may be otherwise overlooked. Finally, how we understand, write about, work with, and value knowledge/practice and cultures of nature directly affects their potential contributions to discourses of conservation, land tenure, and sustainability. This in turn has potentially profound effects on environmental justice and social equity.

APPENDIX A: Harvester Oral History Questions

A. Local History:
1. How long have you lived in this county? How has the county changed in that time?
2. Do you belong to any local clubs or groups? Which ones?
3. Are there any clubs or groups focused on mushroom collecting in Maryland, that you know of?
4. Can you tell me about any major weather/ecological events that you remember or that people still talk about? (eg. hurricanes, fires, windstorms). What kind of damage did it do? What effect did it have on the mushrooms?

B. About morels [morel productivity and harvesting practices]:
1. How many years have you been hunting mushrooms for? Who do you hunt with? How did you learn how to harvest morels? What do you like best about it?
2. What time of year is the morel season? How long does the season last? Does that seem to be changing over the years? How many days during that time of year do you go mushroom hunting? What percentage of that time are you successful?
3. How do you pick morels? What tools do you use for collecting and carrying morels? Have you heard of anyone using a rake to look for mushrooms? (where?)
4. Quantity/Quality:
    a. What are the different types? What differentiates them? (Are certain types only found in certain areas? Certain times? Are you seeing more of some types than others?)
    b. Are certain types of morels more valuable or more prized? Do you have a favorite?
    c. When you find a patch of morels, how do you decide which ones to take?
    d. When you go morel hunting, how many are you hoping to get? (what's that in pounds?) How many have you gotten in the last few years?
5. Who:
    a. How long has your family been hunting mushrooms?
    b. How private do you think your hunting locations are? Are you aware of other people hunting for mushrooms at that same site?
    c. Do you think there is a large demand for morels? By whom?
    d. Describe the average morel hunter for me, where they come from, what they bring with them, how they learned to hunt mushrooms…
    e. How far do you/would you travel to hunt mushrooms? How far do you think other people go?
6. What do you do with the morels that you pick? (Eat them yourself? share them? Have you ever sold any? To whom?)
7. Do you keep records – writing/pictures? What do you record? Can I see?
8. Do you do anything else while you pick mushrooms, like hunt turkey, gather other things, take your dog for a walk, get exercise…
9. What else do you gather at other times of the year?

C. Abundance through time/Overharvesting Concerns/Conservation:

1. In your opinion, how has the quantity of morels in the woods changed over the past 4 – 5 years? Is this difference especially noticeable in certain areas? What changes have you noticed in the environment that you think might be contributing to this?
2. Do morels in different areas: appear at different times? Are they different sizes? Are associated with different types of trees? Has any of this changed over the past 4 – 5 years? If so, why?
3. Where are some places that you used to hunt morels that you no longer have access to? Why are you no longer allowed there? Since when? Do any morels hunters still have access to these places? How do you think the morels are doing on those areas?
4. What do you think could be done to help morels be more abundant again? Who could do this? What would you be willing to do to insure morels in the future?
5. What type of land management policies do you think work the best – when trained professionals make decisions, or when professionals and local residents work together to make decisions, or a different way that I have not mentioned?
6. What type of conservation policies do you think work the best – no access, restricted access, or another way I haven't mentioned?
7. Do you think there needs to be action taken to insure morels in the future? What would that entail? What about for other wild mushrooms?
8. Do you think mushrooms are being overharvested?
9. What would you consider to be the top three threats to mushrooms today?

D. Ecology [general knowledge of fungi and fungi in ecosystems]

1. Do you do anything to spread morels around or to try to make sure there are morels in the future?
2. Describe for me how morels reproduce and grow. Where do the mushrooms come from?
3. Do you think any wildlife eat morels? Which ones? Have you seen or read any evidence of this?
4. What do you know about other types of mushrooms? Do you collect other types or are you specifically interested only in morels? (How do the other kinds you've mentioned differ from morels? How do you learn about these things?)
5. How do mushrooms fit into the cycle of forest life?
6. When you go out to look for a new morel spot, what are you looking for?

E. Park Management/ Relationship and perception of managers/scientists:

1. Where do you do most of your hunting? How would you compare and contrast these areas? How do you think the ownership of the property affects the morels that occur there?
2. What is your impression of the park in general? What do you like or dislike about how they're handling their land?
3. How would you describe the relationships between the park(s) and locals? How is it different with the federal parks and other public land?
4. When the park(s) were established did anything change for morel hunters?
5. Are you satisfied with your level of interaction with park staff regarding morels? What about with other resources like deer or trees?

6. In your opinion, should park staff be concerned about the mushrooms, and if so what should they do about it?
7. What type of regulations would help mushroom hunters?
8. Have you ever met anyone that studies mushrooms for a living? Would you be interested in talking with someone like that, and what would you talk about? What type of work might you do together?
10. Do you think there needs to be action taken for morel growth? Why or why not?

F. Other:

1. What makes a good mushroom hunter?
2. What if you couldn't do this anymore?
3. Do you have any other thoughts or other information you would like to get into this study? Would you like a copy of the final report?

APPENDIX B: Manager Interview Questions

(Interviews will vary depending on whether manager is also hunter)

A. General:

5. How long have you been working in natural resources management? How long in this area? How long at this park?
6. What's your background/education in? Did you take any mycology classes in school or later?
7. Can you tell me a little bit about the history of this park, when it was established, how, why?

D. General knowledge of fungi and fungi in ecosystems

1. Have you observed or know of mushroom hunters actively propagating morel mushrooms? Other signs of active management or conservation efforts by mushroom hunters?
2. Can you explain how morels reproduce and grow? Where do they come from?
3. Do you think any wildlife eat morels? Which ones? Have you seen or read any evidence of this?
5. What can you tell me about the role of fungi in forest ecosystems?
7. Do you know more about certain species of fungi than others? Why are they of particular interest? [variant of 4.]

A4. Can you tell me about any major weather/ecological events that you remember or that people still talk about? (eg. hurricanes, fires, windstorms). What kind of damage did it do? What effect did it have on mushroom productivity?

B. Morel productivity and harvesting practices:

D1. Do people around here do anything to spread morels around or to try to make sure there are morels in the future?

1. Do you hunt any mushrooms? [How long have you been hunting mushrooms? Who do you hunt with? How did you learn? What do you like about it?]
2. What time of year is the morel season? How long does the season last? Does that seem to be changing over the years?
3. What are the harvesting practices in this area? How are they picked/collected/ transported? Have you heard of anyone using a rake to look for mushrooms?
4. Quantity:
    a. Are there different types? What differentiates them? Are certain types only found in certain areas? Are you seeing more of some types than others?
    b. Are certain types of morels more valuable or more prized? Do you have a favorite?
    c. In your experience, do people usually take all of the mushrooms they find or do they look for certain sizes or ages? How can you tell?
    d. What's an average day's yield around here? Has that changed in the last few years?
5. Who:

b. Do you have a lot of traffic to the same mushroom hunting areas? Are people highly secretive about their spots? How do you know?
c. Do you think there is a large demand for morels? By whom? What do you know about the international mushroom trade? How has it played out in this region?
d. Describe the average morel hunter for me, where they come from, what they bring out with them, how they learned to hunt mushrooms…
e. How far do you think people travel to hunt morels?

7. Do people keep records – writing/pictures? Have you seen any?
8. Based on your observations, is mushroom picking the only activity for hunters or is it often combined in a multi-recreational way with other activities?
9. What other NTFPs are gathered in this area?

C. Abundance over time/ Overharvesting/conservation:

1. In your opinion, how has the quantity of morels in the woods changed over the past 4 – 5 years? Is this difference especially noticeable in certain areas? What changes have you noticed in the environment that you think might be contributing to this?
2. Do morels in different areas: appear at different times? Are they different sizes? Are associated with different types of trees? Has any of this changed over the past 4 – 5 years? If so, why?
4. What do you think could be done to help morels be more abundant again? Who could do this? What would you be willing to do to insure morels in the future?
5. What type of land management policies do you think work the best – when trained professionals make decisions, or when professionals and local residents work together to make decisions, or a different way that I have not mentioned?
6. What type of conservation policies do you think work the best – no access, restricted access, or another way I haven't mentioned?
7. Do you think mushrooms are a resource that needs to be actively conserved, why or why not?
8. Do you think mushrooms are being over-harvested? How? Why? Why not?
9. What would you consider to be the top three threats to fungi today?

E. Park Management/ Relationship and perception of harvesters/scientists:

9. What are the resources which are actively managed in this park? Do they have management plans? How long have the management plans been in place? What prompted active mushroom management in this park/region?

C3. How has access to mushrooms changed in your park over the last 25 years? How do you think the morels are doing on those areas with restricted access?

3. Tell me about the relationship between mushroom hunters and park staff, in general? How about your relationship with them? What type of community interaction and outreach does this park participate in? Are you satisfied with your level of interaction with mushroom hunters? What about regarding other resource users?
5. Are you satisfied with your level of interaction with local mushroom hunters regarding morels? How do you work together? What about regarding other resources?

10. Do you think mushrooms are a resource that needs to be actively managed? Why or why not?
11. What is the basis for your fungal management approach? What would be an effective management policy for morels? Who would be involved in developing this approach?
12. Do you have any interaction with mycologists? In what capacity do they inform your fungal management policies? What type of work might you do together? Are you satisfied with the amount of interaction between managers and mycologists? How does your interactions with mycologists compare to that with forestry or fisheries professionals? [or appropriate resources for that park].

<u>F. Other:</u>

1. What would someone need to know to collect morels (physically and in terms of management policy), and how would you suggest they go about learning that?
2. How do you think people in this area would react if they were denied or limited access to wild mushrooms?
3. Do you have any other thoughts or other information you would like to get into this study? Would you like a copy of the final report?

APPENDIX C: Scientist Interview Questions

(Interviews will vary depending on whether scientist is also hunter)

A. General:

5. How long have you been working in mycology? Specifically in fungal conservation? What are your primary research interests?
6. What is your background/ education? How did you first get interested in mycology?

D. General knowledge of fungi and fungi in ecosystems

1. Have you observed or know of mushroom hunters actively propagating morel mushrooms? Other signs of active management or conservation efforts by mushroom hunters?
2. Can you explain how morels propagate and grow? What are the different types and how are they differentiated from each other?

B4a.Are certain types only found in certain areas?

3. How would you describe interaction between fungi and wildlife? Which species are involved? Have you seen or read any evidence of this?
5. Can you briefly describe for me the role of fungi in ecosystems? Specifically basidiomycetes? Morels?
6. Where would you look for morels? Are there any specific species associations or other ecological attributes you would focus on?
8. Can you tell me briefly about the development and history of fungal classification? What do you think about the common misconception that fungi are part of the plant kingdom, or even just similar to plants? What consequences does that level of systematic confusion have for the management of fungi?
9. Are you considered an expert on any species of fungi? Why are they of particular interest to you? To others?
10. What are some of the most significant ecological events that have taken place in your region which had an effect on fungi? What about at the landscape scale? global scale? What were the impacts of these events and how long did it take different fungi to recover? How did you measure/assess this impact?
11. What do you think about theories surrounding fungal succession and the role that process might have on abundance and fruiting of different species?

C. Fungal conservation and management

1. In your opinion, how has the quantity of morels in the woods changed over the past 4 – 5 years? Is this difference especially noticeable in certain areas? What changes have you noticed in the environment that you think might be contributing to this?
3. What changes in access to mushrooms are you aware of that have occurred over the last 25 years? How do you think fungi are doing on those areas with restricted access?
4. What do you think could be done to help morels be more abundant again? Who could do this?
5. What type of land management policies do you think work the best – when trained professionals make decisions, or when professionals and local residents work together to make decisions, or a different way that I have not mentioned?

6. What type of conservation policies do you think work the best – no access, restricted access, or another way I haven't mentioned?
7. Do you think mushrooms are a resource that needs to be actively conserved, why or why not?
8. Do you think mushrooms are being over-harvested? Which species? How? Why? Why not? What are the consequences of overharvesting?
9. What would you consider to be the top three threats to fungi today?
10. What are the primary objectives of fungal conservation, and how have they changed over time? Who are the main actors in this process? What's going on now in fungal conservation?
11. Which species are most important to conserve and why?
12. Is fungal conservation on the radar for conservation agencies, land management agencies, ecologists, scientists? Who do you think is paying attention to fungal conservation and why? Who isn't that should be?

E10.Do you think mushrooms are a resource that needs to be actively managed, why or why not? What would be an effective management policy for morels? Who should be involved in developing this approach?

E11.What do you think should form the basis for fungal management?

<u>G. Relationships</u>

1. How aware of mycology do you think other biological scientists are in general? Is it enough? What else should they know and how can they find out?

E8. Describe your interactions with mushroom hunters or enthusiasts. Tell me about the relationship between mushroom hunters and mycologists, in general. In what ways might you work together?

2. What is your perception of the mycological (and related ecological) knowledge of amateur mushroom hunters? How might their knowledge assist your own research?
3. Would you welcome an opportunity to work in a collaborative effort with amateurs, and if so, how would you go about designing a research project that would incorporate their input?
4. Do you participate in any type of community interaction and outreach with mycological societies/other? Are you satisfied with your level of interaction with mushroom hunters?

E12.Describe your interaction with land managers. In what ways do you inform their fungal management policies? In what ways might you work more together? Overall, are you satisfied with the amount of interaction between managers and mycologists? How do you think it compares to the level of interaction between managers and research scientists focusing on other resources?

<u>B. Morel productivity and harvesting practices:</u>

1. Do you hunt any mushrooms? [How long have you been hunting mushrooms? Who do you hunt with? How did you learn? What do you like about it?]
2. Have you observed any changes in the seasonality or duration of season for specific wild edible mushrooms? Any theories on why this might be happening?
3. What are the harvesting practices in this area? How are they picked/collected/ transported? What are the most popular species that are collected in your area?

4c. In your experience, do people usually take all of the mushrooms they find or do they look for certain sizes or ages? How can you tell? How many would you estimate that people collect on an average day? [in kg or lbs]

5. Who:
    c. What is the level of demand for morels in this region? By whom? What do you know about the international mushroom trade? How has it played out in this region?
    d. Describe the average morel hunter for me, where they come from, what they bring out with them, how they learned to hunt mushrooms…
    e. How far do you think people travel for morels?
7. Do people keep records – writing/pictures? Have you seen any?
8. In your opinion, is mushroom picking the only activity for hunters or is it often combined in a multi-recreational way with other activities?

<u>F. Other:</u>

1. What would someone need to know to collect morels, and how would you suggest they go about learning that?
2. How do you think mushroom hunters that you know would react if they were denied or limited access to wild mushrooms?
3. Do you have any other thoughts or other information you would like to get into this study? Would you like a copy of the final report?

APPENDIX D: Environmental Variables Questionnaire

A. Environmental Attributes (pictures are provided for clarification of some terms)

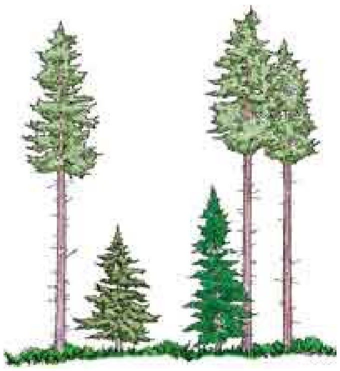
1. What are the MOST significant indicators of morel mushroom presence (pick 5):

____ Surrounding trees (if yes, list species: ___________________________________)

____ Presence of ground cover vegetation (if yes, list species: _____________________)

____ Closed Canopy ____ Open Canopy ____ Sparse understory

____ Dense understory ____ Thick leaf litter ____ Soil texture



Canopy layer: over 6.5 ft. (2 meters) tall

Understory layer: 1.6 ft (0.5m) – 6.5 ft. (2 m) tall

Ground cover: 0 ft (0 m) – 1.6 ft. (0.5 m) tall

____ Wet soil ____ Damp soil ____ Dry soil

____ Soil color ____ Rocky area ____ Depth to water table

____ Fire within the last 10 years ____ Fire within the last 5 years

____ Fire within the last year ____ Atmospheric nitrogen deposition

____ Previous day's rainfall: high/low ____ Previous week's rainfall: high/low

____ Average precipitation over past 3 months: high/low

____ Average precipitation over past 6 months: high/low

____ Average precipitation over past 12 months: high/low

____ Distance from area of recent disturbance (____ ft.)

____ Distance from gaps in the canopy (i.e. open, more sunny areas) (____ ft.)

____ Distance from roads (____ ft.)

____ North-facing aspect ____ South-facing aspect ____ Flat ground

____ Slope 5° - 15° ____ Slope 15° - 30° ____ Slope over 30°

The Duluth, MN hillside at 9° This sand dune is 22° A challenging ski slope - 40°

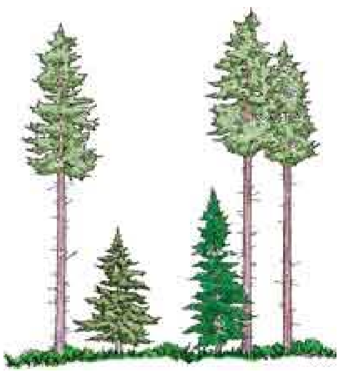
2. What are the LEAST significant indicators of morel mushroom presence (pick 5):

____ Surrounding trees (if yes, list species: ______________________________________)

____ Presence of ground cover vegetation (if yes, list species: _____________________)

____ Closed Canopy ____ Open Canopy ____ Sparse understory

____ Dense understory ____ Thick of leaf litter ____ Soil texture



Canopy layer: over 6.5 ft. (2 meters) tall

Understory layer: 1.6 ft (0.5m) – 6.5 ft. (2 m) tall

Ground cover: 0 ft (0 m) – 1.6 ft. (0.5 m) tall

____ Wet soil ____ Damp soil ____ Dry soil

____ Soil color ____ Rocky area ____ Depth to water table

____ Fire within the last 10 years ____ Fire within the last 5 years

____ Fire within the last year ____ Atmospheric nitrogen deposition

____ Previous day's rainfall: high/low ____ Previous week's rainfall: high/low

____ Average precipitation over past 3 months: high/low

____ Average precipitation over past 6 months: high/low

____ Average precipitation over past 12 months: high/low

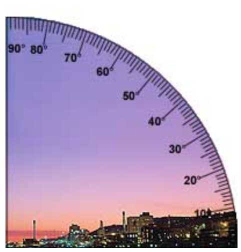
____ Distance from area of recent disturbance (____ ft.)

____ Distance from gaps in the canopy (i.e. open, more sunny areas) (____ ft.)

____ Distance from roads (____ ft.)

____ North-facing aspect ____ South-facing aspect ____ Flat ground

____ Slope 5° - 15° ____ Slope 15° - 30° ____ Slope over 30°



The Duluth, MN hillside at 9° This sand dune is 22° A challenging ski slope - 40°

Use this space to describe in more detail, if you wish, the environmental attributes you selected above. Please specify the attribute and whether you selected it in question 1 or question 2:

B. Significance (if morel hunter)

1. How important is morel mushroom collecting to you? (circle ONE number)

(Unimportant) 1 2 3 4 5 (Very important)

2. How important is morel mushroom picking for your livelihood? (circle ONE number)

(Unimportant) 1 2 3 4 5 (Very important)

3. On what type of land do you harvest morel mushrooms (respond in table below)?

Land ownership of hunting locations (check all that apply)		% hunting time on this type of property	Success of harvesting morel mushrooms (check one for each type of land ownership already selected)			
			Poor	Fair	Good	Excellent
Private (family or friends)						
Private (other)						
County						
State						
Federal						
Other:						

APPENDIX E: Q Statements

Instruction Statement: The following statements represent a range of ideas and opinions about what might be influencing the sustainability of mushrooms and other fungi. Consider these statements while thinking about the protection and preservation of mushrooms or whatever fungi you are most concerned about. Sort the statements according to those with which you most agree (+4) to those with which you most disagree (-4).

1. The yellow morel is found across North America, often under ash and dying elms, so the protection of these and other trees associated with mushrooms is important.
2. Morels come out under the following conditions: 60 degree temperatures and consistent precipitation from mid-April to mid-May; some kind of showers every week.
3. It seems like you're missing something if you don't get to go mushroom hunting every year; it's tradition.
4. It used to be that during morel season first you'd find the black, then white, then yellow. In the last few years they seem to be coming up at the same time.
5. All mushroom hunters in this area agree that the quantity of morels in this area has declined.
6. Fungi are plants which cannot produce their own food like other plants can.
7. Most conifer trees- pines, spruces, cedars, hemlocks, firs - could not live without fungi.
8. Picking a mushroom does not harm the long-lived fungal organism. The "body" of a mushroom is hidden underground.
9. Decreases in morel mushrooms are due to inconsistent weather. I just hope Mother Nature agrees with us and give us the weather we need.
10. Closing off certain areas of the park to mushroom hunters would allow mushrooms to recover and become more abundant in those areas.
11. As far as taking mushrooms off the land, it is not hurting anything, even if we take all the mushrooms the root is still there so that isn't hurting the growth of the mushrooms.
12. In reality, the public owns federal lands, and should have more of a say in what happens and decisions that are made regarding mushrooms on federal property.
13. You will find more morels after fire, tree mortality, or ground disturbance.
14. Managers could manage forests for better morel harvesting if they understood how natural and human disturbances affect morels.
15. In order to protect an area's outstanding natural qualities, mushroom picking and/or collecting should not be permitted.
16. History has many examples of over-consumption of timber, fish, and wildlife. We can not afford to make the same mistake with fungus.
17. Conservation of fungi is, like with organisms, conservation of the places where fungi occur.
18. There is no such thing as overharvesting because you can't find all the mushrooms that are out there to begin with.
19. For morels to recover, it would be better to limit harvesting amounts over a period of time than to ban harvesting for that same period of time.
20. The root problem for fungal conservation is that we do not have the numbers of experts needed to understand different species quickly enough to conserve those species.
21. People who study the relationships between species can be greatly aided by collaborating with people with less formal schooling in mycology.

22. The most satisfactory manner in which to preserve fungi is through protection of the environment and thereby the natural community itself.
23. Land development, that's happening everywhere, and it is hurting the mushrooms.
24. In addition to concerns about the effect of harvesting on morel populations, there is also a need to prevent trampling of associated rare plant species.
25. Morel hunters take all of the mushrooms they find, regardless of size and condition.
26. Some collectors aid their search for mushrooms with leaf blowers or garden rakes.
27. Morels are just like any other plant or animal; if we don't protect them then they'll probably disappear sooner than later.
28. I think that the National Park Service needs a management plan for wild mushrooms.
29. Due to rapid development, more people are hunting for morels on public land.
30. The reproductive biology of edible mushrooms and their habitat requirements is still poorly understood.
31. Decreases in morel abundance are due to environmental changes like global warming.
32. Decreases in morel abundance are due to the high deer populations in many areas throughout the northeastern US.
33. Just like regular crops, if you keep growing the same thing at the same place every year, eventually it will be less productive. It could be the same way with mushrooms.
34. Because the precise ranges of species of fungi present in most areas and how many there are is usually unknown, conservation of mushrooms is meaningless.
35. The future of fungal conservation seems fairly rosy because there is a real interest in fungal conservation among all those involved in harvesting wild mushrooms.
36. Most fungal population declines and extinctions are because of people's energy consumption, the increasing human population, and intensive farming.
37. Mycologists have a lot of work to do in educating the public, government management agencies, and other biologists about fungal conservation.
38. As long as the ground isn't dug up deeply, intensive picking has little influence on future crops of mushrooms and may even make them grow a little better.
39. Fungi need to be considered in terms of their relationships with other parts of the environment.
40. Fungi that have relationships with forest trees are more important than other fungi.
41. A combination of factors is what is important for mushroom fruiting to occur.
42. One of the things I think would help bring morels back would be to timber the forest, or have a forest fire.
43. The presence and abundance of certain fungi may change during forest development.
44. All the mushrooms we collect are near the road or path; we only hunt on pre-made tracks.
45. There are complicated relationships between fungi, animals and trees. Disruption to any one of these will inevitably affect the others.
46. Studies on the role of fire and effects of fire suppression are particularly needed in western forests.
47. The money that I make from selling mushrooms is critical because I am on a very low income, it allows me to pay the rent, it's that critical.
48. As long as mushrooms are being harvested in such a way that the spores are still being distributed then it's not hurting anything.

APPENDIX F: Factor Loadings from Q analysis

Factor Matrix with an X Indicating a Defining Sort: Loadings

QSORT		1	2	3	4
1	S0701	0.3748	-0.0653	0.6864X	-0.1049
2	S0702	0.4850X	0.0342	0.6959X	-0.0910
3	S0703	0.7469X	0.0026	0.0593	0.1887
4	S0704	0.7403X	-0.0090	0.3125	0.1480
5	S0705	0.5841X	-0.1719	0.2940	0.4354X
6	S0706	0.6593X	-0.0487	0.1176	0.3420
7	S0707	0.4102X	0.0281	0.3292	0.3265
8	S0710	0.6973X	0.1539	0.3541	-0.1471
9	S0711	0.5130X	0.0778	0.4373X	0.2487
10	RebMC	0.6899X	0.0942	0.0419	0.3142
11	M0701	0.1427	-0.1449	0.7111X	0.0086
12	M0702	0.1743	0.1050	0.7926X	0.1235
13	M0703	0.2183	0.2256	0.8339X	0.0344
14	M0704	0.3682	0.1859	0.5402X	0.3483
15	M0705	-0.1427	0.4365X	0.5458X	-0.0936
16	M0706	0.5362X	-0.1190	-0.2135	0.4156X
17	H0701	0.2913	0.2010	-0.0872	0.3792X
18	H0702	0.0385	-0.0888	0.5941X	0.3542
19	H0703	0.3372	0.2168	0.3397	0.5351X
20	H0704	0.1181	0.6716X	0.2107	0.2792
21	H0706	0.3117	0.4195X	0.2486	0.3383
22	H0707	0.1939	0.2048	-0.0349	0.5490X
23	H0708	-0.1996	0.5943X	0.0431	0.3845
24	H0709	-0.0215	0.2383	0.6465X	-0.0897
25	H0710	-0.0940	0.3689	0.4596X	0.5288X
26	H0711	0.3564	0.5149X	-0.1078	0.3830
27	H0712	0.3873X	0.2083	0.3588	0.3833
28	H0713	0.2313	0.1976	-0.1112	0.6209X
29	H0714	-0.0772	0.6174X	0.0304	0.1213
30	H0715	0.1373	0.4392X	0.4938X	0.3822
31	H0716	0.2078	0.3648	0.1663	0.5418X
32	H0717	-0.0322	0.2269	0.5714X	0.4851X
33	H0718	0.1321	0.4782X	-0.5171X	0.1335
34	H0719	0.0250	0.5673X	-0.0736	0.0436
35	H0720	-0.1877	0.6065X	-0.0891	0.2359
36	H0721	0.1644	0.1221	-0.0808	0.6259X
37	H0722	0.2070	0.1105	0.1294	0.8140X
38	H0723	0.1576	0.2784	0.1883	0.7563X
39	H0725	0.0605	0.6435X	0.0249	0.1169
40	H0726	0.1632	0.5762X	0.2472	0.3356
41	H0727	0.3517	0.5114X	0.1501	0.0686
42	H0728	0.0493	0.5926X	0.1668	0.0966
43	H0729	-0.0368	0.5811X	0.1870	-0.0531
44	H0730	0.3995	0.4749X	-0.1454	0.2557

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Curriculum Vita
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PROFESSIONAL EXPERIENCE

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