



Names matter: Interdisciplinary research on taxonomy and nomenclature for ecosystem management

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Abstract

Local ecological knowledge (LEK) is increasingly used to provide insights into ecosystem dynamics and to promote stakeholder inclusion. However, research on how to incorporate LEK into ecosystem management rarely discusses taxonomy and nomenclature despite the fact that processes of naming are deeply implicated in what types of knowledge are validated and used. Too often, local names are vetted against and then subsumed under ‘true’ scientific names, producing an oversimplified understanding of local names and perpetuating stereotypes about communities that use them. Ongoing revisions in mycological taxonomy and widespread interest in wild edible fungi make mushrooms an excellent case study for addressing nomenclature as an important part of multi-stakeholder research. We use morel mushrooms collected from the Mid-Atlantic United States to demonstrate a methodological approach to nomenclature – performative method – that focuses both on maintaining culturally meaningful aspects of local names and on recognizing culture and meaning behind scientific names. While recognizing the utility of the Linnaean nomenclatural system, we argue that acknowledging the contextual meanings of names avoids the unequal power relations inherent in integrating local knowledge into scientific discourse, and instead reframes knowledge production around shared interests in environmental questions and challenges.

Keywords

Critical physical geography, situated knowledges, local ecological knowledge, fungi, performative method

I Introduction

Demonstrating the existence of traditional and local ecological knowledge has been a significant tool for indigenous and community rights

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movements to enable greater participation in ecosystem management, and in many ways this tool has worked. Local ecological knowledge (LEK) is increasingly discussed by scientists and used by policy makers to provide insights into ecosystem dynamics and to promote stakeholder inclusion (Berkes et al., 2003; Gadgil et al., 2003; Miller et al., 2008; Raymond et al., 2010; Rist and Dahdouh-Guebas, 2006; Salick et al., 2002). In the majority of research on LEK and ecosystem management, however, taxonomy and nomenclature are rarely discussed. Too often, local names are vetted against and then subsumed under “true” scientific names, or sidelined in discussions focused on relating knowledge to power. Many natural and social scientists perceive scientific and local names as a necessary bottleneck on the way to answering more interesting questions about ecology (Wolfe et al., 2012b), evolutionary biogeography (Wolfe et al., 2012a), indigenous politics (Agrawal, 2002), or critical analyses of community engagement (Brosius and Russell, 2003). While valuable in their own rights, this “bottleneck mentality” on nomenclature distracts from the ethical dimensions of the naming process and the power dynamics inherent therein, perpetuating stereotypes about use, meaning, and value of both scientific and local names, and lay and scientific experts.

Nomenclature includes metrics, mechanics, and techniques that laypeople use in their everyday lives (Bowker and Star, 1999) as well as those that scientists use as part of their work. Considering nomenclature is an important part of an integrated, multi-stakeholder approach to ecosystem research because processes of naming are deeply implicated in what types of knowledge are validated and used (Bowker, 2000). We argue there is a continuing need for in-depth research on taxonomy and classification in both the natural and social sciences, and that these lines of research benefit from being conducted together. This need stems from the power imbalance present when local and scientific

names are encountered as fixed and final. Scientific names are considered more “correct” or “true,” and thus more powerful and relevant for use in environmental management. By extension, scientists’ input is considered ultimately more valuable for ecosystem management decision-making than that of local stakeholder communities, thus extending this power imbalance to concerns of social equity and political economy.

By giving attention to power relations, our interdisciplinary project on taxonomy and nomenclature is intended to highlight ethical concerns about power imbalances among stakeholders by focusing on the *production* of local and scientific names, rather than the names themselves. Our case study examines local and scientific naming processes of morel mushrooms found in the Mid-Atlantic region of the United States. Morels make a particularly interesting case study because they are prized wild edibles among lay experts and their scientific taxonomy and nomenclature, like those of many genera in mycology, has been destabilized in the past few decades. Examining how nomenclatural data are produced, and under what conditions they are used and change, shifts the focus away from hierarchical comparison and knowledge integration, which has proven to be ineffective in enabling real social change in environmental governance and conservation frameworks (Brook and McLachlan, 2008; Lave et al., 2014).

We consider this work within the scope of the emerging field of critical physical geography (CPG) (Lave, 2012), where analyses of biophysical systems are related to and informed by accompanying analyses of cultural and institutional systems (Tadaki et al., 2012). Neither scientific nor social processes are privileged in our analysis. Rather, in accordance with the CPG framework, we “produce critical biophysical and social explanations while also reflecting on the conditions under which those explanations [were] produced” (Lave et al., 2014: 4).

In developing a CPG approach to taxonomy and nomenclature, we consider claims from bioscience and local knowledge to be equally relevant to ecosystem management, and attend to the social power relations between them. We emphasize ethical forms of producing knowledge, rather than the development of knowledge integration protocols. Focusing concurrently on environmental impacts, social equity, and political economic concerns generates an alternative ethical framework for future ecosystem management. With our focus on ecology and critical nature discourses, our work extends the scope of CPG from the geomorphologic to the biotic, and into dialogue with bioscientific research.

The paper proceeds in four parts. We begin section II with a review of a subset of the empirical literature on LEK in resource management, primarily from the social-ecological systems literature focusing on LEK integration. Our specific interests in ecosystem management and social equity are addressed more directly there, although we also find insight in the ethnobotanical and ethnoecological literature often associated with folk and biosystematics (Berlin, 1992; Berlin et al., 1973; Rist and Dahdouh-Guebas, 2006). We also include a review of formal classification in botany and mycology as a point of reference for those unfamiliar with these processes.

In section II we further include a discussion of the concepts of “situated knowledges” and “performativity,” which form the theoretical basis enabling engagement with ethics in our work. The idea that knowledge is situated and differentiated by place, time, personal experience, and social experience is accepted by scholars across the social sciences as the concept of situated knowledges (Fortmann and Ballard, 2011; Haraway, 1988; Haraway, 1991). Performance and performativity are closely related concepts widely used in human geography to examine social identity and social action:

Performance, in short, seems to offer intriguing possibilities for thinking about the constructedness of identity, subjectivity, and agency. Our assumption [is] that a notion of performance is indeed crucial for critical human geography concerned to understand the construction of . . . social power relations, and the way space might articulate all of these. . . . We agree that both performance and performativity are important conceptual tools for a critical geography concerned to denaturalize taken-for-granted social practices (Gregson and Rose, 2000: 434).

When taken together, these two concepts provide a conceptual structure consistent with the aims and goals of our project: to better understand the power relations inherent in the names of organisms by seeing those names come into being in specific places, at specific times, and through shared experiences. We call our approach *performative method*: a form of self-ethnographic data collection, analysis, and learning that produces alternative ways of knowing nature. Our aim with the concept of performative method is to bring the methodological details of interdisciplinary collaboration to the foreground, with special attention to the social actions and identities of local experts, scientific experts, and ourselves as an interdisciplinary research team (Ellis and Waterton, 2005). The conceptual framework of situated knowledges and performativity, in addition to our use of the social-ecological systems literature, further differentiates this project from classical ethnobotanical work.

In section III, we briefly review the history of fungal management and classification for Mid-Atlantic morel mushrooms as background for our own data. We present our case study, with details on collecting specimens, documenting LEK, and generating scientific knowledge. We attend to the power relations inherent in our own project by giving equal treatment to the methods used to collect and record both the LEK and the bioscientific knowledge (Bloor, 1991).

In section IV, we show how our case study demonstrates performative method and its

effects on power relations. Closely examining the processes of naming and use helps us attend to power relations between LEK experts and scientists, showing how classificatory systems are representative of different ways of knowing the environment (Bowker and Star, 1999; Haraway, 1991; Miller et al., 2008; Rist and Dahdouh-Guebas, 2006). In the conclusion we discuss the utility and relevance of performative method by working through a possible management scenario with altered ethical engagement with names. We argue that shifting the analytical focus away from broad categories of knowledge integration and onto everyday practices of environmental knowledge production and use changes the dialogue between laypeople, managers, and scientists, whose identities are shaped by shared interests in environmental questions and challenges (Chilvers, 2008; Miller et al., 2008).

Our goal is to engage in knowledge production that respects stakeholder differences in use and value of targeted species, which, we hypothesize, may lead to more socially equitable and therefore environmentally sustainable ecosystem management. For more management, CPG facilitates this coming together of biology and biogeography on the one hand and critical analysis of knowledges and power on the other.

II Shifting analytical frames from knowledge integration to knowledge production

I Local ecological knowledge and classification in ecosystem management

Following Davis and Wagner, we understand LEK to “constitute a ‘body’ and a ‘system’ of understandings and know-how that arise through time from a variety of individual and shared experiences and observations, mediated by culture, with regard to environmental factors, behavioral attributes, and ecological dynamics”

(2003: 477). It can include experimental as well as observational techniques developed locally, with special attention to local social-ecological relationships in order to answer context specific questions (Fortmann and Ballard, 2011). In keeping with an understanding of knowledge as situated (Haraway, 1991), we understand science *in the same way*, where experiences and observations are additionally mediated through use of the scientific method.

Incorporating LEK into scientific ecological knowledge for resource and land management, and for policy development, is both a research topic and a political agenda. Multiple approaches to this have been developed, including co-management, adaptive management, and participatory research (Berkes, 2009; Berkes et al., 2000; Berkes et al., 2003; Gadgil et al., 1993; Rist and Dahdouh-Guebas, 2006). Community-based resource management, development studies, and indigenous studies also highlight close connections between people, specialized knowledge, and environmental decision-making (Agrawal and Gibson, 2001; Berkes, 2004; Berkes, 2009; Raymond et al., 2010; Richards, 1997).

Despite the growing scientific literature promoting integration and co-management, research consistently demonstrates that local knowledge is not taken as seriously or given as much value as scientific knowledge (Brosius and Russell, 2003). One meta-review showed that, in spite of extensive references to LEK in the ecological and conservation literature, “LEK-based publications remain nearly absent from the more established theoretical literature and are largely restricted to more recent and arguably less prestigious applied and interdisciplinary journals” (Brook and McLachlan, 2008: 3501).

Across disciplines, analysis of the lack of successful integration is leading to a focus on processes rather than products. For example, Raymond et al. (an interdisciplinary group) contend that “the current challenge for researchers

is to develop ‘user-inspired’ and ‘user-useful’ management approaches whereby local knowledge is considered alongside scientific knowledge” (2010: 1766). While arguing “there is no single optimum approach for integrating local and scientific knowledge, [they] encourage a shift in science from knowledge integration *products* to the development of problem-focused, knowledge integration *processes*” (2010: 1766, emphasis added). Social-ecological scientists Bohensky and Maru (2011) similarly advocate for processes of multiplicity and integration, where “knowledge identities are maintained, but enriched through interaction with one another” (2011: 11). Interdisciplinary team Fazey et al. (2006) and mycologists Dahlberg et al. (2010) argue that adopting a more holistic approach that includes reflexive practice will help scientists meet their research goals. In the case of fungal conservation, especially, Dahlberg et al. (2010) argue that mycologists benefit from reflecting on how much knowledge is sufficient to begin to enact conservation protocols, and how similar or different those protocols should be from those for plants and animals.

Focusing on knowledge integration processes and more holistic inclusion of interested parties implicitly acknowledges that different knowledges exist, and can address and inform the same problem. To work with them, however, there needs to be a way to communicate about the resources and environment in question; there needs to be a shared language. A more expansive process-oriented perspective on taxonomy and nomenclature recognizes that this shared language is something that must be considered before names are codified and fixed.

For biologists and biogeographers, classification lends structure and identity to organisms and facilitates communication. How to create taxonomic groups, including what differentiates individual species from one another, is a source of ongoing discussion. Increasingly sophisticated techniques have led to the current emphasis,

especially in mycology, on phylogenetic species identification: a set of laboratory and statistical techniques that have enabled differentiation and identification of species previously unknown or unidentifiable using older techniques. Whether the resulting species groupings are in fact real and different entities, or simply human constructs to assist in our imperfect understanding of the world around us, is a regular topic of discussion among biologists, biogeographers, and others, especially as it relates to quantifying biodiversity (Takacs, 1996). However, most natural scientists maintain that species is a useful concept and that the Linnaean system, with all its problems, should be modified rather than abandoned.

Once a species has been identified, many still consider it “unofficial” until it has been named according to *The International Code of Nomenclature for Algae, Fungi and Plants* (subsequently called The Code). For strict followers of The Code, Linnaean names are the only correct names for organisms, and once determined they are assumed to be universally accepted by scientists as true names. Increasingly, however, The Code has come to emphasize names as tools for identification, rather than purely as descriptions of species. This shift stems from the current reordering of taxonomies according to evolutionary relationships rather than morphological similarities (McNeill et al., 2012).

Emerging biogeographic data and phylogenetic approaches are radically reshaping taxonomy in mycology (Hibbett, 2001; Hibbett and Taylor, 2013; Mueller et al., 2001). Until recently, the idea that “everything is everywhere” was dominant (Taylor et al., 2006), and many fungi were assumed to have global distributions. Phylogenetics enabled the discovery of hundreds of “cryptic” genetic species within what were once described as single, morphological species. “Cryptic” species typically have distinct geographic ranges, but can only be differentiated using DNA sequence data, requiring different names for species that are often not

distinguishable morphologically. These discoveries have obvious implications for fungal ecology and nomenclature previously based primarily on morphology, and for interpreting and relating scientific names to local names (James et al., 1999; Pringle and Vellinga, 2006), since local experts do not have access to DNA analysis.

In the same way that taxonomic research has moved beyond a sole focus on morphology, social science research on “folk biosystematics” has moved beyond describing the environmental knowledge of non-western and indigenous people as “pre-scientific man’s classification” (cf. Berlin et al., 1973: 214). Contemporary ethnobiologists empirically study the function of LEK in societies, and use structural theories that highlight how LEK complements science and supports cultural diversity (Berlin, 1992; WinklerPrins and Sandor, 2003). Because our argument relates more to space than to culture, we do not draw further from the ethnobiological literature.

Spatially, local names and LEK continue to be just that: *local*. When biologists consider *local* names they are tied to places and communities, just as indigenous rights activists want them to be (Agrawal, 2002). Implicitly or explicitly, this pulls local names into comparison with *scientific* names, which are understood to be universal and not spatially constrained (Haraway, 1988; Powell, 2007). This is a proverbial “catch 22.” LEK needs to be identified specifically in order to document it as real, and comparable to scientific ecological knowledge. Yet, in that very act of comparison we reinforce the two-tiered system against which many natural and social scientists are working. Before even arriving at a discussion of nomenclature, we are forced to confront the fact that once a name is identified as local or scientific, once knowledge is identified as either/or, its authority (or lack thereof) is established. For these reasons, we turn to the concepts of situated knowledge and performativity.

2 Situated knowledges and performativity

The concept of situated knowledges highlights that all knowledge emerges from communities, circulates through networks, and is used in different ways and with different meaning by different actors (Demeritt, 1998; Jasanoff, 2004; Latour, 1988). In geography both the geography of science literature (Henke and Gieryn, 2008; Powell, 2007) and the emerging literature incorporating political ecology and science and technology studies emphasize the importance of attending to literal and figurative places where ecological and biological scientific knowledges are produced, circulated, and applied (Goldman et al., 2011).¹

The power of scientific and non-scientific networks to influence ecosystem management and policy remains highly asymmetrical, because knowledge circulates very differently depending on the network and the place where it originated (Livingstone, 2003). Biodiversity, for example, is considered by most biologists to be a well-defined biological concept to structure, account for, and discuss diversity across scales. As it has become more popular and widely circulated outside of the scientific community, the term is often assumed to have a positive meaning; especially in environmental management and conservation, more biodiversity is almost always desirable (Myers et al., 2000). Critical social scientists, on the other hand, point out that biodiversity emerged in the late 1980s as a concept with strong political overtones to support the new field of conservation biology (Lorimer, 2012). Over time, according to social science case studies, the concept of biodiversity has facilitated the creation of new organizations and treaties, generated large amounts of new research, redirected financial investment into biology and associated fields, and led to the massive appropriation of land for conservation (MacDonald, 2010; Takacs, 1996;). For these scholars and some of the communities they work in, the meaning of

biodiversity may thus be more closely associated with political and economic decisions that empower scientists, international agencies, or NGOs, and disenfranchise local people (Ellis and Waterton, 2005; Goldman, 2004; West, 2006). In this example, it is clear that biodiversity means something very different to different communities of scholars. The power of the term depends on whose interpretation one encounters and chooses to use, on which “performance” is more consistent with one’s ecosystem management and policy goals.

Considering scientific knowledge as interpersonal engagement is an alternative perspective to that of seeing scientific knowledge as discovery. Science and technology studies scholars have written extensively about social practices in science (Callon and Rabeharisoa, 2003; Latour, 1988; Latour, 1999) and the ongoing “performance” of scientific expertise (Hilgartner, 2000). This work is consistent with a turn towards the concept of performativity in critical human geography, which directs analytical focus to processes of engagement (e.g. dialogue and experience) rather than end products (e.g. facts and how they are represented) (Gregson and Rose, 2000; Nash, 2000), and conceptually mirrors calls in the social-ecological literature discussed above.

Scholarship on the performativity of knowledge is further enhanced through interdisciplinary collaboration with natural scientists because “every question about what to study and how to study it becomes an ethical opening; every decision entails profound responsibility” (Gibson-Graham, 2008: 620). Thus, incorporating work on situated knowledges and performativity gives physical scientists a conceptual framework and language for understanding the highly complex social systems that shape the physical systems they study. At the same time, working closely with physical scientists grounds research on performativity and situated knowledges in actual practices of environmental knowledge making.

In the following section, we demonstrate the practice of performative method as it relates to nomenclature of Mid-Atlantic morels. To do this we specify the historical context through which the current study came about. We pay close attention to the identity of all participants (including ourselves), their subjectivities and how those are formed, and the agency of different participants vis-à-vis names. We do this to destabilize the naturalized academic distancing of collecting data from local communities, and similarly to bring to light the frequently black-boxed scientific practices of working with DNA.

III Performing a hybrid method: A case study with Mid-Atlantic morels

I Project background

Despite interest by government agencies in involving local communities, finding a common language to talk about morels has been especially difficult. As recently as 2010, many North American species were recognized as distinct from their European counterparts, but had not been identified as such or renamed accordingly.

Morels have been hunted in the Mid-Atlantic United States for over 100 years, and are considered part of the region’s cultural heritage. Anecdotal reports of declines in the mid-2000s thus sparked interest in more active management (Barron and Emery, 2009). In cooperation with the National Park Service, Emery and Barron (2010) presented findings on LEK data related to morel habitat and tree associates, disturbance, and phenology, and compared it with the available scientific literature. Subsequently, emerging phylogenetic techniques made it possible for the first time to compare and identify phylogenetic species worldwide (O’Donnell et al., 2011), a significant advancement in fungal biogeography which is resulting in massive reconfigurations in the taxonomy of many genera

(Mueller et al., 2001; Pringle and Vellinga, 2006; Vellinga et al., 2009).

The instability in the scientific morel phylogeny (Kuo, 2005; Kuo, 2011; McFarlane et al., 2005) contrasted with the relative stability of local morel nomenclature documented by Barron and Emery (2009). In keeping with calls in the literature to compare and integrate local and scientific knowledge to enhance management (Emery and Barron, 2010; Love and Jones, 2001), in 2009 the current authors decided to undertake additional sampling with the goal of explicitly connecting the local taxonomy from the Mid-Atlantic with the available scientific taxonomy. Over the course of the project, however, we began to believe that the comparison of separate sets of names did not address our underlying interests in addressing both the environmental impacts of management practices based on limited scientific knowledge of fungi, and social impacts of management practices developed without explicit inclusion of local experts. Searching for an approach that addressed these concerns led us to the literature on process, situated knowledges, and performativity, discussed above, and the idea of performative method, which we demonstrate below.

2 Sample collection

In 2009, from April 24 to May 3, a local harvester with 53 years experience of morel hunting and a social scientist with two years experience of morel hunting followed the advice of a mycologist with 15 years of experience to collect 30 fresh morel specimens for identification. Most specimens were collected from Frederick County, Maryland, within approximately one mile of the border of Catoctin Mountain Park, in mid-latitude deciduous forest (Figure 1). Location, length, surrounding vegetation, distance to other samples, and any additional observations of interest were recorded at the time of collection. Samples were assigned a numerical value 1–27, with samples 13 and

14 being sub-divided because of proximity to each other and location; 13a–d and 14a–e were collected in Berkeley County, WV, from an old apple orchard (see Table 1 for list of specimens). Specimens were a minimum of 0.25 m apart, but usually 2.0 m or more apart from each other. In situ photographs were taken whenever possible. Ex situ photographs were subsequently taken of all specimens. All fresh specimens were identified by the local harvester, in the field, at the time of collection.

3 Determining local nomenclature

In accordance with LEK being a “shared system of knowledge” (Davis and Wagner, 2003), in 2011 we decided to augment our field identification with assistance from a community of local experts identified from previous research (Barron, 2010). Experts were selected based on the following criteria: (1) over 20 years of hunting experience in the same areas; (2) lifetime residence in county of birth; and (3) knowledge of morels directly learned from a family elder – a parent, grandparent, aunt, or uncle. This type of generational, oral knowledge transmission excludes learning about morels from books, the Internet, or from scientific experts, and is a hallmark of local and traditional ecological knowledge (Berkes, 2008). Based on these criteria, 17 people were identified as experts on Mid-Atlantic morels, 12 were available for follow-up meetings.

By 2011, the original specimens were desiccated and had been cut up for molecular sampling (see next section). Therefore, color photographs from 2009 were used for follow-up identification. In situ qualities such as texture, size, and surrounding habitat are difficult to assess from a photo. However, photographs have been shown to be valid mechanisms for collecting ethnobiological data when it is not possible to accompany people into the woods or sea (Beaudreau et al., 2011; Thomas et al., 2007).

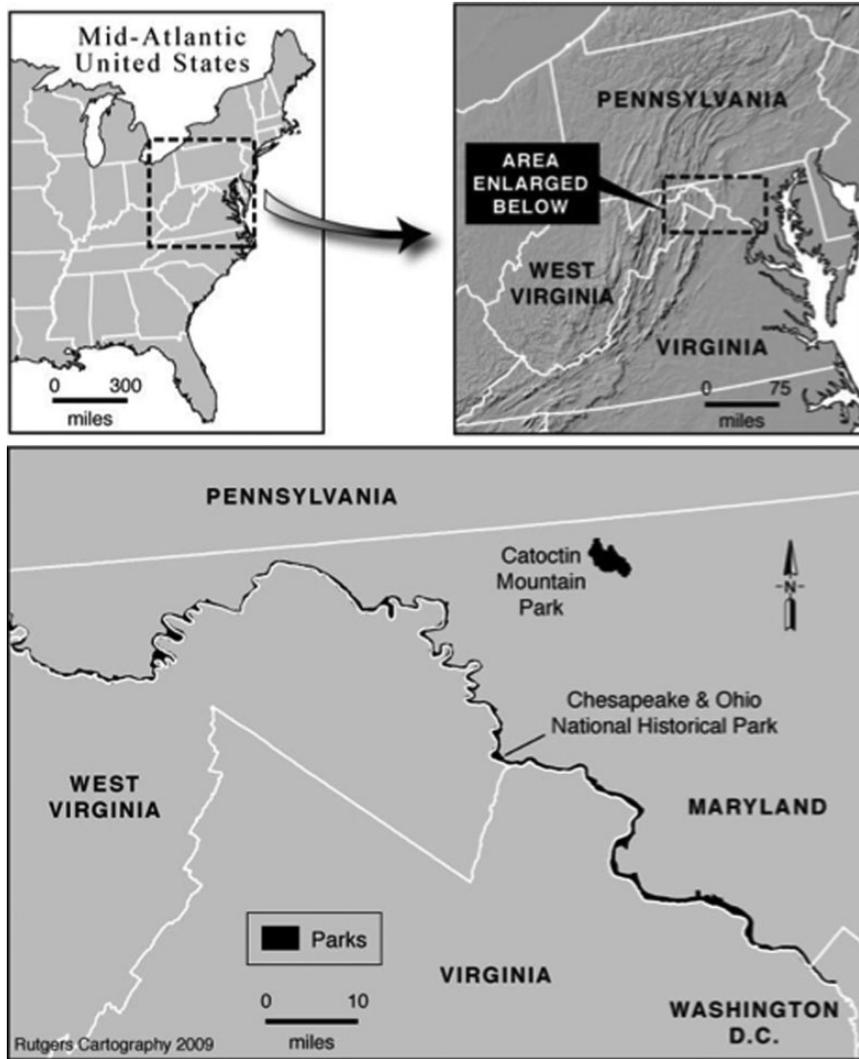


Figure 1. Study area, showing the extent of the Mid-Atlantic states considered in this study, and the national parks around which the study is based.

In January 2012, the first author returned to the area with photographs and descriptions of the 2009 specimens (Figure 2 shows example photographs), and met with local experts in their homes over a period of four days. Each local expert was given a 3-ring binder containing color photographs of 26 of the 30 samples, labeled with their original sample number. Samples 2, 3, 4, and 7 were not included on account

of a lack of high quality photos. There was a brief description below each photograph with the date, general location, and surrounding vegetation where the mushroom was found. Samples were presented in the order in which they were collected. Pages were single-sided so that only one sample at a time was visible. Local experts were asked to provide a name for each specimen, which was recorded by the first

Table 1. Summary of all specimens, with local and phylogenetic names.

Type (LEK)	Group (SEK)	Sample specimens	Local name	Phylogenetic species	Species name
1	1	1, 3 ^a , 5, 6, 7 ^a , 9, 15	Black	Mel-15	<i>M. angusticeps</i>
2	2	2 ^a , 4 ^a , 8, 10	Cappy	Mel-4	<i>M. punctipes</i>
3	3	12, 13a, 13b, 13c, 13d, 14a, 18, 19, 21 ^b	Yellow	Mes-4	<i>M. esculentoides</i>
4	4	16, 17, 20, 22, 23,	Poplar	Mes-2	<i>M. diminutiva</i>
5	4	14b, 14c, 14d, 14e	Gray	Mes-2	<i>M. diminutiva</i>
–	outgroup	11	“poison”	<i>Gyromitra</i> sp.	<i>Gyromitra</i> sp.

^a Morel samples not included in photo book.

^b Single sample where local expert and scientific expert identifications are different.



Figure 2. Sample photographs of morel specimens. Names should be as follows: clockwise from top left: Black, Cappy, Poplar, Yellow, Gray, “poison”.

author on a standardized data sheet. A field assistant recorded additional contextual information.

All names provided by local experts were arranged in a matrix, and known synonyms were

normalized to the most common name. For example, “yellow,” “golden,” and “honeycomb” are all known synonyms for Yellow, so they were all called Yellow in the analysis.

These names are highly context specific, and determining synonyms requires detailed ethnographic fieldwork.² For example, the local name Little Yellow is not synonymous with a description of a morel as a small yellow mushroom, but instead is the LEK nomenclature designation for this type of morel. To acknowledge these differences we use capitalization to connote an established local name (Yellow), and lower case when using words in their descriptive capacity (yellow). This process produced a standardized list of local names that was directly comparable to names derived using scientific methods. The act of comparison has many of the same problems as the act of naming, as discussed earlier. We recognize this challenge, but, like naming, see it as a necessary step. Rather, as part of the performative method approach, while working with our data and preparing this manuscript we spent significant amounts of time discussing the implications of our comparison: why we were making it, how to present it, and what it means in our research.

Accounting for synonyms, local experts divide morels into five groups: Black, Cappy, Yellow, Poplar, and Gray (see Table 1). Additionally, all harvesters identified specimen 11 as “not a morel.” A subset identified it as “poison,” the name we have adopted. A few local experts occasionally mentioned White mushrooms, but this identification was rare and more data would be required to identify White morels as a distinct group. All local experts agreed on the same name for 38% of the samples in the photo book (samples 1, 6, 8, 9, 10, 11, 12, 13a, 13b, 13d), and a strong majority ($\geq 70\%$) of local experts agreed on the same name for 69% (18/26) of the specimens (above plus 3, 15, 13c, 14a, 16, 17, 18, 22) (Figure 3). Identification to type was less definitive for the remaining 31% of specimens (14b–e, 19, 20, 21, 23) (Figure 4). In lieu of consensus, in these eight cases we decided to default to the identifications made in 2009 based on fresh specimens.

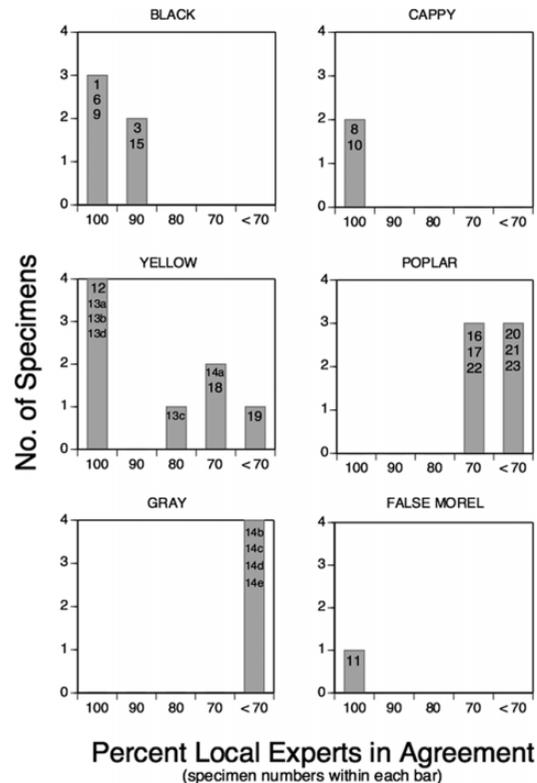


Figure 3. Agreement among local experts on the identity of morel specimens pictured in photo book (N=26). Graphs are interpreted as follows: e.g. see top left chart labeled “BLACK”: 100% of local experts agreed specimens 1, 6, and 9 are black morels, and between 90–100% of local experts agreed specimens 3 and 15 are black morels.

4 Determining scientific nomenclature

Within the bioscientific literature, standard protocols dictate a full description of the methods used to generate data and arrive at nomenclatural designations. In keeping with these protocols, we now explain in detail how DNA sequence data were extracted from specimens. By providing this information, scientists enable other scientists to understand how data were generated, and how to replicate results. In other words, what follows is the performative method scientists use to create and share knowledge with each other.

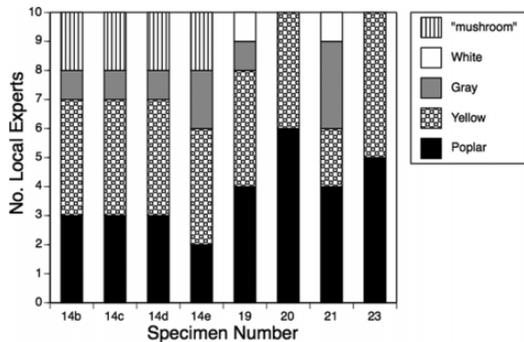


Figure 4. Eight morel specimens were contested by local experts (shown in Figure 3 as having <70% agreement). Graph is interpreted as follows: e.g. see column for “14b”: three local experts identified the specimen as Poplar, four identified it as Yellow, one identified it as Gray, and two identified it as “mushroom.” Inconsistencies were in part on account of the specialized types Poplar and White, which are not identified by all local experts.

To determine the scientific taxonomy of the specimens collected in 2009, we first chose to sequence the internal transcribed spacer (ITS) region of the fungal genome because the ITS has emerged as a standard molecular barcode for fungi (Seifert, 2009). After the second author sequenced the ITS from a subset of samples, the publication of a morel phylogeny (O’Donnell et al., 2011) suggested the nuclear large subunit (LSU) of the 28 S rDNA as a more informative locus, and we aimed to sequence domains D1 and D2 of the LSU from all samples (Appendix 1).

The *Morchella* phylogeny (O’Donnell et al. 2011) significantly expands the number of species within the *Morchella* genus. Species were distinguished by clade (*Mes* for *Esculenta* and *Mel* for *Elata*) followed by an Arabic number. Our explicit aim was to compare our samples to the O’Donnell et al. (2011) samples registered in GenBank. Assignments used the following protocols.

DNA extraction—DNA was extracted from each of the individual morels with a phenol-chloroform and alcohol precipitation method. Briefly: about 0.1 g of dried tissue was

ground with 5–10 0.5 mm sterile glass beads using a high-velocity bead-beater (the Mini-BeadBeater-8, BioSpec Products). Next, 300 ul of a cetrimonium bromide (CTAB) buffer was added, and tubes incubated at 65°C for 60 min. An equal amount of phenol: chloroform: isoamyl alcohol was mixed with the CTAB and tubes were centrifuged for 15 min at 13,000 rpm. Next, 300 ul of the aqueous phase was pipetted out and added to a new tube containing 300 ul of chloroform: isopropanol. Contents were mixed and centrifuged again for 15 min at 13,000 rpm. Next, 200 ul of the precipitate was added to a new tube containing 500 ul of 100% ethanol, 75 ul of sodium acetate, and 3 ul of glycogen; the tube was precipitated at -20°C overnight. The DNA was spun down for 15 min at 13,000 rpm, and washed twice with 100% ethanol before being re-suspended in molecular grade water.

PCR—DNA of target genes was amplified using PCR with either the ITS1F and ITS4 primer pair (Gardes and Bruns, 1993) or NL1 and NL4 primer pair (O’Donnell et al., 1997). PCR was performed in 25 ul reactions containing: 7.9 ul water, 5 ul of a PCR enhancer (Ralser et al., 2006), 2 ul of MgCl, 2 ul of dNTPs, 1 ul of each primer, 0.1 ul of Gotaq flexi, 5 ul of Taq buffer, and 1 ul of a 10-fold dilution of genomic DNA. PCR reactions were amplified in a BioRad iCycler using the following parameters: 5 min at 95°C, followed by 35 cycles of 1 min at 95°C, 55 sec at 55°C, 45 sec at 72°C, and a final elongation of 7 min at 72°C. Successful amplifications were visually checked using gel electrophoresis.

Sequencing—PCR products were cleaned using the Promega Wizard Geneclean kit and sequenced on an Applied Biosystems 3130 sequencer following standard Pringle laboratory protocols (Pringle et al., 2009). Cycle sequencing reactions were performed in 10 ul reactions using BigDye[®] Terminator v3.1 Cycle Sequencing Kits (Applied Biosystems). Both strands of DNA were sequenced for each sample (but, occasionally, one primer failed; in these cases,

sequences are based on a single strand). Sequence traces were edited using the program Sequencher v4 (Gene Codes) and hand aligned using MacClade v4 (Maddison and Maddison, 2005). Further details of Pringle laboratory DNA extraction, PCR, and sequencing protocols are available in the online supplements to Pringle et al. (2009).

Aligned ITS and LSU sequences of morels formed four groups (see Table 1), some of which contained no differences, others of which housed a few single-nucleotide-polymorphisms (SNPs). Representative sequences from each group were compared to the publically available O'Donnell et al. (2011) sequences housed within the National Center for Biotechnology Information database (GenBank, 2010). ITS and LSU sequences of Group 1 are invariant, and also identical to ITS and LSU sequences identified by O'Donnell et al. (2011) as Mel-15. Kuo et al. (2012) identify Mel-15 as *Morchella angusticeps*. ITS and LSU sequences of Group 2 are invariant; the LSU is identical to an LSU sequence named by O'Donnell et al. (2011) as Mel-4 (cf. Taşkin et al., 2012) and as *M. punctipes* by Kuo et al. (2012). One SNP is found within the ITS data of Group 3, but the LSU is invariant and is identical to a sequence identified by O'Donnell et al. (2011) as Mes-4 (cf. Taşkin et al. 2012). Kuo et al. (2012) identify Mes-4 as *M. esculentoides*. The ITS and LSU sequences of Group 4 are invariant and the LSU is identical to a sequence identified by O'Donnell et al. (2011) as Mes-2. Kuo et al. (2012) identify Mes-2 as *M. diminutiva*. The ITS and LSU sequences of sample 11 are a clear match to sequences of the “false morel” genus *Gyromitra*.

IV A performative approach to nomenclature and ecosystems

Focusing on name generating processes shifts attention to the moment of engagement between people and nature, and different uses and values explicated through experience. These values

influence everyday choices in ecosystem management: where will I go to look for mushrooms? How many mushrooms will I pick today? When I tell my friends how many mushrooms I harvested, what details will I provide? Scientists and wild edibles harvesters alike could all pose these questions, but their meaning and intention may differ greatly and in unexpected ways. For example, a scientist may collect only fresh morels she finds in a specific area. She may report that she found X number of *good* morels. When asked why they are good, she may point out that she needs a fresh specimen for proper identification. A harvester may choose to only collect fresh morels from a specific area. She may report that she found X number of *good* morels. When asked why they are good, she may mention that her grandfather taught her that older morels are less desirable for eating, often have insects, and so are not worth the trouble.

The above parallel examples of resource use represent different forms of situated knowledges based on personal and communal engagement. Both examples have the same direct environmental effects (forest disturbance and removal of fruiting bodies), but for very different reasons. In neither case does the a priori name affect the harvesting practice, but in both cases harvesting practices will be affected by changes in ecosystem management that are dependent on nomenclature.

I Etymological comparisons and their meaning

Local harvesters identified five types of morels in central Maryland and northeast West Virginia, USA: Black, Cappy, Yellow, Poplar, and Gray. Four species of morels were identified using genetic and phylogenetic data in the lab: *Morchella angusticeps*, *M. punctipes*, *M. esculentoides*, and *M. diminutiva*. We are not attempting to assess the validity of one nomenclatural system using the other, and strive to avoid

privileging one or the other. Therefore, for the remainder of the paper when referring to the specimens using both local and scientific names together, we refer to them by group (see Table 1). The first three groups are equivalent: 69% of specimens were consistently identified as Group 1, Group 2, and Group 3 using both local and scientific methods. Not all local experts recognize Poplar and Gray mushrooms as distinct types; those that do, differentiate between them based on differences in habitat, phenology, pore spacing, and color. Scientific experts identify these two types as the same species, *M. diminutiva* (Group 4). Gray mushrooms, therefore, form a fifth group unique to local experts (Group 5). Sample 21 is the only sample where the local and scientific identifications were strongly inconsistent. Of the local experts, 70% agreed it was a Gray (or Poplar for those that make this distinction). In contrast, using laboratory methods, sample 21 was identified as *M. esculentoides*. Biogeographically, Group 1, Group 2, and Group 4 are endemic and restricted to the United States east of the Rocky Mountains (Kuo et al., 2012).

Local and scientific experts have different goals, and they use different characters to assign names. As social processes, these goals and how they are met are inherently subjective and change over time. In other words, the goals are situated in place and experience, and are performed differently by different stakeholders over time. For local experts, names enable differentiation among morels occurring in different areas, at different times, and with different plants. The aim is to find morels when they are in good condition, harvest them, and eat them. Local experts classify organisms based on a range of criteria including color, size, shape, habitat, associated trees, texture, phenological order, and pore spacing and patterning (what mycologists call ridge and pit patterning) (Emery and Barron, 2010). This results in a naming system focused on local ecology and

experience, where maintaining a fixed and stable typology is secondary to the aims of locating and collecting morels in edible condition. These purposes are significantly different from the aims of scientific experts.

The goal for scientists is to identify organisms in relation to each other and their evolutionary histories. Scientific names enable communication about species differences at the global scale, across different languages and different scientific cultures (Bowker and Star, 1999). The history and ongoing processes of change of botanical and fungal nomenclature are well documented (Bowker, 2000; Hawksworth, 2001). Currently, the primary criteria used to classify fungi are all based on DNA. Once classifications are made based on DNA, they are regularly related to morphological characteristics (often previously documented) similar to those used by local experts, including size, color, texture, odor and taste, cap structure, spore color, and various microscopic and chemical characteristics. Names are determined based on the Linnaean system, and must be unique. The recent proliferation of cryptic species (often morphologically identical but genetically distinct) has made the creation of new, original Linnaean names more challenging. Although uncertainty is more often assumed to characterize local, common names, in fact scientific names are regularly changed (Kuo et al. 2012). For example, *M. angusticeps* was a name originally used for a “pale-buff or cream-colored” species collected in New York (*Morchella angusticeps* Peck, 1887) and is now used as the scientific name for Group 1, readily identified by its black coloring.

2 Performative method and altered power relations

Once knowledge is named and called “science” or “ethnoscience” it has the political weight of that designation placed on it. These “types” of science suggest specific forms of engagement

between professionals and naturalists or lay experts, which rest on the notion that naturalists and lay experts can help professionals with their work (Ellis and Waterton, 2005). Performative method suggests an alternative engagement with knowledge, names in our case, by examining them more closely as entities that are constantly being produced and revised, making separation of knowledge and the people that produce it much more difficult.

Scientific knowledge has implicit power that has been made independent of the contexts in which it is created or used (Haraway, 1988). In ecosystem management, names tied to evolutionary processes are more powerful than those tied to use values because while ecosystem management and Linnaean names are both expressed in the language of science, local names and use are not. In performative method, we explicitly consider this power imbalance between local knowledge and scientific knowledge by focusing on the interpersonal and intergroup dynamics between local experts and biophysical scientists. In other words, the emphasis is on the people producing the knowledge rather than knowledge as it exists separately from people once it is generated.

The empirical data in section III are our *performance* of performative method: our attempt to produce knowledge in a more socially just and equitable format. Changing the conditions of knowledge production alters power relations in three ways: (1) by refusing to use one set of names to validate the other and maintaining the focus on the Groups, we neither acknowledge or reify a hierarchical comparison, often implicit in paired ethnobiological and phylogenetic studies. (2) Similarly, by going into parallel levels of detail about the social and biological research, we *perform* them as equally important and valid ways of knowing morels. We are intentional about the qualitative methods used and open the “black box” of scientific work. (3) Finally, by being clear about the meaning, value, and uncertainties involved in naming,

we show that names arise out of local spaces for specific uses, a key insight made possible by thinking about space as performative (Gregson and Rose, 2000). When taken together, nomenclature is reframed as an interpretive process producing content for ecosystem management that exists in a circular relationship between creation, cause, and effect. In other words, nomenclature becomes an iterative rather than foundational part of ecosystem management.

Performative method thus departs from previous research emphasizing knowledge exchange (Ellis and Waterton, 2005) and the classification of ethnobiological knowledge (Toledo, 2002; WinklerPrins and Sandor, 2003). Butler suggests “performativity seeks to counter a certain kind of positivism according to which we might begin with already delimited understandings” (2010: 147). According to positivist accounts, local nomenclature is culturally and geographically situated, while scientific nomenclature seems almost spontaneously generated. If instead we see all knowledge as performative, these delimited understandings are insufficient. Local names embody more than culture, and scientific names have historical and social context. Although the concept of performativity is not often associated with systematics, in the case of mycology and fungal conservation, it is timely given the changes in classification and phylogenetics discussed above, which bring the historical, personal, and rapidly changing complexities of taxonomic work to light.

V Conclusion

Performance and performativity have most consistently been used in human geography to engage with human geography interests: notably sexuality (Butler, 1990; Butler, 2010) and economy (Gibson-Graham, 2008; Gregson and Rose, 2000; Thrift, 2000). The novelty of performative method is in the application of

performance and performativity to subject matter from biophysical geography. Close examination of etymology, values, and meanings present in processes of environmental knowledge production illustrate the social and spatial aspects of organismal names often understood without context. This brings to light the power relations in environmental knowledge production, and has substantive implications for environmental management where power dynamics between local experts and scientists can be obscured by assumptions about the character of different knowledge bases. We thus conclude this paper by exploring the management implications of performative method.

What would it mean to make management decisions with special attention to issues of social equity and political economy in relation to environmental change? Below we provide an example of a possible future management scenario that we suggest would proceed differently when informed by performative method.

Understanding how organisms respond to disturbance is an important part of environmental management. For several decades black morels in the eastern United States were identified as *M. elata* (a European name), but then Kuo et al. (2012) identified local Blacks as *M. angusticeps*, using the name for a phylogenetic species originally defined by O'Donnell et al. (2011). Through the use of performative method we recognize that these names are artifacts of experience; for scientists, this species has only recently come into being, whereas for harvesters this type has existed for generations. Kuo et al. (2012) point out that *M. angusticeps* is morphologically indistinguishable from several western North American morel species, all of which occur in conifer burn sites. Ecologists might use this new natural history data to hypothesize that Group 1 morels are also fire adapted, suggesting that prescribed burning and wildfires should not be a concern in the management of Group 1 morels. However, local experts who have a long history of engagement with

Group 1 morels report that disturbances, including heavy timbering, blow-downs, and fire, all negatively impact fruiting (Barron and Emery, 2009). In a performative method approach, these locally generated data would be recognized as *more accurate*, adding place-based data that would otherwise be lacking. This small example shows how environmental management of many resources may be ecologically and politically improved through the use of a performative method approach.

Through the use of performative method we have demonstrated that names arise out of local spaces and for specific uses. The terms “local ecological knowledge,” “local names,” and “local experts” explicitly communicate this contextualization. LEK names are not now, and never were, intended to be universal. They were, and are, intended to facilitate communication about shared experiences and observations. The scientific method is designed to facilitate comparability and universality of knowledge, but it, too, is deeply local because of the particular biogeography of species and the geographically specific character of scientific work (Livingstone, 2003). Where we collected morels for this project was a specific bio-region, now clearly shown to harbor endemic morel species (O'Donnell et al., 2011). The laboratory where we named morels is a local space. Collecting data using performative method understands both local ecological and bioscientific knowledges through a lens of performance, altering power relations between local experts and scientific experts by situating and making explicit processes of naming and research. Nothing is black-boxed (Winner, 1993).

This performative stance is not in opposition with scholarship of ethnobiologists, biogeographers, or those seeking additional strength, support, and space for what is called “Local Ecological Knowledge.” Nor are we in any way trying to negate the role of scientific nomenclature. Rather, we are interested in bringing more attention to the relationship

between ongoing developments in different forms of classification, and how a further awareness of these micro-processes of knowledge production reframe ecosystem management as a reflexive process. In doing so, we answer the multidisciplinary call of Raymond et al. (2010) and others, referenced throughout this paper, for more user-inspired, holistic research where social identities are maintained and respected. CPG enables this process by making conceptual space for in-depth joint work with scientific practice and detailed social theory, following recent trends in physical and human geography that focus on processes over end effects.

We have shown that names matter, but the stability of those names is tied to actions and interpretations. Rather than simply interrogating the relationship between different knowledge systems in taxonomy/nomenclature, in this paper we have *performed* their relationality. Focusing

on processes of naming shows that finding stable, correct names for morels is actually not a priority for harvesters, scientists, or in management planning. Stable names are secondary to the desire to collect and harvest morels in edible condition, to understanding evolutionary relationships, and to understanding natural and social contexts for successful ecosystem management. As with the concept of biodiversity, this begs the question: why and for whom are fixed and stable nomenclatures important? Instead of artifacts of power, is it possible to see names simply as communication devices? In our goal to support and promote ecologically sound, more socially just decision-making, we believe it is possible to approach nomenclature this way. When guided by our passion for morels and fungi, we see the names we use as performances of epistemological choice, which may create different environmental impacts and socially equitable relations in the future.

Appendix I

Group	SPECIMAN ID NUMBER (SAMPLE; ESB)	ITS sequence used (ITS4=sequenced from single strand)	LSU sequenced used (NLI or NL4=sequenced from single strand)
Group 1: Black/Mel-15			
	1	yes	yes-NLI
	3	yes	yes
	5	yes	yes
	6	yes	yes
	7	yes	yes
	9	yes	yes-NLI
	15	yes	yes
Group 2: Cappy/Mel-4			
	2	yes	yes
	4	not successful	yes
	8	yes	yes
	10	yes	yes
Group 3: Yellow/Mes-4			
	12	yes	yes
	13a	yes	yes
	13b	yes	yes-NL4

(continued)

Appendix I (continued)

Group	SPECIMAN ID NUMBER (SAMPLE; ESB)	ITS sequence used (ITS4=sequenced from single strand)	LSU sequenced used (NLI or NL4=sequenced from single strand)
	13c	not successful	yes
	13d	yes	yes
	14a	yes	yes
	18	yes	yes
	19	yes-ITS4	yes
	21	yes	yes
Group 4: Mes-2/Poplar			
	14b	yes	yes
	14c	not successful	yes
	14d	not successful	yes
	14e	not successful	yes
	16	not successful	yes
	17	not successful	yes
	20	yes	yes
	22	yes-ITS4	yes
	23	yes	yes
Outgroup	11	yes	yes-NL4

Notes

1. The role of place is an interesting one to consider in more depth in relation to the universal nature of scientific nomenclature and the connection to place that local names represent. While we believe this is an important element in our paper, unfortunately there is not space to address our interest in performativity and method and to discuss this at length.
2. Ellis and Waterton point out that ethnography is often treated as marginal and “presumptively known rather than respected for its complexities” (2005: 678). We agree, but are not able to include a detailed accounting of the LEK synonym structure here, as it is beyond the scope of this paper.

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