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Implications of Variation in Social-Ecological Systems for the Development of U.S. Fungal Management Policy

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Public lands fungal management in the United States developed in direct response to commercial harvesting in the Pacific Northwest (PNW) in the 1980s. In the early 2000s, concerns over declining morel mushroom abundance in national parks in the greater Washington, DC, region (NCR) led to the creation of harvest limits and stimulated research on the social-ecological system of morels in that region. In this article we compare findings from research on morel harvesting conducted at two national parks in the NCR from 2004 to 2007, with fungal management from two federal units in the PNW. We find substantial differences in existing regulatory policies, historical and cultural harvesting practices, and taxonomic and ecological variation in Morchella*, indicating the need for regionally specific management. To address these differences, we recommend a participatory approach incorporating the local social-ecological specificities of mushroom harvesting and ecology that are missed at coarser spatial and temporal scales.*

Keywords fungi, nontimber forest products, participatory research, resource management, wild edible mushrooms

People harvest nontimber forest products (NTFPs) for a variety of reasons: to earn income, to strengthen intergenerational ties, and to meet subsistence needs including maintaining traditional ways of life (Emery and McLain 2001; Jones et al. 2002). Wild mushrooms, in particular, have been collected by various peoples throughout recorded history (Brothwell and Brothwell 1998). Pieroni et al. (2005) point out that

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the Food and Agriculture Organization of the United Nations has documented contemporary collection of wild edible fungi in more than 80 countries worldwide.

In the United States, professional foresters have long been aware of the use of wild fungi for food, medicine, and other purposes (Vance 2001). However, as volumes harvested and economic values of commercial trade were generally modest, such uses were not regarded as falling within the professional sphere, with its emphasis on industrial timber production. The entry of large quantities of Pacific Northwest (PNW; Oregon and Washington, as defined by U.S. Forest Service) mushrooms into global markets in the 1980s changed that, leading to expanded regulations and public controversy. Commercial trade in mushrooms received special attention because it significantly increased the overall number of harvesters on public lands, making it a major land management issue in the United States for the first time (McLain et al. 1998). Personal and cultural uses remained largely invisible, as commercial harvesting and harvesters in the PNW region gained normative status in both the popular and scholarly literature of this period (Bilger 2007; Robbins et al. 2008).[1] Outside the PNW, mushroom harvesting remained relatively unaffected by these events through the 1980s and 1990s. However, reported declines in morel mushrooms in national parks in the greater Washington, DC, area in the early 2000s changed this. Active fungal management became an issue for federal agencies in the eastern United States for the first time. Contemporary negotiation around these emerging management regimes in two national parks in the greater Washington, DC, area is the subject of this article.

Successful public land management requires a working knowledge of both the ecological and the social systems that are being managed (Kusel and Adler 2003). Because the evolutionary history and taxonomy of morels remains an active research area (see later discussion), mycologists agree that information about morel ecology in the western United States should not be assumed to apply to morels in the eastern United States (Barron 2010). There is no published research on morel ecology specific to the mid-Atlantic region. There are also very few data on morel social systems outside of the PNW and the Midwest (Weber 1988). Therefore, before fungal management proceeds in the East, data on both ecological and social systems are required.

This study addresses gaps in the formal literature by reporting on social aspects of morel harvesting and morel ecology in the mid-Atlantic region of the United States. We present results of research conducted between 2004 and 2007 to learn more about morel harvesting on and around two national parks in the National Park Service (NPS), designated as within the National Capital Region (NCR). The NCR is the smallest NPS region, with the regional boundary being ''indefinite'' but encompassing all national parks (currently 15) in the greater Washington, DC, area including parts of Virginia, Maryland, and West Virginia (Intermountain Region GIS Program Office 2003). The units enrolled in this study were Catoctin Mountain Park (CATO) and Chesapeake and Ohio Canal National Historical Park (CHOH) (Figure 1). At both parks, morel harvesting is a long-standing and popular activity that continues to be allowed because it was a local tradition predating park establishment.

We contrast our findings with existing literature on social and ecological conditions and managerial strategies for morels from two federal units in the PNW region: Crater Lake National Park (CALA) and the Sisters Ranger District of Deschutes National Forest (Sisters). Both of these units are in an active morel

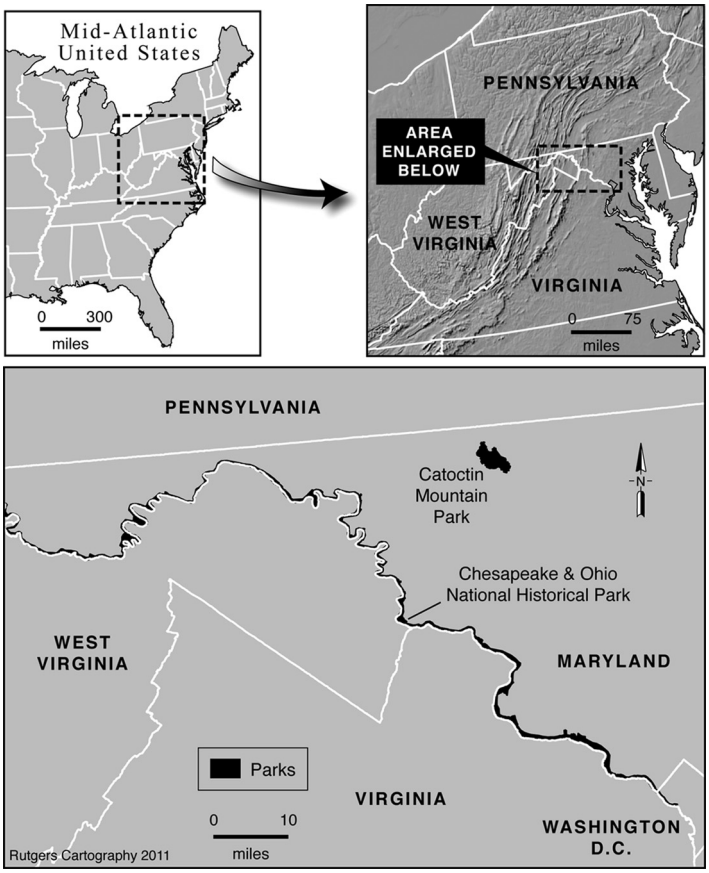

Figure 1. National Capital Region parks.

hunting region of Oregon that includes areas of Willamette National Forest, Deschutes National Forest, and Umpqua National Forest. CALA was chosen for comparison because it is a national park in a popular morel collecting area, with strict harvesting regulations and ongoing mushroom regulatory issues: namely, harvesting of wild edible fungi is strictly prohibited at CALA in accordance with regulation 36CFR§2.1, a federal regulation that governs the preservation of natural, cultural, and archeological resources at all national parks (GPO 2009). However, unauthorized harvesting continues to be a problem there (Rebecca McLain, personal communication). The Sisters Ranger District was chosen for comparison because it is an area of active morel harvesting, because of its proximity to CALA, and because the social dimensions of mushroom harvesting there have been researched and documented by McLain (2008), providing rich material for comparison. For convenience, throughout the rest of the article we periodically use PNW and NCR as shorthand to refer to Sisters and CALA, and CATO and CHOH, respectively.

We find significant differences between federally managed units in the PNW and the NCR in regard to social aspects of harvesting such as regulatory differences, and economies of scale, and in regard to ecological drivers of morel fruiting, specifically

habitat ranges and responses to disturbance. These differences suggest that management policies used in the PNW would not be appropriate in the NCR. Our findings suggest that, in fact, the application of these management practices from the PNW to fungal NTFPs in the NCR could be problematic because of the scope and scale of the social and ecological differences. Instead, we suggest that fungal NTFP management in NCR parks is well suited for approaches such as co-management, and will significantly benefit from a participatory approach to inventory and monitoring and policymaking that incorporates the local specifics of fungal harvesting and fungal fruiting often missed at coarser spatial and temporal scales (Lynch et al. 2004). This type of coupled assessment, carried out in a place-based format, benefits the planning and implementation stages of policy adaptation for NTFPs and other natural resources.

Study History and Methods

In 2002, anecdotal reports of reduced morel hunting success at national parks in the greater Washington, DC, area, including CATO and CHOH, were linked to concerns about the possibility of overharvesting. In response to these concerns, the NPS Urban Ecology Research Learning Alliance, NCR, commissioned a study of "visitor-harvester" experiences. CATO and CHOH are among the largest managed parks in the NCR and were originally conceptualized as recreation destinations for people living in the greater Washington, DC, and Baltimore, MD, areas. Both are managed for cultural and natural history, although CATO is managed with a stronger focus on ecosystem integrity while CHOH has a primary emphasis on historical preservation and interpretation. In keeping with a focus on the more rural nature of the communities surrounding CATO and the northern portions of CHOH, the lower 30 miles of CHOH and the surrounding towns were excluded from the study.

NPS officials recognized that they had limited information on the experience of harvesters. CATO staff, in particular, had worked to establish good relationships with the local community. Therefore, in order to develop practical suggestions for morel mushroom management at the two parks we developed an ethnographic study with the following objectives: (1) Explore and utilize local ecological knowledge to further understanding of morel habitat, ecology, and phenology at CATO and CHOH, and (2) learn more about morel hunting and use practices in these areas. Oral histories were collected in 2005 as part of a preliminary field season. Using a grounded theory approach (Glaser and Strauss 1967), we developed a protocol for the collection of additional oral histories in 2007, emphasizing questions on morel productivity, abundance, and harvesting practices, appropriate management policies, and conservation strategies.[2]

Harvesters who frequent CATO and/or CHOH and surrounding areas participated in the study. Participants were identified through the use of NPS-issued press releases in local papers, suggestions from NPS staff, community presentations, and snowball sampling. Oral histories collected over two field seasons resulted in 43 transcripts from 41 participants representing residents of Maryland, Pennsylvania, and West Virginia. All oral histories and field notes were transcribed in their entirety, and analyses of oral history data were conducted using coding and content analysis: methods that facilitate organization, reduction, and exploration of data by focusing on key themes for analysis and theory building (Cope 2005).

Results

In this section we present a summary of our results on social and ecological aspects of morel harvesting. We compare these findings with available regulations and relevant research from CALA and Sisters. Findings are summarized in Table 1.

Social Aspects of Morel Harvesting

Who's Hunting Morels? Study participants ranged in age from 21 to over 80 years of age, with the majority being over 45 years old. Morel hunting is a heavily male activity in the NCR (61% of study participants), although it is not uncommon for men to be accompanied periodically by female family members. Women, generally, are less likely to go morel hunting alone. Many participants reported going out with their children and grandchildren, and commented on the importance of maintaining the long-standing family practice of morel hunting.

For at least four to six generations, morel hunting has been a significant activity for many families of European descent in the towns of Thurmont, Sabillasville, and Little Orleans, MD (referred to collectively as local area residents). In contrast, McLain reports that people of European ancestry have only been harvesting morels at Sisters in any significant number since roughly 1985 (Rebecca McLain, personal communication). In further contrast, much has been published about influxes of immigrant labor for commercial mushroom harvesting in the PNW (Hansis 2002; Schlosser and Blatner 1995). We find no evidence of recent immigrants or migrant pickers regularly visiting CATO or CHOH to hunt for morels or other wild edible fungi for commercial sale. Rather, our results indicate that hunters at NCR parks are local area residents, recreational hunters from surrounding areas (living within approximately 50 miles of park boundaries), and contemporary subsistence harvesters.[3]

Regulatory Difference and Spatial Domains. Mushroom harvesting in national parks falls under the jurisdiction of 36CFR§2.1, "Preservation of Natural, Cultural and Archeological Resources," in the Code of Federal Regulations (GPO 2009). Specific regulations for each national park are set in the Superintendent's Compendium, updated and revised periodically. Mushroom harvesting is illegal to the public at CALA. The Superintendent's Compendium does not make any reference to mushrooms or fungi. A separate document, available online, states, "Mushroom picking is strictly prohibited in Crater Lake National Park according to 36CFR§2.1" (Ackerman 2009). Morel harvesting is highly regulated at Sisters through the use of a multitiered permit system determined by the ranger district (McLain 2008). In the NCR, current policies regarding morel harvesting on public lands range from open access, to restricted access, to no access. At CHOH, there is a limit of 1/2 gallon per person per day for personal use only (Brandt 2006). At CATO the regulation is the same as in the 2011 compendium (Poole 2011). This is a change from previous compendia, which specified less than one gallon in 2007 and small amounts in 2006.

In the NCR, we found that approximately half of mushroom hunting activities take place on federally owned land. Local area residents often hunt for mushrooms on privately owned property where they or members of their family have been going for many decades. They attribute their lack of interest in mushroom hunting on the national parks to the presence of "outsiders." In contrast, recreational hunters who

Table 1. Social-ecological systems in the PNW and the NCR

System	PNW: Sisters and CALA	NCR: CATO and CHOH
Social		
Species of interest	*Morchella*, *Cantharellus*, *T. magnivelare*, *Tuber*, *Boletus* are major market species for domestic and export markets.	*Morchella* is only species regularly collected.
Official regulations	Mushroom harvesting is illegal at CALA, although some poaching is likely. Non-matsutake mushroom species harvest regulated by U.S. Forest Service through permit system at Sisters.	Harvesting is allowed at CATO and CHOH, with daily limits.
History of policy	Harvesting policies developed throughout the 1980s and 1990s based on special forest product (SFP) policy and in response to widespread commercial harvesting.	Harvesting policies are in development and change regularly. For those that exist, origins are unclear.
Demography	Harvesters identified based on type of use (personal or commercial), and ethnic and class diversity.	Harvesters are identified based on place identity.
Economic activity	Large quantities of morels harvested for local, national, and international markets from Sisters and likely poached from CALA. Exchange value ranges from \$7 to \$18 per pound.	Small quantities of morels harvested for local, informal markets. Exchange value ranges from \$30 to \$100 per gallon.
Ecological		
Taxonomy	Morels currently regularly identified by morphotype, morphospecies, and species.	Morels currently regularly identified by morphotype and morphospecies.
Phenology	Varies greatly from several weeks to several months, depending on rainfall, humidity, and topography.	Maximum fruiting season is from end of March to early June.
Abundance	More abundant, especially in response to disturbances like wildfire.	Less abundant, fruiting suppressed due to some types of disturbance, e.g., flooding.

(*Continued*)

Table 1. Continued

System	PNW: Sisters and CALA	NCR: CATO and CHOH
Distribution and habitat	Ranges based on tree associates, elevation, topography, climate. Affected strongly by disturbance regimes, e.g., fire.	Ranges based on tree associates, soil moisture, microclimate. Affected strongly by habitat loss, (e.g., Dutch elm disease) and development.
Vegetative associates	Morels more often found in association with conifers such as true fir, spruce, subalpine fir.	Morels more often found in association with deciduous trees such as elm, tulip poplar, apple, ash.

are less familiar with the area and its landownership patterns appear to hunt almost exclusively on public lands. This is significant because federal land managers, who participated in related research, commonly perceive that the majority of mushroom hunting in the region occurs on public land. In some cases, NCR managers specifically expressed interest in or desire for a permit system to better regulate mushroom collecting (Barron 2010). For their part, harvesters find existing regulations difficult to ascertain and follow. Policies have been in flux at CATO over the last several years, where they changed twice over the course of this study. Local harvesters informed us that posted information was outdated or incorrect in some areas of the parks, leading to confusion and avoidance of the parks altogether. In some cases, regulations are only available online. Furthermore, local and subsistence hunters are frustrated by the regulation of an activity they have been engaging in for generations. In response to all the regulatory changes and the suggestion that permits may be introduced, one local harvester stated, ''You're just making criminals out of law-abiding citizens.''

We asked participants their opinion on regulations regarding access to morels inside national parks, should it be determined that morels were declining. Approximately one-third of those asked in 2007 felt that morels should remain an open-access resource, while roughly another third felt that public access should be restricted as long as there was clear education and communication about why these restrictions were in place:

> I would have to say somewhat restricted access [is how to protect threatened species], because you don't want to completely destroy or deplete whatever you're hunting, if it's mushrooms or whatever else. You don't want to destroy for the future.

The remaining third felt the issue was too complex to commit to any position. Several commented that the actual regulations regarding a resource were unimportant

because the parks do not have sufficient staff to enforce restrictions. Overall, participants felt that communication with morel hunters was paramount:

> You can't just restrict it and not communicate. If you restrict access and you don't tell them why, then the people aren't going to understand, they're going to complain, and sometimes, not listen.

In anticipation of the development of new policies, we asked participants if they thought land management was most effective when trained professionals made decisions or when professionals and local residents worked together to make decisions. All participants responded that they believed it was better when the local community was involved. They cited past events such as land acquisition and changes in fishing access made without local input, which they believed had socially or ecologically perverse results. Participants were keenly aware of the fact that many professionals are not from the area and felt that despite extensive "book" knowledge, most professionals lack a clear understanding of the place. It was also noted that locals have to live with the long-term ramifications of management changes:

> If you have somebody from the government, who's transplanted let's say, from Utah, they really don't know what goes on. What's good for Utah might not be good for Maryland because of different types of people, weather, animals.

> Well, the local people have to live with the decisions that are made by the technical people that may move somewhere else in a couple years.

Mushroom Economies of Scale. More than 35 species of edible mushrooms and truffles are collected in the PNW for commercial markets. The most economically valuable are *Morchella* (morel), *Cantharellus* (chanterelle), *Tricholoma magnivelare* (American matsutake), *Tuber* (truffles), and *Boletus* (porcini) (Jones and Lynch 2007). In contrast, we found that in the areas around CATO and CHOH, *Morchella* is the only genus of commercial wild edible mushrooms that is commonly collected. In fact, for more than 90% of harvesters in our study, morel mushrooms are the only wild edible fungus they collect.

Based on self-reporting of income data, very few individuals in the NCR are economically motivated to hunt mushrooms, and only 7% of participants who hunted at national parks also currently sell or have sold morels in the past. No harvesters that we met or interviewed in the course of this study were aware of domestic or international trade in morels on the scale reported in the PNW. We found no evidence that morels from CATO, CHOH, or the surrounding areas are entering into major domestic or international markets, and no evidence of wage or day laborers who hunt for wild edible mushrooms as a primary source of income. Local trade in morels was reported by a small subset of participants who sell to local restaurants, at farmer's markets, and to neighbors and community groups. Indeed, in 2007 the morels available at a local chain grocery store in Frederick, MD, originated in Oregon (produce manager, personal communication).

No one reported financial gain as a primary motivation for morel hunting. Instead, for the majority of people in our sample, the main reasons to hunt morels

were to eat them, for the joy of getting outside, because of tradition, and for the challenge. Harvesters commonly reported that morel hunting contributed in a fundamental way to their physical and emotional well-being and to the survival of local cultural traditions:

> I live to hunt the mushrooms, [it's] part of my life. I look forward to spring, mushrooms, turkeys, trout fishing, and to playing in the ground. I guess if I couldn't play in the ground I'd just as soon be under it.

McLain (2008) has reported similar motivations for some harvesters at Sisters. We do not contest that there are many morel hunters throughout the country that are similarly motivated. Rather, we are suggesting that the *vast majority* of morel hunters in the NCR are local and subsistence harvesters and not commercial harvesters; and the *vast majority* of morels collected from these parks are harvested for personal use and not for entry into large-scale markets.

Our observations on the comparatively small scope of NCR economic activity are based on several findings. First, morels fruit in significantly lower quantities in the NCR than they do in the PNW (see section on morel ecology), making it less economically feasible to support multiple levels of operators in market activities, such as mushroom buyers and fungal-centric businesses (e.g., MycoLogical Natural Products in Eugene, OR). In fact, no participants in this study sold morels to anyone who would qualify as a mushroom buyer, or to any business that bought mushrooms wholesale and resold them as a commodity.

Second, economic indicators suggest that local harvesters control the prices of NCR morels, meaning that exogenous factors from domestic and international markets are not influencing morel prices in this region. Instead, prices are set by the seller at the time of each sale depending on, among other things, the season and the relationship with the purchaser. For example, NCR morels are often sold for roughly \$30–\$50/gallon, and have been known to bring in the equivalent of \$100/gallon. According to one local business, morels collected for commercial sale in Oregon in 2011 were being purchased from harvesters for \$7–\$18/lb (MycoLogical Natural Products employee, personal communication). The difference in cost is clearly substantial and, we believe, further indicative of small independent markets.[4]

Finally, anecdotal stories from harvesters from both areas suggest that morels from the two regions have very different shelf lives, an important factor in shipping for national and international markets. So-called "burn morels," the major PNW commercial crop, have a shelf life of up to a couple weeks, making it possible to ship them fresh or chilled. NCR morels last only a few days before they rot or their moisture content and weight decline substantially, decreasing their value and making them unsuitable for shipping. U.S. domestic export data from 2009 showed that only fresh or chilled mushrooms were being exported from the Washington, DC, district that includes CATO and CHOH. These likely originate elsewhere, as the characteristics of NCR morels dictate that they would be exported "provisionally preserved" and/or "dried."

Taxonomy and Ecological Drivers of Morel Fruiting

Taxonomy. The O'Donnell et al. (2011) phylogeny of true morels supports a distinction between eastern North American and western North American morels. They

divide *Morchella esculenta* (yellow morels) and *M. elata* (black morels) into sister groups (clades). Species from both clades occur in the East and the West, but species' distributions are restricted geographically across regions (O'Donnell et al. 2011).

Morels are identified by NCR harvesters according to morphotype: black, gray/white, poplar mushrooms, yellow, and cappy.[5] These types are consistent with the scientific morphospecies descriptions of *M. elata* (black), *M. deliciosa* (gray/white), *M. esculenta* (yellow), and *M. semilibera* (cappy) (Emery and Barron 2010). In contrast, in the PNW morels are identified by morphotype, morphospecies, and species. Pilz et al. (2004) identified PNW morels as natural black, pink, green, gray (*M. atrotomentosa*), and mountain blond (*M. esculenta*). The name "natural black" is derived from commercial harvesters, who collect these "*M. elata–M. angusticeps–M. conica* complex" (Arora 1986) mushrooms from non-burned or non-disturbed and hence "natural" forests. Pink and green morels are types of black morels specifically associated with fire and are also sometimes called "burn morels." This distinction is particularly important to Western commercial harvesters.

Phenology and Ecology. Morel phenology and habitat differ greatly between the two regions. In the PNW, latitudinal and altitudinal gradients exert primary influences, followed by rainfall, humidity, topography, and morphotype (Pilz et al. 2007). Wide variation means morels can be found several months of the year, from spring through the fall. In the NCR, altitudinal gradient is comparatively small. Thus, the fruiting season is influenced primarily by the latitudinal gradient, as well as rainfall, humidity, and microtopography. The maximum length of the NCR fruiting season is from the end of March to early June. Tree associates also vary significantly between the regions (cf. Emery and Barron 2010; Pilz et al. 2007).

There are no data available to directly compare morel abundance at Sisters and CALA (technically illegal so not reported) with that at CHOH and CATO. Harvesters in this study reported that some of their best days yielded 10–15 gallons, with regular yields closer to one gallon. At Sisters, as much as 200–300 lb per day has been reported (Rebecca McLain, personal communication). These harvest figures suggest very different levels of morel fruiting across regions.

Disturbance is strongly and positively associated with morel fruiting in the West, where the vast majority (estimated 99%) of commercial morel production comes from postfire areas 1 and 2 years after a fire occurs if the habitat, climate, and soil conditions are right (Pilz et al. 2007). Fire has not been a part of the contemporary mid-Atlantic landscape and therefore does not influence morel productivity in the region. In contrast, participants in this study reported that disturbance events such as flooding and blow-downs negatively affected fruiting.

Differences in phenology due to disturbance directly affect morel abundance and harvesting. Wildfire is a major driver of morel fruiting and harvesting in the PNW. Although the effects have not been quantified, fruiting of morels following large wildfires in the PNW, coupled with current wildfire regimes in that region, continues to translate into massive fruiting. Interestingly, this means that in years when there is no wildfire, Sisters is not an important site in terms of quantities of morels harvested. How many people hunt morels there, and for how long, depends directly on the fires around the region in the previous year (Rebecca McLain, personal communication). NCR hunting patterns are not similarly affected by disturbance events.

Discussion

Regulation and management of natural resources are most effective when they are developed with consideration to both ecological and social systems. In the case of morels, we have presented data showing that these systems are reliant on each other. Who is hunting morels and why, in any particular location, are functions of economies of scale, of morel abundance, and of history and local context. Morel abundance is related to available habitat and ecosystem disturbance, which are tied strongly to the history of U.S. federal land management. In this section we provide an example of regulatory challenges that arise when these coupled social-ecological systems are not considered in the context of specific places, history and context. To mitigate these challenges, we suggest the use of a participatory approach for policy development.

As Cash et al. (2006) have noted, there is a tendency for management challenges to develop when institutions structured at the national level, such as federal land management agencies, create policies based on knowledge particular to a single place and time in order to fill knowledge gaps elsewhere. The difficulties of enacting policy promote a system in which policies that have some modicum of success in one location are applied throughout the agency's jurisdiction (Cumming et al. 2006). The adoption of daily harvest limits for wild mushrooms in the NCR region over the last decade appears to be such a case.

The historical drivers of the prohibition against mushroom harvesting at CALA and permitting with daily harvest limits at Sisters are clear. Resource extraction, especially timber, drove the PNW economy for many decades. NTFP extraction increased in economic importance in the 1990s with the relative collapse of the timber industry and the entry of mushrooms from the region into global commodity markets (Emery and McLain 2001). Strict enforcement of bans on harvesting any natural resources has been a means for national parks such as CALA to distinguish themselves from surrounding federal land management agencies and to emphasize nature preservation. Permits for mushroom harvesting were issued at Sisters irregularly in the 1980s, and increasingly in the 1990s, to limit "ecological impacts of commercial harvesting activities" (McLain 2008, 346). By 1997, a permitting system was well established at Sisters to track who was picking, who was buying, and where commercial pickers set up their camps. While the stated objective of these permits is morel protection, it is clear they serve primarily as a mechanism for monitoring and tracking people in the woods (McLain 2008). As one resource manager from Washington State said plainly, "You're not managing morels, you're managing people."[6]

As of this writing, permits have not been issued at CATO or CHOH, although there has been some discussion of their potential utility (Barron unpublished). It is unclear why harvesting limits were initially put in place in the NCR. Our results indicate that there is no intensive harvesting for large markets, the main concern driving regulations in the PNW. Further, published ecological research suggests no damage to wild edibles from harvesting (Egli et al. 2006; Norvell 1995). Thus, the logic that led to the policies at CALA and Sisters appears to be absent in the NCR, where harvest limits disrupt long-standing social practices in the region without a clear body of evidence establishing a need to do so, with attendant consequences for relationships between the parks and surrounding communities.

Harvest limits at NCR parks have led some in local communities to conclude that their interests are less important to the agency than maintaining control over

the environment. These individuals chose to avoid the parks, feeling that their rights of access were limited unreasonably and their participation in management decision making was not welcome. At the same time, desire for communication with the parks is evident in the oral histories we conducted with NCR morel hunters. Use of a participatory approach facilitates inclusion of those most affected by policy changes (Ballard et al. 2008). The focus is on the processes of inclusion, trust building, and the fostering of community.

The literatures on co-management (cf. McCay 1992), adaptive management (cf. Jacobson et al. 2009), participatory management (cf. McLain and Jones 1998), and participatory action research (Gibson-Graham 2002) advance stakeholder inclusion in management. These related approaches are fundamentally about context-specific collaboration among stakeholder groups to determine priorities and develop action plans. They address both ecological and social dynamics of natural resources (Kusel and Adler 2003; Lynch et al. 2004). Several works outline the process, benefits, and drawbacks of participatory management (Jacobson et al. 2009; Olsson et al. 2004; Pilz et al. 2006). Fernandez-Gimenez et al. (2008) assert that inclusionary approaches in community forestry have had an overall positive effect on forest-based economies and rural communities. Because of their focus on NTFPs, we find Lynch et al. (2004) to be particularly useful for thinking through the strengths of a participatory strategy for morels in the NCR. We focus on three aspects of their approach next.

1. *Collaborative approaches support two-way education*. All of those interviewed for this study responded that land managers and the local community should be involved in management. Many participants grew up in the area surrounding these parks, where their families have lived for several generations. They believe their temporal and spatial knowledge of this area is inherently different from that of frequently transient land managers and scientists. Professionals, on the other hand, can have valuable biological, ecological, and spatial knowledge that often differs from that of harvesters. In demonstrating appreciation for harvesters' knowledge, managers and scientists facilitate an environment in which their specialized knowledge and experiences are more greatly appreciated in turn.
2. *Inclusion of local communities in management and decision-making deliberations often leads to more effective management*. Two-thirds of participants did not support open access, were concerned about the impacts of morel harvesting, and desired a clearer understanding of why morels seem to be declining. If it were shown that morel abundance and productivity are declining, our results indicate that local community members are invested in and would work toward creating effective management strategies aimed at resource sustainability. Including local communities in management planning efforts fosters data collection at appropriate temporal and spatial scales and may lead to more effective management.
3. *Including local ecological knowledge connects management to place.* The incorporation of local ecological knowledge (LEK) into management makes it more effective by expanding the available base of knowledge about species and their habitats. In conjunction with scientific data, LEK documented as part of this research can be used for morel habitat characterization (cf. Emery and Barron 2010) at a level of environmental specificity that would otherwise be lacking at this time.

Conclusion

This study builds on existing knowledge of fungal management from federal lands in Oregon for comparison with emerging fungal management in two national parks in Maryland to consider strategies for policy development. Our findings indicate that enough differences in coupled social-ecological conditions exist that new approaches to fungal management policy for NCR parks are warranted. Results further suggest that a participatory approach could be successful for the development of these policies.

Participatory resource management for the genus *Morchella* has the potential to be more effective than top-down natural resource management, but care must be taken to proceed thoughtfully. The outlook is promising, as mycologists themselves advocate for the inclusion of harvesters and amateurs in fungal management and conservation (Hawksworth 2003; Molina 2008; Barron 2011). Additionally, these approaches are gaining traction with agencies like the World Bank and international organizations such as the World Wildlife Fund for Nature, as national governments struggle to establish effective strategies for managing citizens and the environment (McCay 2002). However, researchers from different disciplines, land managers and other state officials, amateurs, and harvesters represent diverse stakeholder groups and participatory methods are not a panacea.

In this article we have not argued that NCR morels should not be managed, nor have we suggested that there should not be any concerns about harvesting. Rather, we have shown that the social-ecological contexts of morel hunting on and around CATO and CHOH are significantly different from those at CALA and Sisters, whence management strategies and rationale have emanated. Our results indicate a strong desire on the part of local mushroom hunters and employees of the NPS to participate in joint decision-making processes regarding morel mushrooms. The use of a participatory approach provides a framework in which to begin sharing responsibility and knowledge.

Notes

1. Personal uses include provisioning and recreation. Cultural uses include ceremonial and medicinal (Emery and McLain 2001).
2. For the complete study see Barron and Emery (2009).
3. Where contemporary subsistence is understood as "any direct use of natural resources to meet the requirements of material and cultural survival outside the formal market- . . . [including] gathering to obtain food, medicine, and utilitarian materials" (Emery and Pierce 2005, 983).
4. The common practice of measuring harvest quantities by volume and retail mushrooms by weight makes precise comparisons difficult. However, harvesters in the PNW estimate the conversion factor to be anywhere from 1:1 (pounds:gallons) to 1:2. Either way, the values of prices per unit are substantially different.
5. We use *morphotype* to denote differentiation of individuals based on morphological characteristics, leading to a typology: i.e., black, yellow, etc. *Morphospecies* are defined as scientific species based on morphology, many of which are outdated due to genetic work. The more general word *species* suggests a scientific name based on either morphology, genetic data, or a combination of both.
6. Mark Savage, Special Forest Products Manager for state of Washington, in discussion with ESB (January 2008).

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