Extension Note
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Commercial development of non-timber forest resources: A case study of morels in the East Kootenay, British Columbia

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Abstract

This case study uses primary data from the authors' research in the East Kootenay region of British Columbia, along with secondary information, to present an overview of morel habitat and productivity with an emphasis on the relationship between forest fires and the production of morels. It explores some of the challenges facing efforts to improve the commercial success of morel harvest including inconsistent harvest locations and quantities of morel production. Annual morel harvests depend on the occurrence of unpredictable forest disturbances, principally fire and insect attack. The authors examine the possible benefits of managing for morel production in forest management strategies. They also point to key areas of additional research that could be useful in supporting a healthy commercial harvest of morels.

KEYWORDS: *British Columbia; forest management; morel; mushrooms; non-timber forest products; mycology; wildfires.*

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Editor's Note:

Please refer to Mitchell and Hobby (2010; see page 27) in this special issue for a description of the overall non-timber forest product project and details of the methodology employed in the case studies.

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Introduction[1]

Morel mushrooms are among the most valued of edible fungi, and are traded internationally in both fresh and dried forms (Figure 1). Along with pine mushrooms and chanterelles, morels are one of the principal wild mushrooms harvested in British Columbia, and are an important component of the non-timber forest product (NTFP) sector (de Geus 1993, 1995).

This case study describes features of the substantial morel crop produced during 2004 in the Kootenay region of British Columbia. It seeks to contribute to the meta-analysis of the related NTFP case studies found in this issue of the *BC Journal of Ecosystems and Management*. The objectives of this study were to document the emergence and characteristics of the morel wild-harvesting industry in the Kootenay region in response to wildfires occurring in 2003, to identify key factors leading to the successful commercial development of this industry, and to explore opportunities and barriers to incorporate forest management strategies that promote commercial morel harvesting.

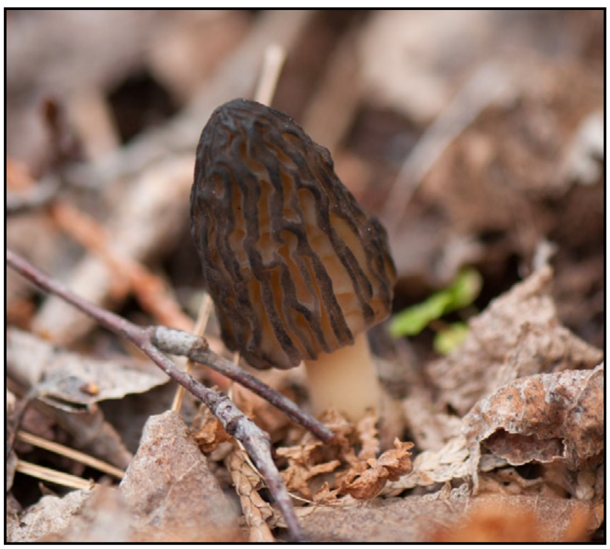

FIGURE 1. A morel (*Morchella*) mushroom growing in the East Kootenay region of British Columbia.

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Materials and methods

Recent literature and surveys

We reviewed the recent scientific and social science literature on morel production and processing. In particular, we focussed on the work of Keefer (2005) and Winder and Keefer (2008), which outlined ecological and socio-economic studies of the 2004 morel harvest in the East Kootenay region. The Keefer 2005 study included a harvester survey, which was developed by the principal author and reviewed by the Royal Roads University Ethical Review Committee to ensure that it met the ethical standards for researching human subjects. The survey was administered to 27 pickers selling their morel harvest at buying stations in the area of the Lamb Creek fire during the 2004 season. Participants were offered a small ethnobotanical book or a gift certificate from a local grocer as an inducement to participate. The survey used a series of standard questions about harvesting practices, prices, and related issues, and follow-up discussion to explore a range of issues about the morel harvest. The non-random survey results provide a useful indication

[1] Extension notes in this issue of the *BC Journal of Ecosystems and Management* are based on a series of case studies that represent an attempt to document economic, social, cultural, and ecological aspects of important non-timber forest products in British Columbia. For more details on the case studies, please contact the Centre for Livelihoods and Ecology through *http://www.royalroads.ca/cle*. It should be noted that the socio-economic data was largely collected through non-random surveys of harvesters, from interviews with key informants (harvesters and buyers), from direct observation, and from a limited amount of published literature from areas outside the case study region. Survey results are based on the responses of a small number of respondents, and should not be taken as necessarily representative of the larger population. Despite these limitations, the extension notes and the case studies on which they are based present new information on little-known resource sectors and suggest a number of useful and important avenues for future research.
Please note that in 2010 the Centre for Non-Timber Resources at Royal Roads University was renamed the Centre for Livelihoods and Ecology.

TABLE 1. Types of morel mushrooms

Common names	Part of the plant used	Management	Degree of transformation	Scale of trade	Geographic range
Morel, black Morel, grey Morel, blonde Morel, fire-site Morel, green	Fruiting body	Many opportunities, but none yet implemented	Low	Global	Global

about the use of the resource and its socio-economic impacts in the region. For more details about the interviews, please consult Keefer (2005). The results of the survey were used to develop a demographic profile of morel pickers and their knowledge of morel ecology, as well as a profile of the production-to-consumption system in the industry.

Physiographic characteristics of the case study area

The study area for this project is within the East Kootenay Regional District, an area of 28 344.3 km^2 with a population of 56 000 (East Kootenay Regional District 2005). The entire study area is within the traditional territory of the Ktunaxa First Nation (Ktunaxa Nation Council 2005). The Purcell and Rocky mountains flank a wide trough known as the Rocky Mountain Trench, which defines this region. In contrast with many rural Canadian areas, this region is relatively economically diverse, possessing a combination of extractive industries (forestry and mining), transportation, service industries, an extensive park network, and tourist-oriented businesses.

High topographical relief and biological diversity characterize the East Kootenay region. Valley bottoms in the Rocky Mountain Trench have a semi-arid climate and a savannah-like mix of grasslands, open forests, and dense young stands dominated by Douglas-fir (*Pseudotsuga menziessii*) and ponderosa pine (*Pinus ponderosa*).[2] As one ascends the mountains, the forests rapidly increase in density and are frequently dominated by lodgepole pine (*Pinus contorta*) and in wetter areas western redcedar (*Thuja plicata*). Higher-elevation forests are dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). Given its topographical and geological diversity, the East Kootenay region includes a wide range of soil types. Dominant soil classes include the Eutric Brunisol, Dystric Brunisol, Gray Luvisol, and Ferro–Humic Podzol (Valentine et al. 1978).

Taxonomy of morels

The “true” morels all belong to *Morchella,* a genus found in the Ascomycetes. The fruiting bodies of Ascomycetes are correctly referred to as ascocarps. *Morchella* is a globally distributed genus, including about a dozen recognized species of morels (Weber 1995). Morels grow widely across North America.

Morels are ascomycetes, a fungal division that also includes another group of sought-after edible fungi: the truffles. There is still a need for a definitive global taxonomic treatment of *Morchella*. The categorization of species within this genus is currently problematic. Fortunately for the morel harvester, all true morels in North America are considered edible (Arora 1986).

Pilz et al. (2007) organize morel species into categories that are also largely recognized by harvesters in the study area. Principal groupings mentioned by harvesters included black morels (*Morchella elata* group), blonde morels (*Morchella esculenta* group), grey morels (also known as fire-site morels), and green morels (Table 1).

[2] In British Columbia, the Biogeoclimatic Ecosystem Classification (BEC) system is used to classify ecosystems according to climatic, vegetative, and site characteristics. Biogeoclimatic Ecosystem Classification zones are areas with broadly similar regional climates, and are named after the tree species that dominate climax ecosystems arising on sites with intermediate soil moisture and nutrient conditions in the zone. In the study region, the low-, mid- and higher-altitude areas correspond to the Ponderosa Pine and Interior Douglas-fir zones (valley bottoms), the Montane Spruce and Interior Cedar–Hemlock zones (mid-altitude regions), and the Engelmann Spruce–Subalpine Fir zone (areas of higher elevation).

Black morels are sometimes called "naturals" if found outside a burned area, but the position of various black morel "species" within this folk classification is currently ambiguous. During spring in the East Kootenay region, black morels are the earliest morel to emerge. Black morels are typically lighter and less compact than other species. They also occasionally cause allergic reactions when consumed, and so are considered less desirable by pickers and buyers.

Harvesters seek blonde morels later in the season, but they are uncommon in the study area. The reasons for this lack of abundance are mentioned in the section of this report dealing with post fire habitat.

Grey morels (*Morchella tomentosa*) are usually found slightly later in the season, often at higher altitudes or latitudes. Some consider the taste of grey morels to be superior to that of black morels (more closely approaching the taste of blonde morels), and allergic reactions to grey morels seem to be less commonplace. Grey morels are therefore often considered to be more valuable than black morels, especially since they also tend to be more compact and therefore heavier by volume. Many pickers describe grey morels as being a "double walled" morel, referring to additional layers of tissue found inside the hollow stipe and cap.

Green morels were previously considered to be part of the black morel group (Pilz et al. 2007). They are found primarily at high elevations, and, partly because they are the heaviest morel per volume, are considered the most desirable morel by harvesters. For this reason and also because they are difficult to find, some buyers pay a premium price for the "greens" to their preferred pickers.

Morel ecology and habitat

Diversity of the morel niche

Researchers are still working on the role and position of morels within ecological food webs. There is evidence for members of the genus being facultatively mycorrhizal (associated with plant roots), saprobic (living on dead wood or other organic substrates), or a combination of the two (Buscot and Kottke 1990; Dahlstrom et al. 2000; McFarlane et al. 2005). Older reports indicate that morels can parasitize certain plant roots (q.v. reviews in Winder 2006; Winder and Keefer 2008).

Morels as saprobes

Morel fruiting bodies have been successfully produced in vitro while growing entirely as saprophytes, as described by Ower (1982). Researchers continue to study the conditions needed for optimal growth of morel cultures (Winder 2006). Although it is possible to cultivate morels outdoors, and Ower's patented methods have been used to artificially cultivate morels in tray systems (Weber 1995), these methods appear to require further development before full achievement of commercial success. The bulk of morels available in the world market continue to be those that are harvested in the wild.

Morels as plant associates

Irrespective of potential symbiotic relationships, morels can associate with plants that show a preference for similar habitat characteristics. In the case study area, black morels were found to associate with plants in various BEC zones (including the Interior Cedar–Hemlock, Montane Spruce, and Engelmann Spruce–Subalpine Fir zones), but in all cases the significant associations were with plants that grew in mesic, well-drained soils (soil moisture of 3.5–4.2 on a scale of 0–8) (Winder and Keefer 2008). Plants in morel-free plots preferred drier soil conditions (soil moisture 4.9–5.6) or more hydric soil conditions (2.9–3.6). Beyond the biological details, plant associations appear to be useful indicators for morel habitat. Many of the plant associations reported by Winder and Keefer (2008) were also reported in the survey of morel harvesters (Keefer 2005).

Plant associates may be useful for locating prime morel habitat. This has implications for harvesters wishing to find morels after fires and for forest managers concerned with estimating and managing this resource before burning occurs. Keefer (2005) and Winder and Keefer (2008) detailed various herb, shrub, and tree species associated with black morels in the case study area. Morel-associated herbs included species such as fireweed (*Epilobium angustifolium*), heart-leaved arnica (*Arnica cordifolia*), and yellow glacier lily (*Erythronium grandiflorum*). Shrubs included, for example, false azalea (*Menziesia ferruginea*), wild rose (*Rosa acicularis*), and thimbleberry (*Rubus parviflorus*). Important trees included the predominant tree species occurring in the BEC zones studied.

Post-fire habitat

In western North America, morels (black and grey) are most renowned for fruiting following major wildfire events. This contrasts with the situation in eastern North America, where a greater proportion of blonde morels are harvested in unburned forests. There is a greater prevalence of limestone bedrock in eastern North America; this situation produces the relatively alkaline soils associated with blonde morels. In contrast, large forest fires in western North America, primarily occurring during drier summers, produce temporary "pulses" of nutrients, alkaline ash, and sterilized soil that promote the temporary growth of black morels (Winder 2006). They may also trigger fruiting by killing host trees (Green et al. 2010). Although some black morels are harvested in non-fire situations, harvesting efforts usually focus on areas recently affected by forest fires (Amaranthus and Pilz 1994; Kenney 1996; Obst and Brown 2000; McFarlane et al. 2005; Wurtz et al. 2005; Pilz et al. 2007). Large commercial harvests in the first post-fire year are common, but morel production decreases markedly and commercial harvest is typically not viable in subsequent years. This attenuation of fruiting has not been quantified in the literature, and is a potential area for future inquiry. Within the area of this study, two visits were made in subsequent years to sites where there had been wildfire activity in 2003. Keefer (2005) visited the site of a 2003 Lamb Creek fire five times within the 2005 growing season, and found no morels; however, a forester active in the region reported that there was moderate morel production in 2005 at the site of the 2003 Mission Creek fire (J. Allen, pers. comm., 2005), a burn that displayed low morel productivity in 2004 (Keefer 2005).

Some researchers have suggested that fire intensity is an important variable in morel production at a given burn site. For example, McFarlane et al. (2005) found that burnt subalpine fir stands with brown needles on the ground were most productive for grey morels. In the area of this study, Keefer (2005) found that the most productive sites for morels were characterized by moderate levels of fire intensity as estimated by the consumption of the duff layer of the forest floor. Winder and Keefer (2008) revised this result, finding that the production characteristics of each fire were unique, and data from additional fires would be needed to correlate production with burning intensity. It was noted, however, that morel production and level of duff consumption in Kootenay National Park was significantly greater than in the other fire areas studied, in concert with a more heterogeneous pattern of burning gradients. Greene et al. (2010) correlated morel production in this same area with tree mortality. The fire in question occurred in the relatively cool, moist conditions experienced in early summer in a river valley with a more continental climate. Although there was no consensus among morel pickers about the level of fire intensity that was likely to produce the most morels, numerous pickers described the ground at the most productive picking sites as "needley" (i.e., as covered by unburned brown conifer needles). This condition indicates areas where fire did not consume the overhead canopy.

Other habitat

Recent reports indicate that tree mortality resulting from mass insect outbreaks and attacks can also produce morels, although the level of production may be less than that associated with fires. This production may be a result of the disruption of the relationship between morels and their associated host trees. In British Columbia, this type of disturbance would include damage from the mountain pine beetle (*Dendroctonus ponderosae*) outbreak, which is dramatically affecting the forest in the East Kootenay region. The beetle has killed considerable numbers of trees and had significant effects on the regional forestry sector, local economies, and on communities the forestry sector supports. The potential of beetle-killed areas for morel production is beginning to receive attention from forest workers, with some reporting significant amounts of morels fruiting following insect attack. In 2004, commercially viable volumes of morels were observed and harvested at one site in the East Kootenay region where the predominant lodgepole pine population was killed by the mountain pine beetle and subsequently salvage logged (Keefer 2005). In 2005 and 2006, surveys by Keefer reaffirmed this result, with morels observed adjacent to virtually all freshly attacked trees (i.e., those trees showing red needles but with bark still mostly attached, also known as the "red attack" phase). The possible links between mountain pine beetle attack and morel production warrant further study.

Harvesting practices

The results of the 2004 harvester survey indicate that experienced pickers do not walk randomly through the forests, but deliberately target certain types of terrain and forest types for their harvesting activities. Morel stipes (stems) are cut with a knife, fingernails, or scissors and are usually around 1 cm long after cutting. Harvesters carry their product in large buckets that have been partially drilled out to allow for airflow to preserve the product. The picker may walk upwards of 15 km a day and drive rudimentary forestry roads across difficult terrain to access mushrooms. Burnt forests producing morels are typically dusty and exposed, where the standing remnants of trees may constitute a particular hazard if toppled. The ash in post-fire situations may also contaminate the morels, producing a less desirable product. Once the bucket is filled, the experienced picker will generally cache the morels in mushroom baskets. In remote sites, the pickers carry out the mushroom baskets in pack frames. Alternatively, the morels may be preserved before transport using various drying schemes. Morels treated in this fashion are less tasty and usually less valuable, but they have a much longer shelf life and are therefore easier to store for later transport.

In 2004, the morel harvesting season in the East Kootenay region began in late April. Harvesting began on warmer, lower-elevation sites and moved on to higher elevations with cooler climates as the spring and summer progressed. Buyers in the region were actively purchasing morels from May to early August, when production on cool sites began to taper off and the professional pickers who participate in harvesting morels had moved on to pick pine mushrooms (*Tricholoma magnivelare*) in other areas of British Columbia.

Economic scope of the harvest

In western North America, the capricious association between black and grey morels and fire habitat results in a wild morel picking industry that is typically localized, ephemeral, and highly transitory. Nonetheless, the economic benefits this industry provides to communities located near recent wildfire sites with high morel growth can be considerable. These benefits may range from camping fees and purchase of supplies to the direct injection of profits into rural communities. The morel crop provides an early economic opportunity for harvesters as they wait for later-developing NTFP crops. Profits from morel harvests are dwarfed by those from timber harvests, but the estimated number of morel pickers (about 300) presumed to be active in the study area during 2004 can be compared to the operation of a small mill.

The morel industry became prominent in the East Kootenay region following the "Canal Flats Fire" in the Lussier River Valley in 1985. A former morel buyer recalls paying over $1.2 million for morels

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in this area in 1985 (B. Shore, pers. comm., 2004). Many locals in the region recall with fondness the profits they made from their first-ever morel harvest during that time. After the Canal Flats harvest, a lack of significant wildfire activity was accompanied by a diminished harvest of morel mushrooms. In 1992, the morel harvest for British Columbia was documented to produce at least 32 000 kg, despite the relatively low amount of post-fire habitat and the unsuitable weather that year (de Geus 1993). Circumstances changed during the summer of 2003, one of the most intense fire seasons recorded in British Columbia. Approximately 250 000 ha of British Columbia forest lands were burnt (Filmon 2004). In the East Kootenay region alone, a total of 43 679 ha burned that year. Based on this figure, the apparent correlation of morel production with recent wildfire exposure, and the morel production levels observed in random experimental plots (7568 morels per hectare), Keefer (2005) estimated that 76×10^7 kg ascocarps grew in the region in 2003. Assuming the average weight of morels harvested in the region matches the 20 g per ascocarp observed by Pilz et al. (2004) in the United States, this would amount to 2.27×10^7 kg of morels produced in the region during the first flush of 2004. The size and scope of subsequent flushes is unknown but based on observations of two additional flushes in the burnt forest at Lamb Creek (Winder and Keefer 2008), the actual size of the potential morel crop could be tripled from the above estimate.

Sustainability

Morels are typically only harvested during the first spring or summer after wildfire, thus there has been little concern about over-harvesting and sustainability. Because mushrooms are fruiting bodies, their harvest is presumed to have little effect on the underground hyphae producing the mushrooms. In addition, the spores of this mushroom are exceptionally long-lived (Winder 2006). Morel inoculum is therefore theoretically capable of persisting in soils for very long periods of time. Optimal morel habitat appears to be widely distributed in most forest landscapes in the study area, but questions remain concerning the prevalence and distribution of inoculum. Details concerning the relative importance of various modes of dissemination and persistence are also somewhat unclear (Winder 2006).

The productivity observed by Winder and Keefer (2008) can be extrapolated to 68 100 000 kg morels (for three flushes). Considering the approximate 90 000 kg harvest reported by Keefer (2005), about 0.1% of the morels produced on burn sites in the Kootenays in 2004 were actually harvested. As observed during fieldwork, morel harvesting was typically intense in easily accessed sites, whereas sites with more difficult access were seldom harvested. These harvest patterns likely ensure ample spore dispersal.

Regarding the sustainability of morel habitat, a possibly significant impact arises from the lack of co-ordination with the morel harvest and salvage logging. At two of the burn sites studied during 2004, the extent of salvage logging was sufficient enough to cause the relocation of some study plots (Winder and Keefer 2008). The majority of pickers surveyed preferred to pick in areas of unlogged timber because of a perception of higher morel productivity. Considerable opportunities exist for compatible management of timber salvage and the morel harvest. An increased understanding of morel ecology may allow forest managers to schedule salvage logging so that the areas least likely to be productive for morels are harvested during or before the morel harvest and productive areas are left until after this critical period.

In summary, the overharvesting of morels might be a concern for certain heavily accessed areas, but the overall abundance of habitat, the abundance and persistence of inoculum, and the negligible harvest (0.1%) translate to a currently sustainable resource. Issues concerning tenure or control of this opportunistic resource represent a greater challenge.

Production-to-consumption system

Socio-economics of production

The 27 harvesters surveyed by Keefer (2005) represent approximately 10% of the harvesters active in the study area during 2004, and are thus assumed to be representative of the larger harvester population.

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Some key findings from the survey include:

- a majority of the harvesters surveyed (74%) were local residents;
- the harvesters were drawn from a diverse set of occupations ranging from skilled professionals to blue-collar workers, housewives, students, and some who were only occupied with NTFP harvests;
- the median age bracket of harvesters was 45–64 years, whereas the mean age bracket was 35–44; and
- a substantial minority (26%) were of First Nations descent, including 15% who were members of the Ktunaxa Nation.

The average daily earning reported by pickers was $91.30, and the most profitable daily earning reported was $381. Transportation to and from picking sites was estimated to be the most significant harvesting cost faced by pickers. We estimated this cost using the total number of kilometres driven per day to the picking areas, multiplied by a mileage rate of $0.45/km. Where the average distance travelled to the sites was approximately 62 km, and where pickers travelled alone, this translates into a daily production cost of around $28 per picker per day; however, many pickers were observed to travel in groups. For the purposes of this study, estimated production costs are therefore reduced to $14 per picker to reflect a more realistic total. Accordingly, we estimate that the average net earnings for a morel harvester of average capabilities in the study region in the 2004 season were approximately $77 per day. More active, experienced, or capable pickers made a net average of $123 per day. From these figures, it is estimated that pickers took home $90–7500.00 for the portion of the season studied, depending on their harvesting skills, and on the number of days worked. It was found that the non-local pickers were more likely to be experienced and highly efficient harvesters and many of these people had pre-existing relationships with the buyers. These pre-existing relationships may result in a higher price paid to pickers (Keefer 2005). In comparison, the mean personal income for the region in 2001 as recorded by the Regional District of the East Kootenay was $29 375 (Regional District of the East Kootenay 2005). This suggests that morel picking served primarily as a source of supplemental income for the majority of local residents participating in the 2004 harvest. The vast majority (84%) of pickers reported earning less than 10% of their annual income from harvesting morels, with a further 12% reporting earnings of 10–25% of their annual income, and the remaining 4% of pickers reporting earnings of 26–50% of their annual income. Clearly, morel pickers rely on a range of other income-generating activities to meet their financial needs. More than half (56%) of those surveyed indicated they harvest other NTFPs, and a third (33%) reported that they harvest other wild mushroom species, including chanterelles (*Cantharellus* and *Craterellus* spp.), boletes (*Boletus* and *Suillus* spp.), brain mushrooms (*Gyromitra* spp.), pine mushrooms (*Tricholoma magnivelare*), and lobster mushrooms (*Hypomyces lactifluorum*).

Most harvesters indicated they sold their harvest to the same buyer every day (56%), or mainly to one buyer (29%). Only 10% of those surveyed sought the buyer offering the highest price. Before the 2004 season, at least seven buyers in British Columbia accepted morels (Berch and Cocksedge 2003). During the 2004 season, up to five competing buying stations were located within the study area; however, these stations paid highly consistent prices on a given day, giving pickers little reason to shop for a better price.

Morel buyers, many who have contractual relationships with larger companies that process and (or) distribute morels, strategically locate themselves near the picking areas. Morel buyers pay pickers in cash. There is frequently high competition for the morels, so many buyers offer additional inducements such as soda pop, snack food, and (or) occasionally beer and cigarettes. At the buying stations, the product is reviewed by buyers who decide whether the morels are in acceptable condition before purchasing them. The product may be deemed unacceptable if it is dirty (i.e., covered in too much ash or road dust), shows signs of decay, has too much moisture, has overly long stipes, or for a variety of other reasons. In some cases, buyers request the pickers to pre-grade and dispose of poor-quality product. In other cases, buyers do all the grading themselves, and pickers displaying poor-quality product are simply turned away. In one case, a buyer was observed turning away what appeared to be pink burn morels as described by Pilz et al. (2004), using the justification that the product was old. Buyers are generally paid the same price for all types of morels but, as previously noted, they may have long-term business relationships with experienced professional pickers to whom they pay higher prices on the basis that their product is of premium quality. Morel grades have been established by the buyers to manage the quality of the product, and are shown in Table 2. Generally, the younger mushrooms are considered of better quality than the more mature morels (B. Shore, pers. comm., 2005). Most inferior morels are designated as "utility" grade.

The preliminary analysis conducted for this study shows that the 2004 morel harvest was a significant contributor to the region's economy.

The preliminary analysis conducted for this study shows that the 2004 morel harvest was a significant contributor to the region's economy. Over 90 000 kg of fresh morels were purchased from the study area. Prices paid to pickers ranged from a high of $11.00/kg to a low of $4.40/kg. Throughout most of the season, the median price remained stable at $6.60/kg. Using the median picker price of $6.60/kg, the overall economic contribution of the harvest to the pickers was estimated at $594 000, and the export value would be approximately $1.2 million.

TABLE 2. Morel grades used by buyers in the East Kootenay Regional District (A. Barnes, pers. comm., 2005)

Morel grade	Quality indicator	Size (cm)
Special	No stems	2–5
Extra	Some stems	3–7
Jumbos		> 7
Utility	Flattened, blackened, or other defects and lower quality	
Field run	Ungraded: exported for later grading	

Processing industry

Most of the morel harvest from the East Kootenay region undergoes minimal processing before reaching the consumer. Some morels are sold fresh at stores or to restaurants in the region. The principal processing method for the remainder of the morel harvest is drying. Morel pickers, buyers, and distributors participate to varying degrees in the drying process. A little less than half (44%) of the pickers surveyed during the 2004 harvest dried at least some of their product before selling it to buyers. A substantial minority of pickers (33%) dried less than 10% of their total harvest, with only a few pickers drying larger portions. Of the fresh morels purchased by local buying stations, roughly one-third were dried in commercial mushroom dryers by station staff before being shipped on to morel distributors, who may dry a further portion of the product before distributing it to the markets. The fresh-to-dry weight ratio for morels averages around 10:1. When properly dried and packaged in airtight vessels, morels are known to stay edible for many years (B. Shore, pers. comm., 2004).

Two-thirds of the morels harvested in 2004 were sold fresh from harvesters to buyers, and from buyers to distributors, and tended to be shipped by air or reefer-truck service to Vancouver, B.C., where they were further graded and repackaged (B. Shore, pers. comm., 2005). Fresh (wet) morels are a highly perishable product and must be chilled as soon as possible after harvest and remain refrigerated until consumption.

Trade and marketing

In British Columbia, the market for morels is export-driven. Although some morels are consumed locally or in other Canadian provinces (Berch and Cocksedge 2003), British Columbia exports most of this commodity to Europe, the United States, and elsewhere. During the period from March 2003 to February 2005, and specifically for the months of April through June, British Columbia exported fresh "non-Agaricus" mushrooms worth approximately $308 000 to the United States and $872 000 to Europe. Dried exports of the same mushrooms totalled $183 000 to the United States and $55 000 to Europe (Berch et al. 2007). We assume that most of these mushrooms were morels, and that some shipments to the United States could ultimately be destined for Europe. Fresh exports to Asia during this period ($12 000) are assumed to be destined for Japan (Berch and Cocksedge 2003). Although the total export figures agree with our estimated value for the morel crop in the study area, other areas of British Columbia (e.g., the Okanagan Valley) also produced morels during 2004. The relationship between declared export values and actual purchase values is therefore unclear in this analysis. European countries importing "non-Agaricus" mushrooms from British Columbia included France (65.0%), Switzerland (11.2%), Netherlands (< 9.0%), Norway (4.2%), Germany (3.8%), Spain (3.3%), Luxembourg (2.0%), United Kingdom (1.0%), Sweden (0.5%), and Belgium (< 0.1%) (Berch et al. 2007).

During the harvest season, fresh morels were observed for sale in Vancouver at the upscale grocery store, Urban Fair, for $150.00/kg and dry morels for $390.00/kg. These figures point to local retail prices that may be an order of magnitude higher than the wholesale price paid to harvesters; the ultimate retail price of exported morels was not measured in this study. It would not be surprising to find substantial opportunities for profit within the commodity chain for morels.

Institutional and policy environment

Although there is provision to regulate NTFPs under the Forest Practices Code of British Columbia and the Forest and Range Practices Act, the provincial government has very little involvement in management, taxation, or research issues related to production of morels. Neighbouring states in the United States have permitting systems in place for NTFPs, including wild mushrooms. Fire morels, however, are an especially challenging resource to manage and regulate, since their ephemeral and transitory nature means they do not regularly recur in areas in subsequent years.

A large majority (81%) of the pickers surveyed were opposed to any regulation of the harvest, and a smaller majority (64%) were also opposed to any regulation of the buyers. This suggests that any management scheme that leads to regulation will face an uphill battle to be accepted by the harvester community. Despite this lack of regulation, and against the assumption of many non-pickers that the morel harvesting industry is characterized by an intensely competitive "Wild West" atmosphere, the majority of pickers (74%) indicated that they did not experience any problems with other pickers. Of those who experienced problems, two harvesters reported stolen product, whereas others perceived that morels were more difficult to secure because of the increased levels of harvesting activity in the region.

No organization represents the morel pickers' interests. The closest thing to an organizational tool is a website devoted primarily to the matsutake or pine mushroom, which features frequent discussions of morels when they are in season.[3] Buyers play a role in the overall organization of the sector by providing advice to pickers on how to handle the morels in order to ensure that a premium product is provided to distributors and consumers.

Trends and issues

The ephemeral nature of the morel resource makes it difficult to predict when and where there will be a major morel harvest until the summer wildfire season concludes. At that point, one may speculate with reasonable accuracy where higher numbers of morels will be produced in the following season. During the 2000–2005 fire seasons, a total of 48 884 ha of forests were burnt by wildfires in the Rocky Mountain Forest District. The mean annual burn area was 8141 ha with a large range of 42 443 ha per year (C. Miller, pers. comm., 2005). The high range of variability in burn areas makes it challenging to develop a consistent local morel industry that is based on wildfire morels. Furthermore, although regular, extensive forest fires may benefit the morel harvesting industry, these fires may also damage the timber reserves, which serve as a significant source of income for communities in the region, and endanger property and lives. Fortunately, it appears that considerable opportunity exists for the development of a non-wildfire-dependent morel harvest associated instead with the prescribed and (or) slash pile burns. Fire (from the perspective of morel harvesting) may be more productive in higher-elevation BEC zones than the Interior Douglas-fir zone because of the increased moisture levels.

A reliable morel harvest might conceivably improve interest in local consumption and provide opportunities to add value to the exported product. These developments could, in turn, provide for more local benefit from the resource.

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Lessons learned

Forest resource co-management practices

As the use of prescribed fire has been increasingly re-introduced to the landscape in various areas of the East Kooetnay region, some of these sites under various conditions of fire severity may benefit morel production.

Fire has other potential uses at higher elevations that could potentially enhance morels, such as when it is employed to reduce logging slash and expose mineral soils before establishing forest plantations. Many of these piles cover an area of close to 0.2 ha. Given this area, the piles may offer an interesting opportunity for the "farming" of morels. Research by Winder (2006) indicates methods for production of inoculum that may be sufficient for "seeding" such areas, further increasing possible morel harvests from burnt slash piles.

Further possibilities for the production of a regular yearly supply of morels may arise from the mountain pine beetle infestation. Research reported in Keefer (2005) suggests that some areas in the region heavily affected by the beetle show moderate levels of morel production in subsequent years, and there is a recent report of commercial morel harvesting in beetle-affected areas near Anahim Lake. (L. Vaughan, pers. comm., 2009). Of course, infestations in the region cannot be predicted but will be variable in the future, depending on climatic conditions, forest composition, and the levels of the attack. Recent estimates show that the total area affected by the mountain pine beetle in the East Kootenay will likely peak by 2007–2010, and that pine beetle infestations will increase from 8% in 2007 to 69% in 2019 (B.C. Ministry of Forests and Range 2009), indicating a potential for large harvests of high-quality morels. Unlike fire morels, beetle-induced morel harvests are unlikely to be contaminated with

[3] See *http://www.matsiman.com*

ash, and because the soils are typically less damaged, the product is cleaner. The beetle-induced morels are largely unknown to the morel pickers and represent a considerable expansion in the morel harvest for as long as the beetle infestation remains. A Ministry of Forests and Range Research Branch document cites this avenue of research as an important part of the provincial mountain pine beetle research strategy (B.C. Ministry of Forests and Range 2005).

While working for the Ktunaxa Nation in 2004, Keefer organized a morel harvester workshop that was attended by close to 40 community members. It is likely that this workshop helped facilitate the relatively high number of Ktunaxa pickers.

In addition to the new opportunities for producing morels described above, an opportunity may exist to develop a stronger value-added component to the morel harvest industry in the East Kootenay area. During the time frame of our study, we observed that fresh morels were rarely available in the grocery stores within the region, and that dry morels were only available periodically. Given the flourishing tourism industry in southeastern British Columbia, an appetite surely exists for locally collected wild morels among higher-end restaurants and consumers. The 2004 morel season saw a number of premium restaurants in the area purchasing morels at prices above those paid by most buyers in the field. One restaurateur commented that if morels were available with greater consistency, he would be certain to feature them in his menu more regularly.

Conclusions

The harvest of morels following wildfire events represents one opportunity for augmenting rural livelihoods in communities; however, our understanding of the production of fire-associated morels and of how this production might be compatibly managed with timber production remains limited. It will always be difficult to assess when and where the next wildfire will occur, and so the timing and location of the morel harvest that will follow is also hard to predict. Further research on morel ecology, possible associations with vascular plants, and the relationship between fire intensity and morel production might help us to pinpoint recently burned locations that may yield particularly high concentrations of morels. Such research would help to quantify the value of delaying salvage logging in areas of highest morel production until after the morel harvest. It would provide useful planning information to forest managers interested in minimizing the impact of post-wildfire logging on the fire morel harvest.

The potential exists for a more consistent morel harvesting and processing industry in the region based on fire use in forest management activities, and the effects of current levels of mountain pine beetle infestation in the region.

The transient nature of wildfire events and the ephemeral nature of the morel resource limits the contributions that the current morel harvesting industry can make to any given community over the longer term. Nevertheless, the potential exists for a more consistent morel harvesting and processing industry in the region based on fire use in forest management activities, and the effects of current levels of mountain pine beetle infestation in the region. The development of such an industry requires that we increase understanding in research areas such as the relationship between the beetle infestation and morels, the possibility of inoculating logging slash piles with morel spawn, and the potential to produce a commercial morel crop through prescribed burns of cutblocks. Work exploring the relationship between insect attack and morel production is of particular interest and urgency. Focussed efforts to promote understanding and stimulate interest in the morel harvest among communities in the province would also benefit the industry and is an important support for the further commercialization of morels in British Columbia.

Note

This series contains information on the ecology and management of non-timber forest products. In promoting implementation of this information, the user should recognize the importance of equitable sharing of any benefits derived from the management and use of this resource as addressed in Article 8(j) of the United Nations Convention on the Conservation of Biological Diversity.

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Test Your Knowledge . . .

Commercial development of non-timber forest resources: A case study of morels in the East Kootenay, British Columbia

How well can you recall some of the main messages in the preceding Extension Note?
Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. What is an ascocarp?
   A) The fruiting body of an ascomycete
   B) The roots of a morel
   C) The head of a clown

2. What plant is believed to be associated with morels?
   A) Marijuana
   B) Wild rose
   C) Cattails

3. Why is the sustainability of the morel harvest of little concern?
   A) Morel pickers only pick a small amount of the crop
   B) The post-wildfire harvest only lasts 1 year
   C) The ascocarps are analogous to the apples on a tree
   D) All of the above

ANSWERS

1. A 2. B 3. D