The Morel Mushroom Industry in Alaska: Current Status and Potential

Written by

Amy L. Wiita
Research Associate
Institute of Social and Economic Research
University of Alaska Anchorage

Tricia L. Wurtz
Research Ecologist
USDA Forest Service
Boreal Ecology Cooperative Research Unit
University of Alaska Fairbanks

Abstract

Morel mushrooms (*Morchella* spp.) collected in the U.S. Pacific Northwest are a non-timber forest product with considerable economic significance. Little information exists on the commercial harvest potential of morel mushrooms in Alaska's boreal forest. We investigated current uses of morels in Alaska, the potential for and constraints to development of an Alaska morel industry and potential resource management and business development implications.

We found that the morel mushroom industry in Alaska is small with few morel harvesters. Morels are harvested for personal and commercial use. Commercial morel harvesting is minimal due to the inaccessibility and unreliable production of morels and the long distances to markets. Permits are rarely issued by state or federal land managers for morel harvesting. The high capital investment for buyers, delayed return on the investment, need for direct product-marketing and creative marketing skills and an inconsistent supply of morels are prominent reasons there are not more businesses involved in an Alaska morel industry.

Alaska appears to be best suited for a dried morel industry and a limited fresh morel market near cities and in local communities where there is a demand in local restaurants. Dried morels from Alaska could be marketed creatively and developed as a small cottage industry that capitalizes on the existing unique opportunities in Alaska such as wild food production, tourism and organic and Alaska Native product marketing.

Acknowledgements

Funding for this research was provided by the New Crops Initiative, University of Alaska Fairbanks, School of Natural Resources and Agricultural Sciences.

The authors thank the various morel mushroom harvesters, agency personnel, business owners, and researchers who generously donated their time to speak with us about morel mushroom harvesting and supplied information for this report. We also thank Gunnar Knapp, Professor of Economics with the Institute of Social and Economic Research at the University of Alaska Anchorage for reviewing this research publication.

Executive Summary
The Morel Mushroom Industry in Alaska: Current Status and Potential

This study looks at morel mushrooms in Alaska—current harvests, the potential for future commercial development of a morel industry in the state, and implications of such an industry for business development and resource management. By "morel mushroom industry" we mean the harvesting, processing, and marketing of morel mushrooms from Alaska.

We did this research in 2004 for the New Crops Initiative, which is part of the School of Natural Resources and Agricultural Sciences at the University of Alaska Fairbanks. Our principal source of information was interviews. We talked with a total of 36 people from the morel mushroom industry, the food industry, universities, and land management agencies in the U.S. and Canada. It was difficult to find morel harvesters and buyers in Alaska; we interviewed only one Alaskan who did harvesting, buying and selling. We also did a broad review of literature about morel mushrooms. Lack of time and money prevented us from going into the field to talk with people collecting morels.

Why Look at Morels in Alaska?

The morel mushroom industry in Alaska is very small right now. We know that Alaskans pick morels (*Morchella* spp.) for personal use, and there is some commercial harvesting—but we could identify only a limited number of businesses in Alaska that currently sell Alaska-harvested morels. We found ten restaurants that serve fresh morels when they are in season but these are both Alaska-harvested morels and morels from the Pacific Northwest. An in-state supplier told us that he sells both Alaska morels and morels from outside the state.

We know there is worldwide demand for morel mushrooms, which are a valuable economic resource in areas where they are harvested commercially. Most commercial morel harvests in North America are from the western U.S.—especially the Pacific Northwest—and from the Yukon, the Northwest Territories, and British Columbia in Canada in areas where frequent wildfires create ideal conditions for abundant morel growth. Morel mushrooms are also found, sometimes in very large concentrations, in Interior Alaska—where summer wildfires are common.

So what affects development of a bigger Alaska morel industry, and what is the potential for growth?

What Affects Morel Harvesting in Alaska?

First, there is still a lot we do not know about the biology and ecology of morels in Interior Alaska. The growing season is from the beginning of June through late August, with most morels appearing in late June and early July. But where morels will appear in any given year, and in what numbers, is unpredictable. Unlike berries and some other wild food harvests, morels do not appear in consistent numbers and locations in Alaska from year to year.

And although we know that morels are most abundant in recently burned areas, even in burned areas Alaska morel productivity varies a great deal. Research is currently underway to document morel productivity following recent Alaska wildfires; when that information is available, we will have more insight into factors affecting productivity. The concentration of morels in burned areas of Alaska might at times be larger than in the Pacific Northwest—but again, such high productivity is not predictable.

Another difference in Alaska is that all morels tend to fruit at the same time—unlike morels in the Pacific Northwest, which fruit consecutively rather than simultaneously. Also, morels in Interior Alaska grow very quickly are generally larger and of poorer form than those in the Pacific Northwest. These mushrooms are not considered top quality on the fresh morel market due to their form, but are well suited for the dried market.

Compounding the problem of unpredictability is inaccessibility. Alaska is far from the Lower 48 and existing markets. It is expensive for pickers and buyers to get here. And within Alaska, morels are often far from roads and difficult and expensive to get to. It is also difficult to get fresh morels to market; typically, morels need to reach markets within 24 hours of harvesting. Harvesters told us that generally only a small percentage of Alaska morels are picked because so many are inaccessible. Viable harvest areas close to the road system are an exception.

What is the Potential Yield of Alaska Morels?

If harvesters were able to pick more Alaska morels and get them to buyers, what is the potential size of the harvest? Limited available data from studies in Oregon and the Northwest Territories suggest that morel productivity in general might range from .03 kg/ha to an estimated 10 kg/ha. (Hectares are a metric measurement equal to about 2.471 acres and kilograms are a metric measurement equal to about 2.2 pounds. So productivity might range from .16 pounds/acre to 54.4 pounds/acre.)

What Does the Morel Mushroom Industry Look Like?

In areas where the morel industry is better developed, there are harvesters, buyers, processors and brokers. But Alaska's small industry consists primarily of harvesters and a few buyers. In Alaska, harvesters and buyers assume the responsibilities of processors and brokers and take morels from harvest through sale.

No license is required to sell mushrooms in Alaska, and within the past 10 years federal land managers have issued very few permits for the commercial harvest of mushrooms; state land managers have not issued any. So there is little data to document how many people are participating in the morel industry. But the difficulty we encountered trying to find people harvesting or buying mushrooms shows that the commercial industry in the state is small.

The few commercial harvesters who pick in Alaska are generally from out of state—we were able to identify and interview only one Alaskan currently harvesting and buying morels. Our informants told us that just one Alaskan was among the buyers after a 1990 fire in Tok, Alaska and that most people harvesting commercially there were from Canada and the Lower 48. People we interviewed also said that some commercial harvesters from the Lower 48 came to Alaska to pick morels more recently, in 2003. But the short window for the harvest, the time and expense of getting to Alaska, and the unpredictability of the harvest deter all but a few harvesters.

Almost all morels commercially harvested in Alaska are dried because of their form; their perishability; the lack of road access between harvest areas and communities; and the logistics of shipping fresh morels to markets.

Fresh Alaska morels are sold to local restaurants and, on occasion—if prices are high enough and if transportation from a burn area to a major city is feasible—fresh morels are shipped to the Lower 48.

Morel Markets and Prices

Morels are harvested and marketed around the globe, but detailed data on morel harvests and markets are hard to come by. Global markets for morels are driven by supply. In a season of many wildfires—and therefore more morels—prices will tend to be lower. Prices for fresh morels can fluctuate daily.

Our interviews indicate that in recent years, prices paid to U.S. harvesters for fresh morels have averaged around $5 to $6 per pound. In 1992, the average annual price processors paid harvesters for morels in Oregon, Washington and Idaho was $4.14 per pound. By 1996, the mean price for morels harvested in those states was $5.60 per pound.

Dried morels command a higher price than fresh, since producing dried mushrooms requires more labor and equipment. Dried morels are marketed both on the Internet and through brokers, with winter prices for dried morels as much as three to four times higher than prices for fresh morels.

It takes approximately eight to ten pounds of fresh morels to produce one pound of dried morels. Assuming an average price per pound of $5 for fresh morels and $125 per pound for dried, and a fresh-to-dried weight ratio of ten to one, dried morel prices are on average about 2.5 times higher than fresh morel prices.

Overall, many we interviewed said that harvesting morels is not a particularly lucrative occupation. One summarized it this way: "Circuit pickers [people that follow the mushroom harvests from place to place] can make more money pumping gas, [but it is] more than just about the money, it is a way of life, freedom, [a] love of the woods."

Competition in Morel Markets

A consultant we interviewed estimated that North America—primarily Oregon, Washington, British Columbia, and Alaska—supplies less than 10 percent of the world's wild mushrooms. Most of the wild mushrooms that are exported from the United States to Europe come from the Pacific Northwest, with most shipped from Seattle.

Mushrooms from China, India, and other countries are increasingly competing on world markets with mushrooms from the Pacific Northwest, according to our informants. China and India can charge significantly lower prices for morels because their labor costs are much lower. European markets are also competing with U.S. morel markets. According to a 2002 publication, "The opening of trade with eastern bloc countries gave the European Union a supply…of morels…that is closer, with lower transportation costs and lower wage expectations, than the U.S. market."[1]

A buyer we interviewed believes that the world market does not need Pacific Northwest morels because they are too expensive, relative to morels from China or India. Others we interviewed disagreed, and said that the United States still has a major role in the world morel industry.

Potential for Growth in Alaska

People we interviewed for this study had conflicting opinions about the potential for a bigger morel industry in Alaska and how to encourage such an industry. Also, critical information about Alaska morels—like why production from year to year is so unpredictable—does not exist. And,

[1] Jones, Eric, Rebecca McLain and James Weigand, eds. 2002. *Nontimber Forest Products in the United States*. Lawrence: University Press of Kansas.

as we have noted, inconsistent production, limited road systems, and distance from markets constrain the potential for growth in Alaska's morel mushroom industry.

Expanding fresh morel sales would generally be very difficult in Alaska, except at the local level, where local harvesters can market fresh morels to local restaurants or at farmer's markets. Restaurant chefs we spoke with in Fairbanks indicated an interest in fresh local morels.

Still, despite these difficulties, there could be limited potential for a small value-added dried morel industry in Alaska, targeted at niche markets such as the Alaska tourist or organic-food markets. The question to ask in evaluating the potential for a bigger Alaska morel industry is: what unique characteristics exist in Alaska that businesses here could leverage? Alaska's established bush pilot network, and the existing wild food and tourist industries, might be the combination needed to make for successful morel ventures.

Combining dried morels with other Alaska wild foods—such as wild salmon, smoked meats, and jellies made with wild berries—might create a package that would be economically viable. We believe that morels alone would not be enough to support commercial enterprises. Also, as with many other products in today's competitive markets, innovative marketing could make a difference in promoting Alaska morels.

Potential Implications for Business Development

Many things tend to discourage development in Alaska's commercial morel industry, including the inconsistent supply of morels, the high cost and difficulty harvesting morels in remote locations, the high capital investment for buyers, the delayed return on the investment, and the need for direct product-marketing and creative marketing skills. Businesses that succeed will need market expertise, flexibility, and a thorough knowledge about the morels harvested. Businesses should be aware that morels retain heavy metals easily and should be tested before they are sold.

An informant we interviewed estimated that to get started morel buyers need $10,000 to $12,000 for equipment and cash to pay harvesters. Buyers or harvesters also need open-air racks or powered dryers, as well as vacuum sealers for processing and packaging dried morels. In remote locations, they also need generators to provide power for dryers and sealers.

Success in the wild mushroom industry in general depends on creativity, ingenuity and fortitude. Records on production and processing from other places are restricted to established processors and shippers. This lack of information, and the cash required, makes entering the industry difficult. Businesses need to be prepared for years with little or no commercially harvestable morel crops and years with extraordinarily large crops.

Potential Implications for Resource Management and Policy

Most land in Interior Alaska belongs to the state or federal governments or Alaska Native corporations. As we mentioned earlier, very few permits for harvesting mushrooms on public lands have been issued in the past 10 years. Representatives of the federal Bureau of Land Management and the state Department of Natural Resources report that they get a few inquiries about commercial permits every year, but few people actually apply for the permits.

Land managers developing any new regulations or permits systems for harvesting mushrooms commercially should keep in mind that there are unlikely to be any large-scale ventures in the foreseeable future. Measures like competitive leases and large-scale land use permits are not

suited for the small businesses and individuals who are most likely to make up any future commercial morel industry in Alaska.

Also, the long-term sustainability of morel harvests is a topic currently under discussion. Little definitive information exists on the sustainability of harvests. The dominant opinion in the literature we reviewed is that harvesting is sustainable, given the abundance of mushroom structure below the soil that is unaffected by the low-impact methods for harvesting morels.

Additional Research Needs

Little is known about the ecology, use of, and market potential for morel mushrooms in Alaska. Broad-scale monitoring of morel productivity, and exploration of factors affecting morel production, would help not only those interested in getting into the morel industry but also land managers making resource management decisions. Knowing more about the relationship between forest fires and morels could also have implications for forest fire suppression policy.

More knowledge about the fruiting requirements of morels in Alaska would allow businesses to better evaluate the feasibility of remote morel scouting by helicopter and bush plane, as is done in the Yukon. Overall, to provide a comprehensive picture of the potential for the morel industry in Alaska, we need a lot of information that is not available right now.

Introduction

Morel mushrooms (*Morchella* spp.) collected in the U.S. Pacific Northwest (PNW) are a non-timber forest product of considerable economic significance. Demand for the resource is world wide and, particularly in regions where French cuisine is practiced. Most commercial morel harvesting in North America occurs in the western United States and Canada where wildfires create an ideal morel fruiting environment for the first year following a fire. Canadian morel hunters have moved farther west and north. After a large wildfire near Tok, Alaska in 1990 a large number of commercial harvesters were attracted to Alaska.

The goal of this research was to examine the current harvesting of morel mushrooms in Alaska, the potential for future commercial development of a morel industry and implications for business development and resource management. Except for our discussion of morel ecology, most of the report is based on interviews with key informants knowledgeable about different aspects of the industry.

Methods

We began this research with a broad review of literature about morel mushrooms with an emphasis on the Pacific Northwest United States and Canada. Our principal source of information was interviews. We conducted key informant semi-structured interviews in 2004 with thirty-six people from the morel mushroom industry, the food industry, universities, and land management agencies in the U.S. and Canada who were identified in the course of the literature review and by key informants. Four people interviewed were from universities; fourteen from state or federal land management agencies; ten from the food industry; two from research institutes; one from a consulting firm; four who were buyers/harvesters in the wild mushroom industry; and one from an Alaska Native Corporation. Informants provided general and specific data on the morel mushroom industry in Alaska and other locations, on regulation and permitting practices and management implications, industry potential and constraints, business and marketing aspects of the morel industry, market information, and suggestions for additional key informants.

It was difficult to find morel harvesters and buyers in Alaska; we interviewed only one Alaskan who did harvesting, buying and selling. Most of the buyers we contacted for key informant interviews were from the Pacific Northwest. A lack of time and money prevented us from going into the field to talk with people collecting morels.

Information and data on the personal or commercial harvest and consumption of morels is limited for Alaska, and more generally worldwide. Key informants provided conflicting information about the potential for an Alaska morel industry. Further research could provide clarification of the answers provided to the questions addressed by this study.

Photos by T. Wurtz

Morel Ecology

Mushrooms of the genus *Morchella* are considered among the choicest edible mushrooms in the world. The taxonomy of the genus is confusing and is still the subject of much debate among mycologists. Identifying specimens to species is complicated because fleshy fungi can vary substantially in appearance in response to different microclimate conditions, can change appearance dramatically as they grow, and are short-lived. Consequently, the number of species of *Morchella* that occur in Alaska is still not agreed upon. Recent phylogenetic analyses by O'Donnell *et al.* (2003) suggest there could be as many as 22 species of *Morchella* endemic to North America.

Two types of morel fruiting are recognized: fruiting in undisturbed locations (where the fruiting bodies are sometimes referred to as "naturals"), and fruiting in response to some kind of disturbance. It appears that some *Morchella* species groups, or putative species, might be likely to fruit in undisturbed habitats and others are likely to be found only after disturbance.

The first type can occur in a wide variety of habitats: undisturbed forests, abandoned orchards, in sand dunes and in sandy soils along streams (Arora 1986, Weber 1995). In such cases, morels can often be found in the same location year after year. But though these morels fruit in the same locations year after year, the number of mushrooms is generally relatively small.

In contrast, when morels fruit following a large-scale disturbance, yields are sometimes expressed in tons (Moser 1949, Duchesne and Weber 1993, Obst and Brown 2000). The disturbance events that prompt fruiting include timber harvest and scarification, insect infestation in the forest overstory, or wildfire (Pilz *et al* 2004). In these cases, while the number of mushrooms might be large, fruiting typically occurs only the first or second spring after the disturbance. Wildfires are common in western North America, and much of the recent interest in the commercial harvest of morels has focused on lands burned in wildfires. The morel growing season in Alaska is from the beginning of June through late August, with most morels appearing in late June and early July.

There are several challenges in understanding why mushrooms appear where and when they do. Fungi are difficult to study in natural habitats; they exist for much of their life cycle as delicate mycelia embedded in the substrate, mixed with other species of fungi (Pilz and Molina 2002). The fruiting bodies of the fleshy fungi are ephemeral, and might not appear at all for decades. In addition, the dynamics of fungal populations in general, and morels in particular, are not well understood (Volk 1991). There is little well-established information on morel reproduction, spore dispersal, colony establishment and growth under forest conditions. Conditions that affect fruiting differ in terms of time-scale from days (weather) to centuries (disturbance intervals), contributing to the challenge of understanding them (Pilz and Molina 2002).

What *is* known is that the appearance of morel fruiting bodies is at least partly dependent on humidity, nutrition, carbon dioxide and temperature (Weber 1995). Certain conditions must be met for the primordia of fruiting bodies to form, and young primordia are very prone to abort if the proper conditions are not maintained (Volk 1991). *Morchella* might be particularly tolerant of cold soil temperatures, allowing it to begin growing earlier in the spring than most other fungi (Schisler and Baker 1974, Schmidt 1983). Working in Minnesota, Schmidt (1983) found that morels began to appear after the soil temperature at 3 cm depth exceeded 10 ºC; the fruiting bodies of common morels take about 30 days to mature (Ower 1982).

A number of people have proposed the following putative life cycle for post-disturbance *Morchella* (Volk 1991, Weber 1995, Miles and Chang 1997). A massive fruiting of morels that follows a wildfire leads to the dispersal of millions of spores. Some settle in the burned area, while others drift into nearby, undisturbed forests. Because morel spores have thin walls and germinate readily under moist conditions, it is unlikely that they persist in the soil for long periods (Schmidt 1983, Pilz *et al* 2004). It is generally believed that they germinate soon after their release (Hervey *et al.* 1978). The spores germinate and produce mycelia. At some point, the mycelium begins to form sclerotia, compact clumps of hyphae in which nutrients are stored (Ower *et al.* 1986, Weber 1995). The organism exists in the soil as mycelium, sclerotium, some combination of the two, or cycling back and forth between them until the next time the forest is disturbed (Volk 1991). For reasons that are not understood, the disturbance event then prompts a new fruiting. It could be that the sclerotia provide a source of nutrients for the production of fruiting bodies when conditions for continued mycelial growth become unfavorable.

The production of sclerotia has been carefully studied by Volk and Leonard (1989). When grown *in vitro*, morel sclerotia do not typically form until the nutrients in a substrate have almost run out (Volk 1991). In addition to their possible involvement in fruiting body formation, sclerotia are believed to play a role in the survival of the organism under stressful environmental conditions, such as cold soil temperatures.

One critical aspect of the life cycle of any organism is its mode of nutrition. Morels were assumed for years to be saprobes. Recent research has found that they might in fact be facultatively mycorrhizal. Alternately, only certain species of morels might be mycorrhizal, or might be mycorrhizal some of the time (Buscot and Kottke 1990, Harbin and Volk 1999, Dahlstrom *et al.* 2000, Hobbie *et al.* 2001). Clearly, saprotrophic fungi would respond differently to the death of the trees in a forest than would fungi that had mycorrhizal associations with those trees. The recent development of molecular DNA techniques is allowing fungal species to be identified from ectomycorrhizal root tips. This method, along with stable isotope analysis, could soon provide the means to answer the mode of nutrition question definitively. This would provide a major piece in the puzzle of why morels fruit when and where they do.

Both the production of the fruiting body from pre-existing mycelium or sclerotium, and the early growth of a mycelium from a newly germinated spore, are believed to be aided by a temporary post-fire decline in fungal competition. Intense fires have been shown to drastically reduce the number of species of ectomycorrhizal fungi in the boreal forests of Fennoscandia (Dahlberg 2002). In northeastern Oregon, six different putative species of morels were identified over two years of sampling in undisturbed forest, insect killed forest, and burned forest. On one insect-killed site, only a single species was found. The next year, after a wildfire burned the site, that species as well as two others were found, all fruiting together (Pilz *et al* 2004). One interpretation of this is that those two putative species required fire to stimulate fruiting. Alternately, the post-fire reduction in competition from other fungi might have enabled fruiting in those two species.

Why Look at Morels in Alaska?

The morel mushroom industry in Alaska is very small right now. We know that Alaskans pick morels (*Morchella* spp.) for personal use, and there is some commercial harvesting—but we could identify only a limited number of businesses in Alaska that currently sell Alaska-harvested morels. Ten restaurants were identified that serve fresh morels when they are in season but these are both Alaska-harvested morels and morels from the Pacific Northwest. An in-state supplier told us that he sells both Alaska morels and morels from outside the state.

We know there is worldwide demand for morel mushrooms, which are a valuable economic resource in areas where they are harvested commercially. They grow in limited numbers in undisturbed forests and other places, but are known to be much more abundant in areas recently burned by wildfires. Most commercial morel harvests in North America are from the western U.S.—especially the Pacific Northwest—and from the Yukon, the Northwest Territories, and British Columbia in Canada in areas where frequent wildfires create ideal conditions for abundant morel growth.

Morel mushrooms are also found, sometimes in very large concentrations, in Interior Alaska—where summer wildfires are common. A large wildfire near Tok in 1990, for example, was followed in 1991 by a huge crop of morels that drew 200 pickers and 20 buyers, according to our informants. There has not, however, been a morel harvest of that size in Alaska since then.

So what affects development of a bigger Alaska morel industry, and what is the potential for growth?

What Affects Morel Harvesting in Alaska?

Most morel fruiting occurs in the first or second spring after a fire. Sometimes rainfall will provoke several flushes of morels during a single growing season (Obst and Brown 2000). Although in other locations, such as Canada and the Pacific Northwest, morel species might fruit in succession, key informants interviewed indicated that all morels found in Alaska tend to fruit at the same time. This challenges harvesters to deal with harvesting morels all at the same time with no reprieve. The long day light hours in Alaska facilitate the harvesting but also create long, sometimes twenty hour, days of harvesting.

Morels in Interior Alaska often grow at a very quick rate resulting in larger sized morels than those in the Pacific Northwest. The quicker growth rate generally results in mushrooms that do not have the appropriate proportions to be considered top quality on the fresh morel market.

These larger morels are well suited for the dried morel market providing more dry product per mushroom harvested.

We know little about where and why morels fruit in Alaska at a site specific level. Key informants and literature provide varying descriptions of what conditions are required for morel fruiting. Key informants noted, in Interior Alaska, morels have been noted to fruit most reliably in white and black spruce forests after a fire. They are not generally found in burned Sitka spruce or birch forests. This could limit the area of potential production of morels. Key informants reported the main area of morel production in Interior Alaska surrounds Tok, Alaska.

Alaska's morel production is more inconsistent than other similar morel producing areas, such as the Yukon, making a steady industry difficult. In addition, the lack of road access in Alaska puts an additional constraint on building a viable industry. Morels are episodic. They do not recur in the same general location year after year with the level of reliability and consistency as do other wild harvested foods such as berries.

The most pressing constraints on a morel industry in Alaska are morel production, road access and marketing. (Kenney 1996, 53) found a lack of knowledge about the international industry and distance from European markets to be the two largest constraints on developing a Yukon morel industry. All key informants indicated that morels do not fruit in great intensity on a reliable basis in Alaska, although fruiting can be abundant at times, reliable crop production could be Alaska's greatest constraint.

The fire season around the world affects the viability of harvests worldwide. If it is a high fire season in the Lower 48 and a low season in Alaska, Alaska harvests will be difficult. Even during a high fire season not all, if any, fires will produce an abundance of morels suitable for a large commercial harvest. The simultaneous fruiting of morels combined with the quick spoilage time make it difficult to harvest and preserve commercial quantities of morels. There might simply be too many mushrooms to harvest and preserve in the short window of the fruiting. This significantly increases the work load for harvesters in a given time period.

Morels spoil quickly once they are harvested. Harvesters estimate that fresh morels will spoil in a single day without refrigeration. With refrigeration, morels spoil within two to three days. Fresh morels loose ten to fifteen percent of their moisture content in the first twenty-four hours after harvest. Eighteen to twenty percent moisture loss is average from harvest to final point of sale. Moisture loss is a loss in revenue for fresh morel sales because final payment amounts are determined by weight at the final point of sale. Fresh morels typically need to arrive at the final point of sale, including European markets, within twenty-four to thirty-six hours of harvest.

Potential Yield of Alaska Morels

If harvesters were able to pick more Alaska morels and get them to buyers, what is the potential size of the harvest? Limited available data from studies in Oregon and the Northwest Territories suggest that morel productivity in general might range from .03 kg/ha to an estimated 10 kg/ha (Table 1).[2] (Hectares are a metric measurement equal to about 2.471 acres and kilograms are a metric measurement equal to about 2.2 pounds. So productivity might range from .16 pounds/acre to 54.4 pounds/acre.)

[2] Obst and Brown (2000) estimated the overall morel productivity of a burned area in the Northwest Territories at about 10 kg/ha. In northeastern Oregon, productivity of recently burned sites ranged from 0.6 to 9.0 kg/ha (Pilz et. al. in-press).

Table 1. A comparison of post-fire morel productivity: Northeastern Oregon; Yellowknife, Northwest Territories, Canada; and Interior Alaska.

Location	Year	N/ha	kg/ha (fresh weight)
Malheur NF[1]	1995	315	0.65
	1996	325	5.71
Umatilla NF[1]	1995	2,950	4.158
	1996	450	9.08
Wallowa-Whitman NF[1]	1995	4,350	3.8
	1996	290	2.23
Yellowknife, N.W.T.[2]	1999	350 – 2320	10.00 (estimate)
Alaska			
Survey Line	2002	985	6.57
West Fork	2003	10	0.03
Tolovana Hot Springs	2003	225	2.63

[1] Data from Pilz *et al* 2004.
[2] Data from Obst and Brown 2000.

Research is underway to document the morel productivity in recent Alaska burns, but the typical patchiness of morel fruiting locations (even in disturbed areas) makes characterizing yields per hectare challenging. Information on morel yields after disturbance can help managers consider the potential for the commercial harvest of morels when developing management plans for Alaska's boreal forest region. Nevertheless, much of the underlying biology and ecology of *Morchella* remains poorly understood.

An average of 286,000 hectares burned each year in Interior Alaska between 1950 and 2000, and in a major fire year over a million hectares burned (Kasischke et al. in press). But years of high fire activity were interspersed with years of low activity; 55% of the entire area burned between 1961 and 2000 occurred in just six years (ibid.).

Morels can fruit prolifically after forest fires in Alaska producing higher yields than the Pacific Northwest. A key informant noted the year after the 1990 Tok fire morels were "thicker than grass" on one person's front lawn. However, the fruiting is so inconsistent in Alaska that it is unreliable.

The 1991 harvest after the 1990 Tok fire is legendary in mushroom circles and is still referred to today. There were an estimated 200 harvesters and 20 buyers at this fire. There has not been a morel harvest of this size since. In contrast to the 1990 fire the 1997 Tok fire did not produce a great abundance of morels. Alaska is legendary for its abundance of morels, but areas of abundance are widely scattered and unpredictable.

The Morel Mushroom Industry

The industry in the Pacific Northwest consists of harvesters, buyers, processors and brokers. Harvesters, sometimes referred to as pickers, locate and pick mushrooms; buyers, often associated with a processor, purchase mushrooms from harvesters usually in the field near harvest areas; processors handle, clean, pack and ship the mushrooms and provide cash and field

prices to buyers; and brokers market the processed mushrooms around the world (Pilz and Molina 1996, 42).

In the Pacific Northwest, pickers can be individuals or family groups. They can travel as groups using drivers or individually to forested and burned areas for harvesting. Morels are harvested by cutting the mushrooms at the stem with a serrated knife. The harvested mushrooms are carried in containers that allow for air circulation, such as buckets with holes in them, to keep the mushrooms as fresh as possible during harvesting. Fresh morels are brought to buying stations for sale to buyers or can be dried in the field or at home. Both harvesters and processors can dry morels for future sales.

Field drying morels can be as simple as air drying or as complex as using drying shacks with dryers powered by generators. Morels are laid out in a single layer and air circulating around the mushrooms dries them. Drying shacks are often constructed with shelves to lay mushrooms on and dryers to heat, dehumidify, and circulate the air around the mushrooms to decrease the drying time. Once the morels are dried they must be packaged to prevent rehydration. This is often accomplished using vacuum packaging.

Industry in Alaska

The morel industry in Alaska is not neatly segregated into the more detailed job categories of harvesters, buyers, processors and brokers as it is in the Pacific Northwest. The industry consists primarily of harvesters and very few buyers. Harvesters, and buyers, assume the responsibilities of processors and brokers and possess the complete range of skills necessary to handle morels from harvest to sale.

Harvesters from the Lower 48 and Canada do not generally pick in Alaska due to the time and expense of traveling here. Harvesters tend to follow the mushroom trail from California, through the Pacific Northwest to Canada following the more reliable harvests and more prevalent road access. The uncertainty of the Alaska harvest is a high risk to undertake considering the expense involved in reaching Alaska.

Key informants stated that the few commercial harvesters who pick in Alaska are generally from out-of-state. This was the case with the 1991 harvest season at the Tok fire where only one person from Alaska was buying morels and most people harvesting commercially were from Canada and the Lower 48. Most buyers were from Vancouver, British Columbia. Harvesters indicate that only a small percentage of morels is being harvested in Alaska due to the inaccessibility of the resource. Even in Oregon, where access is considerably better, harvesters stated that only a fraction of the morel crop is purported to be harvested.

The commercial harvest of morels in Alaska is focused on lands burned by wildfires. We spoke with a harvester that picked burned areas in Delta Junction, Tok, and Chicken, Alaska. Each location had varying degrees of productivity and very few harvesters. Very few people picked the 1999 Delta Junction fire until the end of the season when, even then, only approximately fifty people were picking. The harvester we spoke with shipped fresh morels to the San Francisco Bay area from the Delta Junction burn by renting local freezer space and then shipping them from Fairbanks. Prices were high enough and the harvest area was close enough to Fairbanks to make this feasible. Only a handful of people picked morels on the 1997 Tok fire which also had low productivity.

The fire season world wide also drives competition. Places with more fires out-produce areas with few fires. A consultant interviewed estimated that although there is a large North American wild mushroom market, Oregon, Washington, British Columbia and Alaska jointly supply less than ten percent of the world's wild mushrooms. Most edible wild mushrooms exported from the United States to the European Community come from the Pacific Northwest, and the majority are shipped from Seattle (Jones, McLain and Weigand 2002, 142).

Morel mushroom harvesters in Alaska appear to primarily harvest for their own personal use. However, at least nine restaurants in the state use fresh morels in their cuisine seasonally. It is difficult to say if a greater volume of morels is used for personal or commercial use. Restaurants purchase fresh morels from both local and out-of-state suppliers. Most Fairbanks restaurants that use morels purchase them from large food suppliers in the Lower 48 states. A Fairbanks restaurant indicated they would purchase morels from a local supplier if they were available. An in-state supplier indicated he sells both Alaskan harvested morels as well as morels harvested outside the state. This would suggest that Alaska demand for morels currently exceeds the quantity harvested within the state.

Alaska Natives did not traditionally eat wild mushrooms. (Jones 1983, 144) states mushrooms were traditionally never eaten by the Inupiaq people of Alaska and there was a strong taboo against eating mushrooms. They are listed in Jones' book in the section on plants to be avoided. A key informant indicated that fungi are not generally mentioned by Alaska Natives in subsistence surveys conducted by the State of Alaska. He noted they do not appear to be a major traditional food, are not preserved and are not written about in stories.

There are no licensure requirements to sell mushrooms in Alaska. It is difficult to say how many people are participating in the industry except to say the difficulty encountered trying to find people harvesting or buying mushrooms indicates there is little commercial industry currently in the state. A key informant indicated there is only one in-state commercial supplier of morels.

Very few permits have been issued in the past ten years by any state or federal land management agency in Alaska for the commercial harvest of morel mushrooms. Permits are general land use permits with a specified use of mushroom harvesting. The Alaska Department of Natural Resources has not issued any permits for the commercial harvest of mushrooms. The Bureau of Land Management has issued very few (less than ten) permits for mushroom harvesting over the past ten years. Interest in commercial harvesting on BLM lands has diminished during this time. Each year both the DNR and BLM have inquires about morel harvesting but few inquiries result in the issuance of commercial permits.

There are no authorizations required to buy or sell wild mushrooms as a food product in Alaska. This is also the case in Washington State where there are also no food handler permits required and no oversight of mushrooms in the market place. Key informants noted harvesters and restaurants have successfully self-monitored the sale of mushrooms to date.

Morel Markets and Prices

Morels are harvested and marketed around the globe. Prices can be high but vary on a daily basis along with markets. There is limited data on morel harvesting and markets making it difficult to determine industry activity. There is significant competition for the Pacific Northwest industry from other countries such as China and India. Markets are sensitive to the number of wildfires

that occur. There are markets for fresh and dried morels, with dry morels commanding a higher price and requiring more labor and resources than fresh morels.

The global market is driven by product supply and prices fluctuate daily for fresh morels. (Kenney 1996, 12) notes "the best word to describe the global market dynamic for morel volume might be **erratic**." He continues "there are no comprehensive statistics kept by nation on morels…distributors raise the price when supplies are low and the market drives the price lower when harvests are bountiful." Blatner and Alexander, 1998 equate varying mushroom prices to those of wheat—news of a good crop from overseas can adversely affect prices in the Pacific Northwest and timing of large shipments entering a specific market will affect local prices. Our interviews indicate fresh morel prices paid to harvesters generally average $5-$6 per pound. In 1992, the average annual price paid by processors in Oregon, Washington and Idaho for morels was $4.14 (Schlosser and Blatner 1992, 33). By 1996 the mean price for morels harvested in Oregon, Washington and Idaho was $5.60/lb (Blatner and Alexander 1998, 31).

Most harvesters do not make a great deal of money harvesting morels. Given the world market for the product, large companies and big buyers have more control over market prices. A key informant noted that "circuit pickers [people that follow the mushroom harvests from place to place] can make more money pumping gas, [but it is] more than just about the money, it's a way of life, freedom, [a] love of the woods." Another person interviewed said that he only makes $30,000 in a good year harvesting a variety of mushrooms.

Dried morels have a high value on the world market. The recent influx of product from China and India, however, has reduced this value. Dried morels are marketed on the internet and through brokers with winter prices for the dried product being as mush as three to four times higher than prices for fresh morels. The ratio of fresh to dried morel weight averages approximately eight to ten pounds of fresh morels to one pound of dried. Assuming an average price per pound of $5 fresh and $125 dry and a wet to dry weight ratio of ten to one, dried morel prices are, on average, approximately 2.5 times higher than fresh morels.

(Schlosser and Blatner 1992, 31-36) conducted a survey of the wild mushroom industry in Washington, Oregon and Idaho. They estimated that 1,325,827 pounds of morels were harvested during 1992 with $5,222,237 paid to harvesters. Oregon supplied 68% of this harvest. Schlosser and Blatner found that the primary market for morels was the Western United States but mushrooms might have been shipped overseas after this point of sale making the final point of sale potentially unknown. In 1997, however, Parks and Schmitt note that forty percent of the morels harvested in the Blue Mountain region of Oregon were sold to Asian and European markets and 42% were sold in the Western United States, indicating domestic and foreign sales were approximately the same (Parks and Schmitt 1997, 4).

Competition in Morel Markets

China and India are playing a significant role in the morel industry recently with the ability to charge significantly lower prices due to lower labor costs. The United States is also experiencing competition from Canadian and European companies. "The opening of trade with eastern bloc countries gave the European Union a supply…of morels…that are closer, with lower transportation costs and lower wage expectations than the U.S. market" (Jones, McLain and Weigand 2002, 122).

A buyer interviewed stated that the world market does not need Pacific Northwest morels. They are higher priced than morels from China or India. The buyer stated that good quality dried morels from the PNW generally sell for $125-$175/lb with poor quality dried morels selling for approximately $50/lb. And, in contrast, India is selling good quality dried morels for only $25/lb. The industry in the PNW is diminishing due to increased competition and poor weather conditions. Others, however, maintain that the United States still has a major role in the morel industry.

Potential for Industry Growth in Alaska

Alaska morel harvesting can be compared with that of the Northwest Territories and Yukon. The similar climate, transportation, and access provide comparison. Yet, the productivity in the Yukon appears to be more reliable than either Alaska or the Northwest Territories. The Yukon also benefits from the established industry in British Columbia. Established buying networks and proximity to markets is an advantage for harvests in British Columbia. There could be limited potential for a small value-added dried morel industry in Alaska. Inconsistent production, limited road infrastructure and distance from markets constrain the industry.

Morels are widely harvested in the Yukon and Northwest Territories (NWT) in Canada which are similar in climate and remoteness to Interior Alaska. The industry is well established in the Yukon and is struggling in the NWT. (Obst and Brown 2000, 1-49) report on a morel harvest pilot project in the NWT in 1998. The report is generally optimistic and encourages the development of a morel industry in the NWT. Speaking with key informants indicated that the morel industry in the NWT has not flourished in the past six years. A key factor is the Northwest Territories does not have well developed access and transportation costs are high. A key informant indicated “the [NWT] industry lost money even in good production years.” Morel production in the NWT is not as consistent as it is in the Yukon. Key informants indicated that the NWT attempted to create an industry that it was not prepared for from an infrastructure and knowledge capacity.

The Yukon enjoys more consistent morel harvests, a developed road infrastructure and an established buying network seated in Vancouver, British Columbia that jointly have created a viable industry. (Wills 2002b, 9) states “in a good year, approximately 225,000 kilograms of morels are harvested in British Columbia (B.C.) and the Yukon, but in a bad year this figure may fall to the range of 10,000-20,000 kilograms.” (We interpreted this to refer to fresh weights.) Even with supposedly more consistent morel harvests as compared to the NWT and Alaska the Yukon and British Columbia still experience variability in their harvests. Seventy-five to eighty percent of all morels exported from B.C. come from the Yukon due to fire suppression policies in B.C. (ibid.). Most buyers and pickers in the Yukon are from British Columbia.

Alaska’s morel industry has potential but must be pursued cautiously. The 1990 Tok fire indicates if a fire is large enough, burned areas are accessible, and market prices are sufficient, people will come from around the state, the Lower 48 states and other countries to harvest mushrooms in Alaska. This level of morel harvest, however, has not been experienced in Alaska since the 1991 harvest season

Alaska’s potential for a morel industry lies in the small scale production of value-added dried morels targeted at niche markets such as the Alaska tourist or organic market. Organic or Alaska Native harvested products have potential in the European market where organic and Native American products are preferred. Numerous key informants indicated it is doubtful Alaska

would be able to adequately compete with the less expensive and more reliable harvests of other places on the worldwide fresh and dried morel markets. Alaska's morel season is slightly later than the Lower 48 and Canada providing late season production and market potential when prices are higher. The season, however, might not be sufficiently late enough to provide a competitive advantage especially considering the inconsistency of production.

Dried morels command a higher price in the winter months when supplies are low. They are easily processed and can be marketed directly or over the internet. Marketing dried morels can provide needed flexibility to take the unpredictable harvests in Alaska into consideration. Morels can be dried and vacuum packaged on site in remote locations, easily transported and sold at a later date. A key informant noted that if the Alaska industry had been prepared for the 1990 Tok fire, dried morels would still be being sold from Alaska. Although dried morels might not be viable for sale after such a long period of time, the important message from this statement is to be prepared for the harvest when it is bountiful.

Fresh morel sales would generally be very difficult in Alaska, except at the local level where local harvesters could market fresh morels to local restaurants or at farmer's markets. Restaurants in Fairbanks indicated an interest in fresh local morels. Fresh morels need to be shipped to destinations within twenty-four to thirty-six hours of harvest to ensure quality and reduce the loss of revenue from dehydration.

Alaska's established bush pilot, wild food and tourist industries could be the combination of factors key to successful morel ventures. The question to ask in evaluating the potential for business in an Alaskan morel industry is: what unique characteristics exist in Alaska that do not exist elsewhere that a business can leverage in an Alaska morel industry? The answer could lie in our tourists, wild foods, and natural specialty products.

Combining dried morels with other wild foods such as wild salmon, smoked meats, jams, and jellies could provide the alternative revenue sources necessary to create economically viable harvests. The morel industry in Alaska would need to be more than simply morels to succeed. There could be potential in a business that combines various wild resources targeted at the established tourist industry. Existing bush pilot transportation could provide access to remote harvest areas.

The potential for an Alaska morel mushroom industry will be partially determined by the degree of innovative marketing employed in the industry. Local cooperative extension offices, small business development offices and research institutes could facilitate the dissemination of knowledge needed for the marketing, processing, handling and acquiring of business skills necessary to develop a morel business. (Wills 2002a, 2) notes "emerging products and industries typically have high risks and high development costs at the outset, and, if successful, high payoffs in terms of employment and diversification…Asian market economies, Ireland and many other countries which have been successful in diversifying on the basis of new industries have often done so with substantial government assistance at the outset."

A few people each year in Alaska contact the University of Alaska Fairbanks to discuss how to make money by commercial wild mushroom harvesting. This indicates, at a minimum, a peripheral interest exists in a commercial mushroom industry in Alaska. Almost all morels commercially harvested in Alaska are dried due to the perishability of the morels, the lack of road access between harvest areas and communities, and the logistics involved in shipping fresh morels. Fresh morels are sold to local restaurants and, on occasion, if prices are high enough and

a burn area is close enough to a major city, fresh morels are shipped to the Lower 48. As recently as 2003, commercial harvesters from the Lower 48 came to Alaska to pick morels. The short window for the harvest, time and expense to reach Alaska and the unpredictability of the harvest deter most out-of-state harvesters from coming to Alaska.

Potential Implications for Business Development

Informants stated that the most prominent reasons there are not more businesses involved in an Alaska morel industry is: the high capital investment for buyers, delayed return on the investment, need for direct product marketing and creative marketing skills and an inconsistent supply of morels. Inconsistent fruiting makes providing a consistent supply of product difficult. Businesses will need to work with federal, state and private land owners for access to harvest areas. Access to land is critical; the more remote a harvest area is the more costly the harvest is. Businesses will need market expertise, organized business skills and a thorough knowledge of the morels harvested. Businesses should be aware that morels retain heavy metals easily and should be tested before selling.

A key informant estimates an initial need as a buyer of $10-$12,000 for equipment and cash to pay harvesters. The initial investment required will vary based on the type of equipment purchased and size of the buying season. A buyer or harvester will need open air racks or powered dryers and vacuum sealers for processing and packaging dried morels. A generator is necessary in remote locations to power dryers and sealers.

The wild mushroom industry is highly dependent on an individual's creativity, ingenuity and fortitude to make a business viable. Records on production and processing from other places are restricted to established processors and shippers and the mushroom business has largely been an "underground" business dealing in cash (Parks and Schmitt 1997, 4). This lack of information and the cash-based economy make entering the industry difficult. Businesses need to be prepared for market challenges in years with little to no commercially harvestable morel crops and years with large crops. Winter months are generally used for alternative employment opportunities and to study the fire season. Fire maps are used to determine burn locations, burn intensities and access. Climate data, snow depths, temperatures, and terrain are also used to estimate the up-coming season's morel crop location and abundance.

Buying and marketing morels requires an extensive knowledge of morel markets, business savvy, cash to purchase morels and capital investment in both time and money. Harvesting is difficult, intense labor requiring experience to predict the time, location and abundance of morel fruitings with generally low returns on the time and effort invested. Finding lenders for the cash necessary for buying is difficult due to the spoilage potential of the product and the sizable amount of cash needed for transactions. According to key informants, a weekend of buying in the Pacific Northwest might require $150,000.

The morel season in Alaska is a time when most people are already engaged in subsistence or recreational activities. People might find it difficult to stop everything they are doing to harvest a massive fruiting of morels that has to be harvested and processed all at once. Periodic, small harvests, however, might not be worth the effort. Harvesting a burn area is generally hot, dirty, difficult work.

Key informants agree that a business in the morel mushroom industry in Alaska must be flexible and accommodate unpredictable morel fruitings, employ creative marketing, have knowledge of

morel markets and direct-marketing techniques and the ability to splice morel business with other business ventures. Alaska has opportunities for marketing various wild foods to tourists, as organic or Native harvested products both of which are of interest to European markets. In Saskatchewan, business in the wild mushroom industry can be lucrative, but yields vary widely depending on weather. “Harvesters have to maintain a portfolio of activities and choose the product which gives the greatest potential return in a given year” (Saskatchewan Environmental Society, no date, 4).

The government of Saskatchewan in Canada actively encourages wild mushroom harvesting and promotes the involvement of First Nation and local communities. The industry is promoted through the media, government subsidies and small business development programs. A Saskatchewan Trade and Export Partnership (STEP) February 20, 2004 news release states “cooperative relationships between Saskatchewan Agriculture, Food and Rural Revitalization, Agriculture Canada and STEP provide Saskatchewan organic producers and exporters with all the tools to successfully market their products in Europe and beyond.”

Businesses would need to develop creative marketing plans to find niche morel markets best suited for the industry in Alaska. Drying morels allows time to learn the morel markets and develop marketing plans unlike selling perishable fresh morels. Local communities and businesses could consider developing cooperatives and the sale of an organic or Alaska Native product in the European market to address the European demand for organic and Native products. Harvesters in Saskatchewan have sought out their own markets and developed cottage industries to increase the value of their product and to avoid dealings with large-scale brokers by focusing their attention on niche markets for their cottage industry (Saskatchewan Environmental Society, no date, 8).

(C. Schnepf, no date, 1-3) with the University of Idaho, College of Agriculture, Cooperative Extension system, presents a summary of the production, marketing and management needs to be considered by businesses wanting to become involved in the special forest products (SFP) industry. Key issues and questions relating to why a business might want to enter the SFP industry, market considerations, harvest sites, harvest feasibility, and pricing are briefly discussed. (Saskatchewan Environmental Society, no date, 3) stresses the need for businesses to understand marketplace standards, packaging, pricing and distribution, and most importantly how to run an effective business which can be relied upon by the market place.

Potential Implications for Resource Management and Policy

Most lands in Interior Alaska, where morels would be found after a forest fire, are private land (including Native Corporation lands), State of Alaska, or Bureau of Land Management lands. Regulations and permitting by the various land managers in Alaska have not targeted wild mushroom harvesting.

Prices for permits vary by land management agency. According to key informants at the time this research was conducted, the BLM commercial permit for harvesting less than $2,499 of product is appraised at market value when an application is filed. There is no annual fee for these permits. A request to commercially harvest over $2,499 of product from BLM lands requires a competitive bidding process. The BLM can also conduct a National Environmental Protection Act (NEPA) compliance review to issue a commercial mushroom harvest permit. This process can take from one week to several months to complete. The sale of small amounts of mushrooms may not require a NEPA review.

The Alaska Department of Natural Resources charges $100 for an annual land use permit for the commercial harvest of mushrooms. A fee of $.20 per pound, which is five percent of the average fresh price per pound, is charged for mushrooms. This fee for harvesting on DNR lands was developed in comparison to other agencies as well as the private sector and formalized in the Alaska Administrative Code (11 A.A.C. 05.010).

Permit fees are often developed when market prices are high and harvesting is intense and generally do not change with changing market conditions. Permits that encourage stewardship of the land and resource and provide incentives for data collection could be a better alternative to the standard use permit. Foraging permits modeled after hunting and fishing licenses might also be an alternative for a practical more cost effective permit system accessible to harvesters.

Regulations and policies governing increased harvesting in the Pacific Northwest were primarily implemented to prevent picking in specified areas and to manage the people picking rather than the amount of morels harvested. Large numbers of harvesters in a confined area have lead to regulatory needs for camping, sanitation, personal safety, and user group conflict in the Lower 48 states.

The sustainability of morel harvests is a topic under discussion. Concerns about sustainability have arisen due to high harvest levels in the Pacific Northwest and prolonged harvest levels in Europe combined with declining production levels of fungi in Europe (Pilz and Molina 2002, 14). Given so little is known about the ecology and biology of the mushroom little definitive information exists on the sustainability of harvests. Picking the fruit of fungi can be equated to picking apples from an apple tree; even if all the apples are picked the tree would not be killed (Molina et al 1993, 22). (Pilz *et al* 2004) found no significant difference between morel productivity in sample plots that were harvested and those that were not harvested. The literature outlines the dominant opinion at this time as harvesting is sustainable given the abundance of mushroom structure below the soil unaffected by the low impact harvest methods for morels. Morels are harvested by cutting the fruiting body at the stem. The subsurface mushroom structure is generally not disturbed by this method of harvest.

Regulations and permits must be developed with the purpose of the management measures keenly in mind. What is the purpose of management? Does the resource, people, or land need management? Who do regulations and permits affect and how? Local input from Alaska Native people and non-Native people in the industry must be acquired, not merely sought, to inform the management process in Alaska. Numerous key informants indicated that permitting in many other locations is not effective except to manage camping and litter impacts from large numbers of harvesters. Competitive leases, concession leases and large scale land use permits are only affordable for large commercial companies and exclude participation of smaller businesses and individuals. Given the unlikely nature of attracting large companies to Alaska due to factors previously mentioned, large scale land based permitting would not be a likely option for an industry in Alaska.

The morel industry is highly variable due to the inconsistency of morel production. If regulations or permits are developed to address the industry and management of the resource they must take this intrinsic nature into account. It is difficult to regulate or manage a resource that is dispersed on the landscape, based on random catastrophic events with unpredictable production.

Additional Research Needs

Little is known about the ecology, use and market potential of morel mushrooms in Alaska. Broad scale monitoring of morel productivity and the exploration of factors affecting morel production such as burn conditions would help to better inform managers making resource management decisions. Knowing more about the relationship between forest fires and morels could have implications for forest fire suppression policy. (Pilz *et al* 2004) note "opportunities exist to promote morel crops while achieving fire control and timber production goals. However, our limited understanding of morel productivity, diversity, and ecology hinders such synergistic management." (Pilz and Molina 2002, 9) also note that opportunities to increase the size, regularity, or frequency of morel crops might be enhanced if managers better understood how each morel species responded to various disturbances.

(Pilz and Molina 2002, 14) note "although edible mushrooms seem to be a resilient resource as long as they have appropriate habitat, the limits to their sustainable use remain unknown. Research and monitoring are fundamental to determining those limits and improving resource management guidelines."

Key informants gave seemingly contradictory observations about the conditions that influence morel fruiting in Alaska. Knowledge of the habitat, burn and other fruiting requirements of morels in Alaska would facilitate business plan development and allow businesses to better evaluate the feasibility of remote morel scouting by helicopter and bush plane as is done in other areas such as the Yukon.

A survey of community interests, business opportunities and social issues specific to Alaska would help to better inform managers about morel harvests in Alaska. The biological, social and economic aspects of the morel industry should be further investigated to provide a complete report of morels in Alaska.

Conclusions

The morel mushroom industry in Alaska is extremely small at this time. Morels are harvested for personal and commercial use. A limited number of businesses in Alaska currently sell Alaska harvested morels. Restaurants in the state use fresh morels seasonally. Dried morels from out-of-state companies can be found in various grocery stores. Permits are rarely issued by state or federal land managers for morel harvesting.

Alaska appears to be best suited for a dried morel industry and a limited fresh morel market near cities and in local communities where there is a demand in local restaurants. Dried morels from Alaska could be marketed creatively and developed as a small cottage industry that capitalizes on the existing unique opportunities in Alaska such as wild food production, tourism and organic and Alaska Native product marketing.

Given the inconsistency of morel production, businesses need to splice various compatible activities to form a viable business that can weather seasons with little or no morel crops. Businesses should start small and test markets and gradually gain experience in the wild mushroom industry. Informants stated that the most prominent reasons there are not more businesses involved in an Alaska morel industry is: the high capital investment for buyers, delayed return on the investment, need for direct product marketing and creative marketing skills and an inconsistent supply of morels.

The current level of commercial morel harvests and industry activity do not appear to warrant the implementation of additional regulation or permitting. Managers should, however, plan and be

prepared for times of high morel production, such as was experienced after the 1990 Tok fire. Being prepared will facilitate the management of the resource and people in times of high demand.

Additional research would help inform resource management and policy by providing basic biological, social and economic information that is currently lacking for morels in general and particularly in Alaska. Priority areas for research include, but are not limited to, the research and monitoring of basic morel ecology, market potential and productivity, fire regime and disturbance relationships, harvest sustainability and the ethnography of the morel industry in Alaska.

Bibliography

1. Arora, D. 1986. Mushrooms demystified: A comprehensive guide to the fleshy fungi. Ten-Speed Press, Berkeley, CA. 959 pp.
2. Blatner, Keith A. and Susan Alexander. 1998. Recent Price Trends for Non-timber Forest Products in the Pacific Northwest. *Forest Products Journal*. 48:10: 28-33.
3. Buscot, F. and I. Kottke. 1990. The association between living roots and ascocarps of Morchella rotunda Boudier with roots of Picea abies (L.) Karst. New Phytologist 116: 425-430.
4. Dahlberg, A. 2002. Effects of fire on ectomycorrhizal fungi in Fennoscandian boreal forests. Silva Fennica 36(1):69-80.
5. Dahlstrom, J.L., J.E. Smith, and N.S. Weber. 2000. Mycorrhiza-like interaction by Morchella with species of the Pinaceae in pure culture. Mycorrhiza. 9:272-279.
6. Duchesne, L.C. and M.G. Weber. 1993. High incidence of the edible morel Morchella conica in a Jack pine, Pinus banksiana, forest following prescribed burning. Canadian Field-Naturalist. 107:114-116.
7. Harbin, M. and T.J. Volk. 1999. The relationship of Morchella with plant roots. Abstracts XVI International Botanical Congress, St. Louis, MS. USA, p 559.
8. Hervey, A., G. Bistis, and I. Leong. 1978. Cultural studies of single ascospore isolates of Morchella esculenta. Mycologia. 70:1269-1274.
9. Hobbie, E. A. N.S. Weber, and J.M. Trappe. 2001. Determining mycorrhizal or saprotrophic status of fungi from isotopic evidence: implications for element cycling and fungal evolution. New Phytologist:150:601-610.
10. Jones, Eric, Rebecca McLain and James Weigand, eds. 2002. *Nontimber Forest Products in the United States*. Lawrence: University Press of Kansas.
11. Jones, Anore. 1983. *Nauriat Niginaqtuat: Plants That We Eat*. Written pursuant to Indian Health Service Contract Number 243-79-0220.
12. Kasischke, E.S., T.S. Rupp, and D.L. Verbyla. (in press.) Fire trends in the Alaskan boreal forest region. In: Chapin, F.S.III, M. Oswood, K. Van Cleve, L. Viereck, and D.L. Verbyla. Alaska's changing boreal forest. Oxford University Press.
13. Kenney, Nedd. 1996. *An Overview of the Yukon Morel Mushroom Industry*. Prepared for Government of Yukon Department of Economic Development, Department of Renewable Resources.
14. Miles, P.G. and S. Chang. 1997. Mushroom biology: concise basics and current developments. River Edge, New Jersey, World Scientific. 194 p.
15. Molina, R., T. O'Dell, D. Luoma, M. Amaranthus, M. Castellano, and K. Russell. 1993. *Biology, Ecology, and Social Aspects of Wild Edible Mushrooms in the Forests of the Pacific Northwest: A Preface to Managing for Commercial Harvest*. General Technical Report PNW-GTR-309. United States Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland Oregon.
16. Moser, M. 1949. Über das Massenauftreten von Formen der Gattung Morchella auf Waldbrandflächen. Syndowia, Annales Mycologici ser. II, 3: 174-195.
17. O'Donnell, K., N.S. Weber, S. Rehner, and G. Mills. 2003. Phylogeny and biogeography of Morchella. The 22nd Fungal Genetics Conference. March 2003. Asilomar. Fungal Genetics Newsletter 50 (Supl.), Abstract #443.

18. Obst, Joachim. and Walter. Brown. 2000. *Feasibility of a morel mushroom harvest in the Northwest Territories*. Arctic Ecology and Development (AED) Consulting, and Deton'cho Corporation.
19. Ower, R.D. 1982. Notes on the development of the morel ascocarp: Morchella esculenta. Mycologia: 74(1):142-144.
20. Ower, R.D., G.L. Mills, J.A. Malalchowski, inventors; Neogen Corporation., assignee. June 17, 1986. "Cultivation of Morchella." U.S. patent: 4,594,809.
21. Parks, Cathrine G., Craig L. Schmitt. 1997. *Wild Edible Mushrooms in the Blue Mountains: Resource and Issues.* General Technical Report PNW-GTR-393. United States Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland Oregon. 22 pp.
22. Pilz, D., N.S. Weber, M.C. Carter, and C.G. Parks. 2004. Morel mushroom productivity, ecology, diversity and genetics in burned and insect-killed forests of northeastern Oregon. *Forest Ecology and Management*. 198(2004):367-386.
23. Pilz, David. and Randy Molina. 2002. Commercial harvest of edible mushrooms from the forests of the Pacific Northwest United States: issues, management, and monitoring for sustainability. *Forest Ecology and Management* 155:3-16.
24. Pilz, David. and Randy Molina, eds. 1996. *Managing Forest Ecosystems to Conserve Fungus Diversity and Sustain Wild Mushroom Harvests*. General Technical Report PNW-GTR-371. United States Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland Oregon. 104 pp.
25. Saskatchewan Environmental Society. No Date. *SES Fact Sheet, Non-Timber Forest Products: Economic Development While Sustaining Our Northern Forests*. Available from World Wide Web: (http://www.environmentalsociety.ca/)
26. Schisler, X. and K.F. Baker. 1974. In: Biological control of plant pathogens. Ed: Baker, K.F. and J.R. Cook. W. H. Freeman. San Francisco, 433 p.
27. Schlosser William E. and Keith A. Blatner. (1995). The Wild Edible Mushroom Industry of Washington, Oregon and Idaho: A 1992 Survey. *Journal of Forestry*. 93:3 31-36.
28. Schmidt, E.L. 1983. Spore germination of and carbohydrate colonization by Morchella esculenta at different soil temperatures. Mycologia. 75(5):870-875.
29. Schnepf, Chris C. No Date. *Special Forest Products. Alternative Agricultural Enterprises: Production, Management and Marketing publication Series*. University of Idaho, College of Agriculture, Cooperative Extensions System and Agriculture Experiment Station. Available from World Wide Web: (http://info.ag.uidaho.edu/pdf/CIS/CIS0952.pdf)
30. Volk, T.J. 1991. Understanding the morel life cycle: Key to cultivation. McIlvainea 10(1):76-81.
31. Volk, T.J. and T. J. Leonard. 1989. Physiological and environmental studies of sclerotium formation and maturation in isolates of Morchella crassipes. Applied and Environmental Microbiology. 55(12):30905-3100.
32. Weber, N.S. 1995. A morel hunter's companion: A guide to the true and false morels. Thunder Bay Press, Holt, Michigan. 209 p.
33. Wills, Russel M. 2002a. *An Economic Strategy to Develop Non-Timber Forest Products and Services in British Columbia (1).* Available from World Wide Web: MushWorld, Mushroom Information Center: (http://www.mushworld.com/common/)

34. Wills, Russel M. 2002b. *An Economic Strategy to Develop Non-Timber Forest Products and Services in British Columbia (3).* Available from World Wide Web: MushWorld, Mushroom Information Center: (http://www.mushworld.com/common/)