White paper on strategies to reduce risks and expand appreciation of foraged wild mushrooms

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Abstract

Poisonings by mushrooms in the Pacific Northwest (USA) and British Columbia (Canada) will likely increase because of rising interest in foraging for wild food. Among these, serious poisonings may also increase because the non-native death cap mushroom *Amanita phalloides* is spreading in our cities, parks and orchards. To draft recommendations to address these problems, mycologists, medical professionals and research staff met at the University of British Columbia on May 27 and 28, 2017. In this paper, we outline goals for the development and dissemination of information on edible and poisonous mushrooms for healthcare professionals and the general public. To improve on the miniscule 5% of mushrooms identified following calls to poison centers, clear procedures for front-line workers should be developed and implemented so that samples of ingested and potentially poisonous mushrooms are routinely and rapidly conveyed to mycological experts for identification. Through collaboration with mushroom clubs, we recommend expanding training in identification. In consultation with regional governments, voluntary certification programs to help consumers recognize high quality in retailed foraged mushrooms should be developed. We offer a list of regional mushroom species generally regarded as edible for harvesting and consumption. We acknowledge that our recommendations range from readily feasible to difficult but the time has come for an explicit wish list. The recent death of a small child in BC and serious illness in 14 people in California from eating death cap mushrooms lends new urgency to developing strategies to reduce risks from poisonous species.

Key words: center for disease control, death cap mushrooms, edible species list, government regulation, harm reduction, identification, poisoning, public education

Introduction

Many wild edible mushrooms are delicious and also valuable to our regional economies. We are all descendants of foragers. Some peoples, including some indigenous peoples in northwestern North America (Spak & Hazelbower, 2014) and in Mexico (Ruán-Soto et al., 2006; Santiago et al., 2016), have long and deep traditions of foraging for edible mushrooms. Across much of North America, however, foraging more or less disappeared as immigrants adapted to supermarket shopping. Its rediscovery began as export markets for Pacific Northwest (PNW) and BC wild mushrooms expanded in the 1970's and 1980's (F.B.M. Consulting Ent., 1989). In more recent years, the tastes and textures of foraged wild mushrooms have become deeply appreciated by North Americans (Arora, 2008; Ehlers & Hobby, 2010; Gamiet et al., 1998). As the number of mushroom hunters is increasing, we as a society should be equipped to minimize or handle associated risks.

Last fall, a three-year-old in British Columbia who had eaten death cap mushrooms (*Amanita phalloides*) died in spite of heroic efforts to save him (Smart, 2016). In California, 14 people were poisoned by death caps in 10 separate incidents and although all survived, three needed liver transplants and one, an 18-month-old baby suffered permanent neurological damage (Vo et al., 2017). These tragedies highlight the potential risks associated with consumption of wild mushrooms.

Our goals are to support the appreciation of wild mushrooms in northwestern North America while contributing to strategies for scientific data collection and dissemination, public education and consumer protection that will minimize the risks of poisoning. We specifically consider approaches to reduce the chances of further poisonings from the invasive introduced species *Amanita phalloides* (Wolfe et al., 2010).

Recommendations to reduce risks of poisoning:

- Strengthen communication among healthcare providers, poison control centers and expert mushroom identifiers to improve the likelihood of correct identification of suspect fungi that had been eaten. Develop and promulgate standardized procedures for collecting specimens, conveying them to identifiers, and recording and curating the final identifications.
- Publicize data from mushroom exposure records to raise awareness among healthcare providers and veterinarians about the circumstances and the range of symptoms related to mushroom poisoning.
- Research on toxins is still needed for dangerous but understudied taxa like *Gyromitra* spp., *Galerina* spp. and *Amanita smithiana.* It remains unclear whether mushroom toxin levels are species or strain specific, or variable depending on environment.
- *Amanita phalloides* is an emerging threat to human health. Find ways to minimize harm from this and other poisonous species. Poisoning from wild mushrooms is as much an emerging issue in cities as in forests and we have an opportunity to reduce risk of serious harm to casual toddler and pet grazers as well as to adult foragers.
- Expand public education initiatives, bearing in mind the need to reach diverse communities in our multicultural societies.

Less than 1% of calls to poison control centers in North America involve mushrooms. Of the 83,140 cases of actual or suspected ingestion of mushrooms reported to poison control centers in the USA from 2001-2012, 77.6% involved children (Hatten et al., 2012). Of the calls, minor symptoms were reported in 10,953 cases; moderate symptoms in 7805 and major symptoms in 568. Death resulted in 45 cases. No symptoms were reported in 76.7% or 63,770 cases (Hatten et al., 2012). Most cases of mushroom ingestion where, for example, a child had only nibbled a small piece did not result in any poisoning symptoms. However, even in the absence of symptoms, possible ingestion of an unidentified mushroom can lead to much anxiety for parents (and sometimes the patient) and may result in a hospital visit.

When mushroom poisoning does occur, it can be difficult to manage. Hospitals do not have staff mycologists. Healthcare personnel have limited ability to identify mushroom species and must rely on recognition of clinical syndromes to guide management. Because it is uncommon, the diagnosis of mushroom poisoning may be delayed or missed, sometimes with disastrous consequences. Treatment of mushroom ingestion is largely symptomatic and the mushroom species involved is only identified ~5% of the time, or only 10.4% of the time where a serious effect or death resulted (Hatten et al., 2012). Reliable antidotes are lacking for the most serious types of mushroom poisonings.

Fig. 1. Identification of these poisonous west coast mushrooms can help save the life of someone who ate one. A) death cap, *Amanita phalloides* Mushroom Observer 211761 UBC F32774, B) deadly parasol *Lepiota subincarnata* UBC F29841, C) *Galerina marginata*, D) *Cortinarius rubellus*, E) Smith's amanita *Amanita smithiana* PK7613, F) false morel or brain mushroom, *Gyromitra esculenta* Mushroom Observer 195828 UBC F31398. Photos A, B, F by A. Ceska; E by L. Le Renard; C, D by M. Beug.

Improving rates of identification of mushrooms requires coordination between healthcare professionals and mycologists.

Identification of a mushroom becomes relevant in cases of serious poisonings caused by toxins with delayed actions. The identification can confirm a diagnosis and it can help in predicting the course of the illness and in preparation for later phases of treatment. Intensive care, antidotes, and a liver transplant may be necessary to save victims of *A. phalloides* or of *Lepiota* or *Galerina* species (Figs 1A-C) that contain toxic cyclic peptides (Leikin & Paloucek, 2008). Tragedies in recent years highlight the need for doctors to access the best available treatment protocol where poisoning by cyclic peptides is involved (Beug, 2016a). The toxin orellanine from some *Cortinarius rubellus* (Fig. 1D) can cause kidney failure two days to three weeks after ingestion (Berger & Guss, 2005). As yet uncharacterized toxins from *Amanita smithiana* (Fig 1E) may cause kidney failure 2-5 days after eating the mushrooms (Warden & Benjamin, 1998). Liver, kidney, and neurological toxicity may follow 1-2 days after ingestion of *Gyromitra esculenta* (Fig. 1F) that contain gyromitrin (Michelot & Toth, 1991).

In less severe poisonings, identification is still useful even if it does not change the course of clinical treatment because it can improve our understanding of the edibility or toxicity of species, and our ability to predict and prevent poisonings. In Switzerland, ~49% of mushrooms responsible for poisonings from 1995-2009 were identified, according to the Swiss Toxicological Information Centre database (Schenk-Jaeger et al., 2012). Schenk-Jaeger et al. (2012) pointed out that careful identifications exposed *Caloboletus radicans* for the first time as a poisonous species. In the past, *C. radicans* was likely mistaken for the edible *Boletus edulis* and poisoning was perhaps blamed incorrectly on individual intolerance or on improper food handling. With better lines of communication between healthcare professionals and mycologists, it should be possible to identify a higher proportion of the mushrooms responsible for poisonings in North America as well. Poison control centers and the North American Mycological Association (NAMA) maintain lists of experienced mycological identifiers from across the USA and Canada. Included on the lists are members of mushroom clubs, governmental organizations and universities. If a life is potentially at risk, mycologists will drop all else to try to identify a specimen and to revisit the location where a suspicious mushroom had been collected.

While some mushroom species can be recognized from good quality photographs, for positive identification a mycologist needs a physical sample. If the 'sample' consists of the remains of cooked food, stomach contents, or feces, it is often only possible to identify the mushroom by molecular approaches involving PCR or DNA sequencing (Epis et al., 2010; Kowalczyk et al., 2015). The necessary specialized equipment would likely be available to identifiers who work in research laboratories, but it can take days to identify mushrooms by their DNA. If the sample is a fresh mushroom, it will probably be collected, packaged and transported by a non-expert under less than ideal conditions. As far as we know, there have been no experimental studies of simple and effective ways for non-specialists to prepare decay-prone mushroom samples so that their microscopic and DNA characters remain intact and so that they can be preserved as voucher specimens. Undergraduate or graduate students could contribute to developing evidence-based protocols through independent research projects.

The mushrooms or samples related to exposures or poisonings should be preserved in public herbaria to document incidents and to substantiate identifications. After being accessioned into the electronic database of a herbarium, each geo-referenced specimen appears as a point on publicly-available species distribution maps (e.g., http://www.pnwherbaria.org/, Abarenkov et al., 2010; Klinkenberg, 2017). Accumulating data on species' geographical and seasonal distributions will help guide deployment of poisoning prevention efforts to areas of greatest need.

Raising awareness of symptoms and circumstances related to mushroom poisonings.
Much of the current information on edibility in mushroom field guides is based on scant data. This can be remedied in part by making metadata from poison control centers more widely available to the mycological community and health professionals. In the USA, human exposures to mushrooms are included in the American Association of Poison Control Centers National Poison Data System <http://www.aapcc.org/data-system>. Entering Canadian exposure data into a database, prioritizing symptomatic exposures but including non-symptomatic cases where possible, would provide another valuable source of data. For reasons related to privacy and confidentiality, poisoning records are not generally available to the public. However, the poison control centers are open to requests for release of specific information to advance public health goals. NAMA routinely reports on mushroom poisonings using published data or data filed directly by individuals (Beug, 2016b). NAMA reports are readily available but because they are not indexed in PubMed, they may not come to the attention of healthcare professionals. Case studies (eg., Leathem et al., 1997) and U.S. Centers for Disease Control and Prevention reports (eg., Vo et al., 2017) on mushroom poisoning are often coauthored by a mycologist who identified the specimen as well as the doctor in charge of treatment and they are often indexed in PubMed. Case studies usually focus on serious poisonings, which means that less serious poisonings escape the attention of mycologists and healthcare professionals. We recommend publicizing and analyzing the full range of possible exposures and poisonings to search for patterns that will help guide our efforts to minimize the incidence and impact of future poisonings.

Research on toxins is needed.
Even if a mushroom can be identified, more information on toxicology would be welcome for many species. New information on clinical effects from poorly known species can be slow to emerge in publications. The effects of eating some kinds of mushrooms can vary from person to person. For example, some people regularly eat *Gyromitra* species without becoming sick while others become ill (Leathem et al., 1997). Mushrooms can contain complex mixtures of toxins that are, in many cases, poorly characterized chemically. It is often unclear whether toxin types and concentrations vary by species, geography, handling, or cooking. Amatoxins are the most dangerous of the mushroom toxins. While amatoxin concentrations in some species are well established, concentrations in others are unknown. Toxin analysis of carefully identified voucher specimens will improve the accuracy of advice that field guides and mobile apps can offer to foragers and help clinicians better anticipate poisoning symptoms.

Amanita phalloides*: an introduced species and an emerging threat to public health.*
Amanita phalloides is a non-native species that is increasingly common in boulevards, parks, orchards, woodlands, and yards in California, the PNW, and BC. Its beautiful, large mushrooms look like the straw mushrooms (*Volvariella volvacea*) that are commonly eaten in parts of Asia, or like some other species of *Amanita* that are edible (Bunyard, 2015). Mistaking an *A.*

phalloides mushroom for an edible species can be deadly; half a cap of a death cap mushroom can be enough to kill a small child (Vo et al., 2017). *Amanita phalloides* is not easily eradicated as the fungus lives hidden as belowground mycelium and as ectomycorrhizas on host trees for most of the year. Not until rainfall (or lawn watering) in late summer to fall does it give rise to mushrooms. *Amanita phalloides* is selective in its hosts but preference seems to vary with geography (Wolfe & Pringle, 2012). In eastern North America, it commonly grows with pines and other conifers. In Europe and the PNW, it most often partners with plants in the oak family but has also been reported with other kinds of trees including pines (Wolfe & Pringle, 2012). Likely introduced into California on imported nursery stock of exotic tree species, *A. phalloides* then established itself as a common associate of native coastal live oak (*Quercus agrifolia)* in relatively undisturbed woodlands as well as in urban settings (Pringle et al., 2009). The first confirmed record of the death cap in western North America was a collection made in Monterey California in 1938. Data from subsequent collections suggested that it spread to other parts of coastal California, dispersing by spores at approximately 3 to 9 km per year (Pringle et al., 2009). In British Columbia, in Victoria and Vancouver, the fungus appeared more recently and is most often associated with non-native broad-leaved trees, including boulevard plantings of hornbeam (*Carpinus betulus*) (Berch et al., 2017). Berch et al. (2017) detected *A. phalloides* on BC's native Garry Oak (*Quercus garryana*) and we are concerned that, as in California, the fungus will now spread into some of BC's native forests.

Without 100% effective public education, poisonings by death caps are probably inevitable as long as these mushrooms are abundant in our neighbourhoods. Minimizing annual mushroom production, possibly by slowing the transfer of *A. phalloides* from tree to tree or to native tree species in BC and the PNW may save lives. Genetic data suggest that *A. phalloides* has a short life span as an underground mycelium and that the species must reproduce regularly by spores (Dickie et al., 2016). This raises the possibility that collecting and discarding mushrooms before spore release, or reducing watering to reduce mushroom production may slow the spread of *A. phalloides*. In consultation with local city and parks planners and arborists gradual replacement of known *A. phalloides* host trees with non-host species in boulevards and parks may contribute to a long-term management regime. It may be possible to suppress or partially suppress death cap mushroom production along boulevards and in parks using N-fertilization, a strategy known to reduce fruiting in many mushroom species (Hasselquist & Högberg, 2014).

Expand public education initiatives.

Experienced mycologists in mushroom clubs or associations, academic and governmental mycologists, poison control center staff, and public healthcare professionals have long been engaged in public education. Government agencies have been developing print and electronic advice on, for example, collecting mushrooms (BC Ministry of Forests and Range, 2010) and avoiding poisonous mushrooms (BC Centre for Disease Control, 2016). Clubs host fall mushroom shows featuring displays of edible versus poisonous mushrooms. Club members and academic mycologists teach about the roles of mushroom-forming fungi in decomposition and nutrient recycling, and in forming partnerships that provide nutrients to trees. They lead nature walks to observe mushrooms and may lead public forays to collect mushrooms. They offer advice on which mushrooms may be safe to eat.

However, we need to expand our public education efforts to respond to the new level of danger posed by *A. phalloides*. Approaches may include developing a publicly available web site to map areas where *A. phalloides* mushrooms have been sighted, taking advantage of crowd sourcing for data entry, with support from members of mycological clubs and poison control centers for data verification. Following the example of the Australian Capital Territory Health in Canberra, we can consider working with local governments to post warning signs at locations where these mushrooms are common (Dickie et al., 2016). As a society, we increasingly turn to our cell phones for information. In recognition of this, we are developing a free online mobile application to distinguish common edible from dangerous poisonous species of BC and PNW (draft <http://www.biodiversity.ubc.ca/mushroom/>). Acknowledging that we are increasingly multicultural, we can invite community volunteers to translate warnings about poisonous mushrooms into European and Asian languages. In preparation for our northwest coast fall mushroom season, we can offer television, newspaper or radio interviews in non-English media.

Recommendations to expand the appreciation of edible species:

- Provide a list of species generally considered edible to guide foragers, restaurants and farmers' market organizers. Listed species are enjoyed by many if appropriately handled and cooked (Table 1).
- Increase acceptance of the range of species considered edible through education of chefs, farmers' market organizers and the public.
- Develop a voluntary wild-harvested certification program that will provide consumers with quality assurance and with added information about species and sources of wild mushrooms.

Background

Although tragedy brings mushrooms into focus, out of perhaps 7000 mushroom species reported from North America (MyCoPortal, 2017), very few are dangerously poisonous. North America and Europe likely have similar ratios of edible to toxic species. However, in Europe, mushrooms are much better known and there is a much longer history of mycophagy. Italian author Bruno Cetto's multi-volume field guide (1970, 1976, 1979, 1983, 1987, 1989, 1993) discusses edibility of almost 3000 species but categorizes only 0.2% of them as deadly poisonous. About 3% are poisonous (including the deadly species), 29% are considered edible (with varied degrees of desirability), and about 60% are inedible for reasons such as texture, taste or size. Increasing numbers of people ranging from professional foragers and chefs to private individuals have been seeking the delicious species to sell or to cook and eat (see Table 1). When all goes well, foraging is an enjoyable form of recreation with a valuable, tasty and nutritious reward.

Fig. 2. Some of the ~13,000 kg of wild pine mushrooms harvested annually in BC each year arriving at the Vancouver International Airport for export to Asia.

The largely unregulated wild harvest of boletes (*Boletus edulis* and relatives), morels (*Morchella* spp.), matsutake (pine mushrooms, *Tricholoma murrillianum*) and chanterelles (*Cantharellus* spp.) (Fig. 2, Table 1) brings much needed income to rural economies (Arora, 2008; Ehlers & Hobby, 2010; Gamiet et al., 1998). Much of the foraged mushroom crop is sold for export with minimal official documentation. Given the informal nature of transactions, until and unless the countries importing mushrooms become concerned about their quality or wholesomeness, there is little incentive to regulate or inspect.

More regulation applies to mushrooms for the domestic market. In the USA, the federal Food, Drug, and Cosmetic Act serves 'To prohibit the movement in interstate commerce of adulterated and misbranded food, drugs, devices, and cosmetics...' Additional legislation is applied at the state or local levels (Nair, 2016). In Canada, sales of wild mushrooms are subject to general regulations about wholesome food. The Food and Drugs Act (Government of Canada, 2016) prohibits sales of food with any poisonous or harmful substance. In BC, provincial authorities (Government of British Columbia, 1999) regulate the premises selling the food, requiring that food is obtained from an approved source and is not unfit for consumption. Governmental programs such as FOODSAFE BC support proper food handling.

Improper food handling or preparation rather than misidentification has been implicated in almost all cases where illness from wild mushrooms was traced to commercial establishments such as restaurants. The USA Centers for Disease Control and Prevention and the BC Centre for Disease Control document cases of illness resulting from exposure to mushrooms. In 1987, five of 31 patrons at the Five Sails Restaurant at Vancouver's Pan Pacific Hotel required hospitalization after exposure to botulism through improperly canned chanterelle mushrooms (McLean et al., 1987). In 1991, 77 out of 483 guests at a Vancouver BC banquet for a retiring police chief became ill from morels that were served raw instead of cooked thoroughly as is necessary to make them edible (Kroeger, 1991). The relative rarity of such cases indicates that food handling regulations are, by and large, effective. Poisoning by unidentified or mis-identified foraged mushrooms usually takes place at home (Schenck-Jaeger et al. 2012), affecting private individuals or their pets (Beug et al. 2006).

Species generally considered edible.

To guide amateur and professional foragers and consumers, we provide a list of wild species in the PNW and British Columbia that are generally considered edible (Table 1). The listed species are widely harvested, eaten and exported, and they are enjoyed in many parts of the world. If in good condition and correctly identified, it is appropriate to sell these species in farmers' markets and to serve them in restaurants. Similar lists of mushrooms suitable for commercialization are used in other parts of the world. In some jurisdictions (for example, in Belgium and Sweden), lists are like ours in providing recommendations without legal standing while in others, lists are backed by legislation, for example, in Austria, Spain and Washington State (Peintner et al., 2013; Washington State Legislature, 2013).

As a caveat to any list, a few individuals will react adversely even to relatively reliable species (Table 1) and basic recommendations for safe consumption include cooking wild mushrooms thoroughly rather than eating them raw and sampling only a small amount for a first experience with any new mushroom. Even for experienced connoisseurs, eating a few mouthfuls rather than gorging on a plateful of morels will be less likely to lead to an unpleasant reaction (Saviuc et al., 2010). Wild mushrooms should be enjoyed in moderation.

Providing education on safe foraging seems logical based on evidence that education reduces harm from, for example, sex or alcohol (Kohler et al., 2008; McBride et al., 2004). Some USA states would regulate training for commercial foragers but they have had difficulty implementing a hands-on course (Bos, 2015; Kamila, 2012). Affordable training can be provided through an online, text and image-based course (Wright et al., 2017) and if such an approach proves effective, it could be more widely implemented. Some European countries train mushroom identifiers to support recreational foragers in their local communities. In France, for example, training in mushroom identification is part of the university curriculum for pharmacists (although it is perhaps with less rigorous now than in the past, Denys, 2014). Although not all French pharmacists are highly skilled identifiers, some are willing and able to go through their customers' foraged collections, distinguishing the edible from the poisonous (Denys, 2014). In Switzerland, foragers can bring their collections to a controller, who will similarly examine specimens, discarding any that are not edible. To be certified, a controller must undergo training and an examination offered by a national organization, the Schweizerische Vereinigung Amtlicher Pilzkontrollorgane (2017). It is difficult to assess the impact of training but, encouragingly, none of the mushrooms checked by Swiss controllers were responsible for hospitalizations, based on exposures recorded from 1995 to 2009 (Schenk-Jaeger et al., 2012).

Increase acceptance of edible species through education of chefs, farmers' market organizers and the public.

Mushroom identification courses, developed in collaboration with mushroom clubs, foragers and academic or governmental specialists would be popular with chefs and the foraging public. Classes for chefs and other professionals could be offered in conjunction with annual shows organized by mushroom clubs, using the fungi collected from the show to illustrate key characteristics of target species. Initially, grant funding would be needed to offset start-up costs, but afterwards, course fees would have to be high enough to cover expenses. The curriculum should include basic mushroom-related food safety as well as the skills necessary to distinguish among the most highly prized edibles and the most toxic species. This could lead to certification of professional competence with wild mushrooms as food.

Develop a voluntary wild-harvested certification program.

A system of certification of mushrooms harvested by trained foragers could be implemented, possibly similar to existing certification systems for organic food. To be meaningful, certification would require government and possibly regulatory backing. A potential increase in value might induce producers to offer documentation of the batch, scientific name, and geographical provenance of foraged mushrooms as well as adhering to standard safe food handling protocols. If accepted as a guarantee of quality, certification could drive not only improved consumer protection but also expanded market opportunities for producers.

Conclusion

Mushrooms are an essential part of our ecosystems and the benefits they offer greatly outweigh the risks they pose. Northwestern North Americans are taking pleasure in eating an expanding range of wild mushrooms while benefiting economically from sales of prized edibles. Associated with these trends however, the frequency of death and serious illness from poisonous mushrooms will increase unless prevented by deployment of our societal strengths. These strengths include members of mycological societies and associations, academic institutions and government departments, poison control centers and the medical community. Together, we have an opportunity to prevent tragedies while championing the benefits of enjoying mushroom diversity in northwestern North America.

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Table 1. Draft List of Wild Mushroom Species Generally Regarded as Edible from the Pacific Northwest and BC

Note:

- Some of these species have poisonous look-alikes. Learn the characters of the poisonous species to avoid mistaking them for an edible species.
- Cook wild mushrooms thoroughly before eating them.
- 'Generally regarded as edible' means widely eaten and edible for most people but not necessarily for you. Sample only a small amount of any species new to you to minimize any unpleasant reaction due to personal sensitivity.
- Even when no associated illnesses have been reported, this represents lack of data rather than a 100% safe mushroom. Most if not all mushroom species cause problems for some ~~few~~ people.
- Eat wild mushrooms in moderation. Large servings, several days in succession, are associated with unpleasant reactions from some 'edible' species such as morels.

A or B[1]	Genus[2]	Species	Common name	Reports of associated illness[3]	How widely harvested, eaten[4]
A	*Boletus*	*edulis*	king bolete, penny bun, porcini, steinpilz	Rare gastrointestinal upsets	Extensive harvest and use with a well-developed retail market.
A	*Boletus*	*rex-veris*	spring king bolete	Not reported but possible rare gastrointestinal upsets	Some regional use; recently described regional endemic had been misidentified as *Boletus edulis.*
A	*Cantharellus*	*cascadensis*	Cascade chanterelle	Not reported but possible rare gastrointestinal upsets	Some regional use; recently described regional endemic; usually misidentified as Pacific golden chanterelle.
A	*Cantharellus*	*formosus*	Pacific golden chanterelle	Rare gastrointestinal upsets	Extensive harvest and use with a well-developed retail market.
A	*Cantharellus*	*roseocanus*	rainbow chanterelle	Not reported but possible rare gastrointestinal upsets	Some regional use; recently described regional endemic; usually misidentified as Pacific golden chanterelle.
A	*Cantharellus*	*subalbidus*	white chanterelle	Rare gastrointestinal upsets	Some regional use; Western N. America regional endemic.
A	*Hydnum*	*repandum* (and others*)*	hedgehog mushroom	Not reported	Extensive harvest and use with a well-developed retail market.
A	*Hypomyces* (on *Russula*)	*lactifluorum*	lobster	Must be cooked. Rare gastrointestinal upsets.	Extensive harvest and use with a well-developed retail market
A	*Morchella*	*americana* (and others)	yellow morels	Must be cooked; even if cooked may be responsible for	Some harvest and use with a well-developed retail market. More than one species may

A or B[1]	Genus[2]	Species	Common name	Reports of associated illness[3]	How widely harvested, eaten[4]
				gastrointestinal upsets or central nervous system effects that usually resolve themselves within a day.	be sold under the same name.
A	*Morchella*	*snyderi* (and others)	black morels	Must be cooked; even if cooked may be responsible for gastrointestinal upsets or central nervous system effects that usually resolve themselves within a day	Extensive harvest and use with a well-developed retail market. More than one species is sold under the same name.
A	*Polyozellus*	*multiplex* group	blue chanterelle	Not reported	Uncommon in some regions (Kagan et al., 2016) so conservation needs of the species should be considered. Some harvest and use; some retail market.
A	*Sparassis*	*radicata*	cauliflower mushroom	Not reported	Some harvest and use with some retail market.
A	*Tricholoma*	*murrillianum* (previously misidentified as *T. magnivelare*) in our region.	western matsutake; western pine mushroom	Rare gastrointestinal upsets	Extensive harvest and use with a well-developed retail market; exports to Asia.
B	*Calvatia*	*booniana*	giant puffball	Rare gastrointestinal upsets	Commonly eaten; rarely retailed.
B	*Clitocybe*[5]	*praemagna*	lightning mushroom	Not reported	Considerable, First Nations. For wider commercialization, the characteristics that distinguish this species from the several poisonous *Clitocybe* species would need to be well understood.
B	*Lepista*	*nuda*	blewit	More difficult to identify than some of the other species. Rare gastrointestinal upsets	Considerable harvest and use with some retail market. May be imported rather than collected from the wild in our region.
B	*Coprinus*	*comatus*	shaggy mane	Rare gastrointestinal upsets	Commonly eaten; rarely retailed.
B	*Craterellus*	*calicornu-copioides* (until recently, identified as	horn of plenty; black chanterelle	Rare gastrointestinal upsets	Considerable retail market.

A or B[1]	Genus[2]	Species	Common name	Reports of associated illness[3]	How widely harvested, eaten[4]
		C. cornuco-pioides in our region.			
B	*Craterellus*	*tubaeformis*	winter chan-terelle; yellowlegs, yellowfoot	Rare gastrointestinal upsets	Some harvest and use; some retail market.
B	*Hericium*	*abietis* (and others)	bear's head fungus; conifer coral mushroom	Not reported	Some harvest and use; some retail market.
B	*Hericium*	*erinaceus* (and others)	lion's mane fungus	Not reported	Some harvest and use, sometimes cultivated; some retail market.
B	*Lycoperdon*	*perlatum*	common puffball	Rare gastrointestinal upsets	Commonly eaten; rarely retailed.
B	*Lyophyllum*	*decastes*	fried chicken mushroom	More difficult to identify than some of the other species	Considerable harvest and use with some retail market.
B	*Pleurotus*	*populinus* & *pulmonarius*	oyster mushroom		A cultivated species is extensively grown and sold. Some foraging but little marketing of wild specimens.

[1]A--Widely appreciated as edible species that appear at least sometimes in the retail market; B--some retail market, may require more experience for accurate identification.
[2]List of mushrooms from Berch and Cocksedge (2003) and from sequence analysis of UBC (2017) specimens (Berbee, unpublished).
[3]Reports of illness from Beug et al. (2006) or exposures to mushrooms from BC Centre for Disease Control (unpublished).
[4]If seven or more buyers bought and sold the species in BC (Berch & Cocksedge, 2003), that is evidence of extensive use with a well-developed retail market. Four or more buyers indicates a still considerable retail market for the species. Some species are recommended as 'edible' in mushroom guides but are not commonly sold on the retail market. Some species are closely related to common edible species so they are reasonably presumed to be edible, although testing has been limited. The more widely a mushroom species is eaten, the better the evidence that the species is generally safe and the more likely that rare but unpleasant side effects are characterized.
[5]*Clitocybe praemagna* consumption reported in Spak & Hazelbower (2014). Several *Clitocybe* species are poisonous. However, the lightning mushroom is biologically not a *Clitocybe* species and the scientific name applied to it will require updating based on new DNA sequence data (D. Arora, personal communication June 2017; S. Berch unpublished results).
[6]

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