Extension Note

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The chanterelle mushroom harvest on northern Vancouver Island, British Columbia: Factors relating to successful commercial development

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Abstract

This paper presents a synthesis of an original case study that investigated the social, economic, and ecological characteristics of the Pacific golden chanterelle (*Cantharellus formosus*) harvest in British Columbia, with an emphasis on northern Vancouver Island. It draws on the experience of wild mushroom harvesters and buyers, current forest mycological research, and global trade data. The wild mushroom resource contributes directly to rural economies and is part of the natural capital of the region. Wage expectations are generally low, but many people pick mushrooms for personal use and recreation, regardless of profit. Sustainability of chanterelle harvests is tied to forest management practices; the absence of any regulatory or policy framework for addressing the management requirements for chanterelles creates uncertainty about future supplies. Shorter timber harvest rotations are implicated in the loss of habitat and harvesting opportunities; however, there is reason to believe that timber and chanterelles can be managed compatibly, albeit with some tradeoffs. Available inventory information can be used to identify the best habitats that should be managed on longer rotations. Alternatively, compatible management strategies could include green-tree retention focussed on the best chanterelle habitat; commercial thinning that maintains a sufficient density of chanterelle host trees, and manipulating younger stands to enhance production at an earlier age. Global trade data indicate a slight decline in the value of the Canadian chanterelle harvest in recent years; however, the industry is relatively young and characterized by fluctuations in production and markets, and there is reason to be optimistic for the future of the industry on Vancouver Island.

KEYWORDS: *British Columbia;* Cantharellus formosus*; chanterelle; compatible management; non-timber forest products; Vancouver Island.*

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Editor's Note:

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

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Introduction[1]

Over 70 species of chanterelles (*Cantharellus* spp.) have been described worldwide, with many different national and regional common names attesting to their global popularity (Pilz et al. 2003). Chanterelles are particularly prized for their culinary value in Europe and North America. Their elegant stature, delicate flavour, and fruity aroma make them one of the most popular wild edible mushrooms (Arora 1990). They are also nutritious: chanterelles are about 10% protein by weight (Danell and Eaker 1998, in Pilz et al. 2003), high in vitamin A, and one of the highest natural dietary sources of vitamin D (Matilla et al. 1994 in Pilz et al. 2003).

While there has been some success with artificial cultivation of chanterelle mushrooms (Danell and Camacho 1997), the practice is not thought to be profitable, given the high cost of producing mushrooms using current methods combined with the relatively low market value of chanterelles compared to other wild mushrooms. World supplies, therefore, are currently limited to wild harvests.

Of the three recognized species of chanterelle mushrooms in British Columbia, the Pacific golden chanterelle (*Cantharellus formosus*) is the primary commercial species (*C. subalbidus* and *C. cibarius* var. *roseocanus* are the other two species; Berch and Cocksedge 2003).[2] It occurs in western coastal North America, from northern California to northern British Columbia (Redhead et al. 1997). The major commercial harvesting regions in British Columbia are Vancouver Island, on Haida Gwaii (formerly the Queen Charlotte Islands), the southern Coast Mountains (especially around Powell River, the Sunshine Coast, Chilliwack, Hope, and Pemberton), and the northwest coast (Prince Rupert area) (de Geus 1995; Wills and Lipsey 1999). In the United States, commercial production is focussed on coastal areas of Washington and Oregon (Love et al. 1998).

This case study investigated the social, economic, and ecological characteristics of the chanterelle harvest on northern Vancouver Island, British Columbia.

European settlers were likely the first people to harvest chanterelles actively in coastal areas of British Columbia. There is little evidence that coastal Native peoples used chanterelles, or any mushrooms in pre-contact times (Kuhnlein and Turner 1991). Commercial harvesting did not become established until relatively recently in the late1970s, becoming more wide-scale through the 1980s (Love et al. 1998; Betty Shore, pers. comm., 2001). Since then, the industry has matured, yet there are still no professional associations representing the interests of participants and no formal provincial management strategy to ensure its sustainability.

The purpose of this extension note is to present a synthesis of an original case study that investigated the social, economic, and ecological characteristics of the chanterelle harvest on northern Vancouver Island, British Columbia. The objective of the case study was to gather information in a format that can be adapted to a comparative case study methodology developed by the Centre for International Forestry Research to identify the factors that are most critical to successful commercialization of non-timber forest products (NTFPs) (Mitchell and Hobby 2010, see page 27 in this issue).

Here, we examine the factors involved in the production-to-consumption system for chanterelles as it relates to sustainable forest management and as it contributes to the economic capacity of rural, resource-dependent communities. We profile the harvesters and present economic data for valuing the harvest from individual to global scales, and we discuss the ecology of the species and the role of forest management in sustaining wild harvests.

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

[2] British Columbia NTFP Mushrooms website: *http://bcmushrooms.forrex.org/ntfp/index.html*

Chanterelle study details

The broad area considered within this case study is Vancouver Island, with a particular focus on the Nimpkish Valley situated on northern Vancouver Island, around the communities of Woss and Port McNeill (Figure 1). Most lands in the study area are publicly owned Crown land with timber rights allocated to forest companies in the form of tree farm licences. The study area also includes portions of the traditional territories of the 'Namgis, Kwakiutl, and Quatsino First Nations.

Information collected for this study draws largely from past and ongoing research on chanterelle ecology, productivity, and management in the Nimpkish Valley. The North Island Non-timber Forest Product Demonstration Project produced an inventory of NTFP plant and fungal species and baseline information to characterize and map chanterelle habitat.[3] Subsequent work focussed on more detailed chanterelle habitat modelling and monitoring annual productivity.[4] In 2006, as part of the CIFOR comparative NTFP case study methodology, a survey was designed by the Centre for Non-Timber Resources (CNTR), Royal Roads University (Mitchell and Hobby 2010) to gather data on the socio-economic aspects of the chanterelle harvest. Surveys were administered through informal interviews with 15 mushroom harvesters and 2 buyers contacted in the northern Vancouver Island region, near the community of Woss, in the fall of 2006. There was very little harvesting or buying activity that year because of an exceptionally poor mushroom crop, which limited the number of participants in the survey. A mushroom buyer in Woss assisted in survey data collection by interviewing people she knew had picked in the past when there were more mushrooms. As such, the survey is non-random and biased toward the contacts of a single buyer and community. Though useful in developing the case study, the survey was not rigorous enough to represent the larger chanterelle harvesting and buying community that may exist on the North Island in a good mushroom year. Supplemental information was gathered from experienced chanterelle harvesters and buyers outside the study area, including the primary author's personal observations. Secondary research was also used as input for developing the case study database descriptor variables.

Biology and ecology of the Pacific golden chanterelle

Pacific golden chanterelle is an ectomycorrhizal fungus, associated with western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), and shore pine (*Pinus contorta* Dougl. ex. Loud. var. *contorta*) (Redhead et al. 1997). Mushrooms

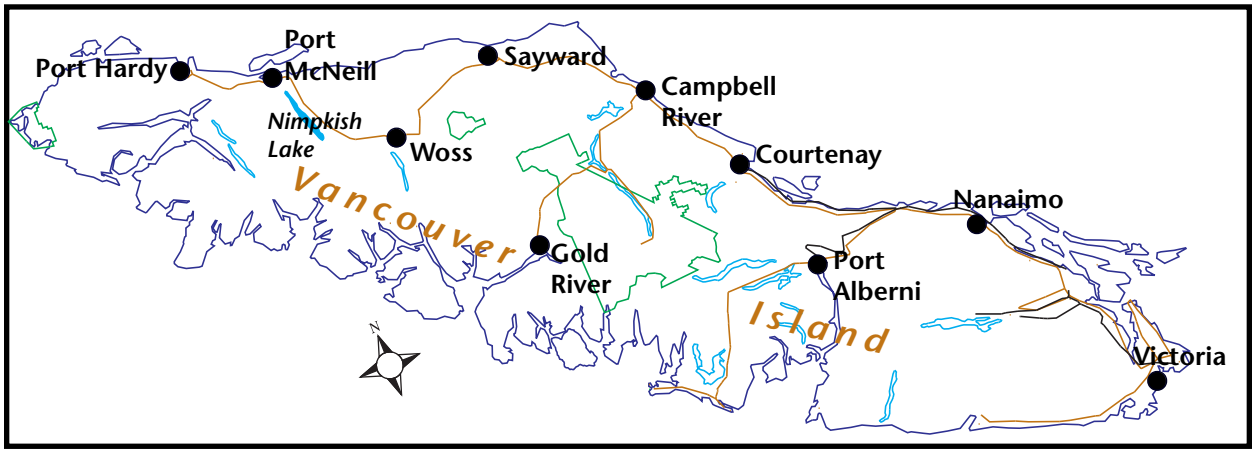

FIGURE 1. Chanterelle case study area on Vancouver Island.

[3] Mitchell Consulting Associates 2002. Integrated Demonstration Project for Non-Timber Forest Products, Northern Vancouver Island. Forest Renewal BC (Ref. number: PAR0211-03. Appendix A. NTFP plant and fungal species inventory.

[4] T. Ehlers. 2007. Chanterelle mushroom habitat modelling and inventory. British Columbia Forest Investment Account, Forest Science Program, Project no. Y082163. Unpublished report. *http://www.for.gov.bc.ca/hfd/library/FIA/2007/FSP_Y071163.pdf*

are the fruiting bodies (or sporocarps) of the main organism, which resides in the upper horizon of the soil matrix. As long as the mycelium is not damaged, it continues to produce mushrooms under suitable environmental conditions.

Fruiting bodies often appear alone or in scattered patches on the forest floor from mid-summer through fall (July–December). They are variable in size, but robust specimens (up to 14 cm) are not uncommon. The vase-shaped caps (Mckenny and Stuntz 1987) range in colour from dull orange yellow to brown orange (Pilz et al. 2003). The gills are blunt, deeply ridged, forked, and decurrent (run down the stem). They are pale orange-yellow and often with a pink cast (Figure 2). The pale flesh is firm and compact and often has a fruity, apricot-like aroma. The stalk is stout and often contorted. The spore print is yellowish white (Pilz et al. 2003).[5]

Compared to other forest mushrooms, chanterelles grow relatively slowly and are fairly rot-resistant. Growth rates of 2–5 cm per month, and duration of fruiting bodies of more than 90 days, with spore dispersal occurring from 1–2 months have been reported (Largent and Sime 1995; Norvell 1995, in Pilz et al. 2003). Chanterelles are resistant to predation by insects and other animals (de Geus et al. [editors] 1992).

FIGURE 2. Pacific golden chanterelle.

Stand, vegetation and site characteristics

On northern Vancouver Island, Pacific golden chanterelle occurs across a wide range of age classes but production is highest in stands dominated by 40–80 year-old Douglas-fir and western hemlock. Commercial harvesters primarily focus their activities in these maturing second growth stands. Canopy crown closure averages between 70–80%. Understorey vegetation is generally sparse and moss-dominated, though swordfern (*Polystichum munitum*), deerfern (*Blechnum spicant*), salal (*Gaultheria shallon*), and red huckleberry (*Vaccinium parvifolium*) are relatively abundant on some sites. These species (especially salal) are also commercially harvested NTFPs in the region, sometimes from the same sites that produce chanterelles.

Soils are typically well-drained, coarse-textured and nutrient-medium arising from glacio-fluvial or morainal landforms. In northern California, chanterelles have been found to fruit in nitrogen-poor soils (low exchangeable acidity, pH 4.0–5.5), moderate duff depth and in areas with bare humus and needle cover of less than 30% (Bergemann and Largent 2000).

Ecosystem classification[6]

The Coastal Western Hemlock (CWH) biogeoclimatic zone is the predominant biogeoclimatic ecosystem classification (BEC) zone in the study area where the majority of timber and NTFP harvesting activity takes place. Within the CWH, chanterelle production is concentrated in four BEC subzones/variants as described by Green and Klinka (1994): CWHxm (very dry maritime), CWHmm1 (submontane moist maritime), CWHvm1 (submontane very wet maritime), and CWHvm2 (montane very wet maritime). The CWHxm exists in the valley bottom and on lower slopes of the Nimpkish Valley. It has a relatively dry, warm climate, long growing seasons, and moist mild winters with relatively little snowfall. Dominant tree species on zonal (typical) sites are Douglas-fir, western hemlock, and to a lesser extent, western redcedar (*Thuja plicata*). The CWHmm1 exists above and adjacent to the CWHxm. Douglas-fir is a major tree species in this zone. The CWHvm is divided into two variants, the CWHvm1, and above this in terms of elevation, the CWHvm2. The CWHvm1 experiences greater amounts of precipitation than the CWHxm leading

[5] Common names: Pacific golden chanterelle, chanterelle, common chanterelle, egg mushroom, golden chanterelle, north west golden chanterelle, western chanterelle, yellow chanterelle.

[6] See Mitchell and Hobby (2010, page 27 in this issue) for a description of the biogeoclimatic ecosystem classification system (BEC).

to a wetter, more humid climate. Summers are cool and winters are mild. Dominant tree species on zonal sites are western hemlock and amabilis fir (*Abies amabilis*), with lesser amounts of western redcedar. The CWHvm2 is colder and wetter than the CWHvm1. Yellow cedar (*Chamaecyparis nootkatensis*) and mountain hemlock (*Tsuga mertensiana*) can grow on zonal sites.

Natural productivity of chanterelles

Baseline information on the distribution and abundance of mushrooms is needed for economic valuations and monitoring efforts to incorporate wild mushroom production into sustainable forest management plans. Chanterelle fruiting is influenced by a number of factors, including host tree vigour (since the host tree provides food to the fungus), annual weather patterns, and environmental conditions of the forest floor during the fruiting season. Productivity can be highly variable from year to year and therefore must be measured over several years to obtain reliable estimates.

Within a generally productive area, chanterelles appear singly or in clusters (patches) unevenly distributed throughout a stand. Harvesters intimate with their areas will target sites in a systematic manner, with the greatest concentration of patches. Since it may be impractical to map the distribution of individual patches across a large area, unbiased estimates of productivity related to ecosystem types that can be modelled at landscape levels are most useful to land managers concerned with sustaining chanterelle production.

On northern Vancouver Island, chanterelle productivity (fresh weight, commercial grade only) averaged about 5 kg/ha across three ecologically similar sites over four years (Ehlers 2009, unpublished data). This is consistent with findings elsewhere: in the Skidegate Lake area on the Queen Charlotte Islands productivity ranged from 3.4 to 7.49 kg/ha (Peterson et al. 2000), and in the U.S. Pacific Northwest it ranged from 2 to 20 kg/ha, averaging 5 kg/ha (Liegel 1998, as cited in Pilz and Molina 2001). These values are for fresh weight and moisture content can vary considerably between collections.

The chanterelle harvest

The chanterelle season on northern Vancouver Island runs approximately from late July to December but varies considerably from year to year. As with all wild mushrooms, the distribution, abundance, and timing of harvests can fluctuate widely. Under optimal weather conditions, commercial harvests can begin in July, with successive flushes every 2–3 weeks until cold weather precludes further fruiting. In 2006, the year that survey data were collected for this case study, an unusually hot and dry summer and early fall resulted in no significant commercial quantities of mushrooms being produced until mid- to late October. Consequently, there was very little harvesting activity and only one buyer in the town of Port McNeill, B.C., was open intermittently for about 4 weeks. By the time production peaked in late October, most commercial harvesters were discouraged by the short harvest window and lack of available buyers that year. High variability of wild mushroom crops from year to year creates a "boom and bust" situation that is one of the major challenges to commercial development of the wild mushroom industry.

Harvester profile

Mushroom harvesters (pickers) can be broadly categorized as transient or local. Within the transient group are the "circuit pickers," who follow the annual fruiting patterns of various commercial mushroom species, perhaps beginning their season with the spring morel (*Morchella* spp.) harvest as it progresses from south to north, then targeting the fall fruiters such as boletes (*Boletus* spp.), chanterelles, and pine mushrooms (*Tricholoma magnivelare*), following the fruiting season from north to south. Circuit pickers consider mushroom picking to be a lifestyle, and it is their primary source of income. Another group of transients is the "destination pickers" who are primarily motivated by the recreational rewards of the hunt. For this group, mushroom harvesting provides an excuse to be in nature and might only be one of many activities in which they participate when visiting the area. Many gather only what they need for personal consumption and do not sell their mushrooms. The majority of pickers on northern Vancouver Island are local, from traditionally forest resource-dependent communities. They live close to mushroom-producing forests and can pick whenever opportunity presents. They are motivated by income, recreation, and subsistence.

Survey respondents said they actively harvest from 2–8 hours/day over 2–20 weeks, depending on the season. Experienced harvesters consistently bring only the best quality and most valuable fresh market mushrooms to the buyer.[7] Inferior quality chanterelles are only incorporated into the harvest when there is a shortage of high quality mushrooms.

[7] Harvesters who establish relationships with buyers may receive incentives in the form of a bonus, perhaps 10% above the advertised price.

Harvester income

Average picker wages are difficult to determine since seasonal mushroom abundance and daily prices are highly variable. Prices are usually higher to start, and drop as global chanterelle supplies increase. Prices paid to pickers for fresh chanterelles range from CAD$2.20/kg to $16.50/kg. The wild mushroom economy still works in pounds, with prices averaging CAD$2.25/lb. Commercial pickers we interviewed claimed to harvest an average of 4.6–27.3 kg/day. Based on the average price of $2.25/lb ($4.95/kg), expected daily incomes range from $22.50 to $135.00/day, though at the high end some pickers claim they can pick 45 kg/day and at the highest price this would earn them $750. Such variability in harvest volumes and prices paid is typical of the wild mushroom industry in general.

Non-timber forest products are largely seasonal with low wage expectations, particularly when compared to the timber, mining, and fishing industries. There can be high volatility in the market due to fluctuating demand and uncertainty in supply. Prices paid to the picker are subject to change daily and wages are never guaranteed. The number of field buying stations available for pickers to sell their mushrooms is also limiting. All of these factors present a disincentive to those who might have the skill or the inclination to pursue NTFPs commercially. Consequently, there are relatively few mushroom pickers, and even when and where wild mushroom resources are plentiful as they can be on Vancouver Island, their value goes unrealized. There is also currently no organizational structure or association supporting the interests of chanterelle harvesters, although there are recognized benefits to organization, including:

- combining harvests and increasing total volumes to bargain for better prices with buyers;
- sharing transportation costs to increase individual harvester profit, reduce pollution, and export mushrooms to a wider range of markets; and
- increasing product awareness and marketing to domestic buyers.

Although NTFPs currently do not generate employment and revenues equivalent to timber and fish resources, they provide additional income opportunities, which help to diversify the regional economy. This is particularly important during economic downturns in traditional forestry and fishing industries. As an example, in 2005 there was a temporary shutdown of forestry operations in the Nimpkish Valley. This directly affected the town of Woss, where most of the residents are employed by the logging industry. A corresponding increase occurred in the level of mushroom harvesting activity in the forests surrounding Woss that year (L. Corcoran, pers. comm., 2006). High unemployment in traditional sectors, the presence of a mushroom buyer in town, and abundant commercial wild mushrooms all contributed to increasing the number of people who participated in the harvest that year. Resurgent interest in NTFPs following economic downturns in other higher-paying industries is a phenomenon that is likely to be repeated and emphasizes the importance of NTFPs in diversifying local economies.

Sustainability issues related to harvesting

When questioned about their preferred method, harvesters interviewed in the study area either cut or pulled mushrooms from the ground, while at least one said he did both. Long-term studies have demonstrated that there is little difference in future production using either harvest method (Egli et al. 2006; Norvell 1995). Excessive ground trampling during the harvest can affect young mushrooms developing under the duff and reduce total production within a fruiting season; however, it does not appear to have any measurable influence on future production in subsequent fruiting seasons (Egli et al. 2006).

Questions remain, however, about the effect of continuous removal of fruiting bodies on spore dispersal and future establishment of mushroom colonies. It is commonly believed among mushroom harvesters that harvesting can increase spore dispersal because mushrooms are carried throughout the forest and away from where they were found growing. Many harvesters promote the use of ventilated collecting containers to allow spores to pass through, and also return post-processing mushroom waste materials back to the forest (Lonick 1999). Some buyers discourage picking immature, undersize mushrooms (generally based on a cap size equivalent to the diameter of the Canadian $1 coin, approximately 2.5 cm; L. Corcoran, pers. comm., 2006).

Buyer profile

The number of buyer-distributors for all edible wild mushrooms in British Columbia fluctuates but is estimated to be 10–20 (Tedder et al. 2002). Along with pine mushroom, Pacific golden chanterelle was bought and sold by the largest number of British Columbia wild mushroom buyers (10) interviewed in 2002 (Berch

and Cocksedge 2003). Each buyer-distributor can have many field agents buying for them across British Columbia[8] and several distributors may be represented in a prime commercial harvesting area. Field buyers are paid a commission, generally around $1.10–$2.20/kg of mushrooms they buy.

Processing chanterelles

Chanterelles receive very little post-harvest processing. Mushrooms are brought to field buying stations where they are sorted into three commercial grades: #1 fresh, #2 fresh, and driers (or canned). Not all buyers sort lower quality mushrooms for drying or canning, as there is a limited market for these products. Betty's Best Mushrooms Inc. practises the following grading standards (Chanterelle Grading Specifications, Betty Shore, pers. comm., 2001):

- #1 Grade – Fresh market "buttons," with the edge of the cap rolled down and curled underneath the cap. There is no dirt on the mushrooms, and they have been sliced cleanly near the base with a sharp knife that minimizes any bruising to the flesh. Size ranges from quarter size (2 cm) to 10 cm.
- #2 Grade – Fresh market "leaf," whole, firm, clean mushrooms. The edge of the cap can be flat, but not floppy, sagging downward or curled upwards. Mushrooms are not water-logged, or broken at the edges of the cap. Cleanly cut and no dirt.
- Drier Grade – Good older mushrooms. Edges of the cap are becoming thin and slightly tattered. Not waxy feeling. Some trimming of bruised or mouldy areas may be necessary. Also can include damaged Grade #1 and #2 mushrooms.
- Rejects – All mushrooms that are dirty, soggy, bruised, mouldy, previously frozen (slippery or waxy feeling), or generally over-mature.

Processed mushrooms are placed into industry standard plastic storage baskets and weighed. The weight per unit volume will vary with moisture content but, on average, a full basket weighs about 5–7 kg. Full baskets are stored in a cooler and shipped within 1–3 days by air or land to second-order buyers, located mainly in the Vancouver area. Less than 1% of fresh and dried product is marketed to local restaurants (sometimes directly by pickers) or sold to tourists who visit buying stations.

Once received by the buyer-distributors, mushrooms are further sorted and placed in cold storage. It can take 3–5 days for mushrooms to reach their final destination in Europe, during which time there can be an additional 3–7% moisture loss, on top of an estimated 5–10% moisture loss in shipping from field stations (Tedder et al. 2000). Exporters must account for these moisture losses in determining their profit margins.

Global trade

Global trade in chanterelles is estimated to be US$1.67 billion, based on world production ranging from 150 000 to 200 000 metric tonnes per year (Watling 1997). The primary market is Europe, with France and Germany having particularly high demand (Schlosser and Blatner 1994). Rough estimates of the total volume of chanterelles harvested in British Columbia range from 187 500 kg in a poor year to 750 000 kg in a good year (Wills and Lipsey 1999). Haida Gwaii is one of the largest production regions in British Columbia. Crude estimates of total production there in a good year are approximately 115 00 kg, with a net worth to the pickers ranging from CAD $225 000 to $350 000, based on a price ranging from $5.50–$9.25/kg; Tedder et al. 2000).

The 1995–2005 trade data for the European Union markets indicate a slight overall decline in the value and volume of Canadian chanterelle mushroom exports, which ranged from $1 to $5 million annually (Cocksedge and Hobby 2006). Possible reasons include increased global competition coupled with decreasing domestic production. An exception to the declining trend was 2004, noted by reports from British Columbia harvesters as one of the best commercial mushroom-producing years on record. Unfortunately, the high production levels were met with lower than average prices.

Managing forests for chanterelles

Air pollution, short timber rotations,[9] clearcutting, depletion of soil litter layers, and harvesting pressure are all cited as factors that have contributed to decreases in the production of chanterelles and other mushroom species in Europe during the past several decades (Pilz et al. 2003). Climate change was also of concern to half of the respondents to the survey.

[8] Only two buyer-distributors were represented in this case study's surveys of field buyers on northern Vancouver Island in 2006.
[9] In short rotations there is an average of 50–60 years between tree planting and harvest.

Unfortunately, there is little certainty about, or local control over, the impacts of global climate change and pollution on chanterelle production.

Within the habitat range of Pacific golden chanterelle on Vancouver Island, logging has been the predominant negative impact on the landscape influencing chanterelle distribution and abundance. Habitat loss caused by logging is the major factor implicated in limiting production of chanterelles and other NTFPs by harvesters we interviewed. Before the advent of widespread logging, fires would have been the most frequent disturbance agent on the landscape. Chanterelle abundance correlated positively with fire history in the Skidegate Lake area on Haida Gwaii (Peterson et al. 2000), but fire suppression activities in the last 50 years have greatly reduced the frequency and severity of fires in British Columbia.

Inventory and mapping of productive habitats is paramount to developing effective management strategies. Some of this work has been done for chanterelles and other species on northern Vancouver Island. Given their preference for maturing second-growth stands, chanterelles may now be more abundant on northern Vancouver Island than prior to logging;[10] however, as the timber industry has recently shifted from old growth to second growth, these same stands are now being targeted for logging, at a time when many of them are entering their prime for chanterelle production. Short rotation ages of 50–60 years means that good mushroom stands will only be commercially harvestable for 10–20 years before timber harvesting. Since chanterelles depend on host trees for their growth and survival, clearcutting will preclude mushroom production until a new suitable stand of host trees regenerates. For chanterelles to begin to fruit in the wild, host trees need to be 10–40-years-old (Danell 1994, cited in Pilz et al. 2003). Forty years appears to be the approximate threshold age for optimal chanterelle production on northern Vancouver Island; stands younger than 40 years are rarely targeted by commercial pickers, and have been found to produce fewer chanterelles than older stands (Ehlers 2009, unpublished data). Increasing timber rotation ages in current highly productive chanterelle forests is an important consideration in sustaining chanterelle production until younger stands reach optimal production age.

Options to mitigate timber harvesting impacts on chanterelle habitat may also exist where resource management objectives overlap. Green-tree retention (also referred to as "variable retention") is a modification of a traditional clearcut timber harvesting system that is gaining wider popularity, particularly in Douglas-fir ecosystems of the Pacific Northwest. Green-tree retention maintains intact legacies of the original stand by reserving a portion of mature trees throughout the timber harvest area, or cutblock. The general goal is to sustain biodiversity and other forest values while economically harvesting timber. Specific applications of green-tree retention designed to optimize timber and chanterelle production need to be investigated, specifically with regard to how much should be retained and in what pattern (density and spatial arrangement of reserved trees). For ectomycorrhizal fungi in general, the greater the proportion of mature trees retained using a combined pattern of even dispersal throughout the opening and larger (1 ha) aggregated patches, the better the effect is on preserving the ectomycorrhizal fungal community in Douglas-fir forests in the United States Pacific Northwest (Luoma et al. 2004).

Chanterelles fruit in clusters; their distribution is linked to the presence of suitable host trees, soils, and other site-specific environmental factors. There is no set pattern to their occurrence, although they will fruit in the same patches year after year. Prior to timber harvest, surveys during peak seasonal fruiting periods, and (or) the expertise of harvesters intimate with the site may be sufficient to identify fruiting locations and associated host-trees that should be reserved from harvest. Chanterelle habitat can be reserved either in smaller patches dispersed throughout the stand, or in larger contiguous areas where chanterelles are concentrated.

With adequate inventory information, green-tree retention can achieve multiple conservation objectives. Stand-level resource inventories are routinely conducted to protect key habitat features for wildlife species. Within the study area on northern Vancouver Island for example, an area of productive chanterelle habitat was incidentally reserved from clearcut timber harvest to protect a nesting site of the red-listed Northern Goshawk (*Accipiter genitilis laingi*). Although much of this once-popular chanterelle harvesting site was logged, chanterelles continued to fruit in the reserve area.

[10] Among respondents to the harvester survey, 87% (n = 13) indicated that chanterelle production was highest in second-growth stands resulting from past logging. A few harvesters thought that past fire and stand thinning had a beneficial effect on chanterelle production.

Green-tree retention could also facilitate more rapid colonization of regenerating stands with chanterelle mycelia and accelerate the development of a productive chanterelle stand. Although we are not aware of any studies that have looked specifically at Pacific golden chanterelle, ectomycorrhizal fungal species richness on seedlings has been shown to decrease with distance from the rooting zone of mature trees (Hagerman et al. 1999). Seedlings planted in proximity to paper birch (*Betula papyrifera*) trees reserved within openings were found to have a higher ectomycorrhizal species richness than those outside the rooting zone of reserve trees. Site-specific variables need to be considered in applying green-tree retention, such as the risk of damaging reserve trees, susceptibility to windthrow and other biodiversity objectives for the site. From a timber harvesting perspective, it may be more economical to reserve mature trees in larger patches than in an evenly dispersed pattern throughout an opening.

Commercial thinning is another option to maintain timber flows while sustaining chanterelle harvests. A long-term prospective study on the response of chanterelle productivity to thinning of approximately 50-year-old Douglas-fir and western hemlock stands in Oregon found that although chanterelle productivity drops significantly in the years immediately following stand thinning it rebounds within 6 years and might even surpass pre-thinned levels over time (Pilz et al. 2006). Some of the best chanterelle sites in the Nimpkish Valley were commercially thinned in the past; however, this practice has not been widely adopted likely because of economic constraints in the timber industry.

Enhancing chanterelle production in younger stands also holds promise in accelerating the recruitment of productive chanterelle habitat. Planting seedlings pre-inoculated with chanterelle mycelia soon after timber harvest on suitable sites could result in increased fruiting at a younger age. There has been some success at culturing golden chanterelle (*C. cibarius*) from seedlings (Danell and Camacho 1997). Other mycorrhizal mushroom species, particularly highly valuable truffle species, are widely cultured in plantation settings. Early stand tending could also enhance subsequent chanterelle production. Species selection, stand density, coarse woody debris attributes and amounts, understorey condition, and timing of silviculture treatments are some variables that can be manipulated in attempts to accelerate the development of favourable habitat conditions. The mutual benefits of improved chanterelle production and timber quality need to be evaluated against the associated costs of silviculture treatments and the potential negative effects of excessive site disturbance.

Comparative stand values

Over the long term, chanterelle production from the best habitat might vary between 5 and 20 kg/ha per year over the total land area generally productive for chanterelles (Liegel 1998). With an average price paid to the picker of $4.95/kg, the potential value of the chanterelle harvest to pickers ranges from $24.75 to $99.00/ha per year. The per-hectare value could be much higher if only the actual area of mushroom patches within the general habitat area were factored into the productivity measurement, and if mushrooms were only sold at the highest price paid in a season. At a field price of $16.50/kg, for example, the per-hectare value increases to $330. Pickers who direct market to restaurants can fetch double this price, though this market is currently limited.

Alexander et al. (2002) compared stand value estimates of mushrooms and timber in the United States Pacific Northwest using a method called the Faustman formula, or soil expectation value (SEV) to derive equivalent per-hectare values of mushrooms and timber from the same sites. Using this method, which includes many assumptions about yields, prices, and costs, they found that the discounted present value in perpetuity (SEV) of timber (high-value Douglas-fir in this case) was 12–200 times higher than that of chanterelles for the sites they compared on the Olympic Peninsula in Washington State.

Although the comparative economic values favour timber using this method, the analysis does not reflect other social and environmental values associated with prime mushroom hunting grounds. Alexander et al. (2002) noted that their analysis was for the stand as a whole but point out that, at the scale of an individual mushroom patch and its associated host trees, the value of mushrooms may be greater than the trees over time. Intensive co-management (as discussed above) that identifies and reserves these patches from timber harvest might best optimize the value of land.

Environmental costs are extremely complex to assess, full of uncertainty, and therefore difficult to include in economic analyses. Even though commodity values may be higher for timber than for mushrooms, timber harvesting is more disruptive to forest values, such as fresh water, erosion control, wildlife habitat, and medicinal plants than mushroom picking. Forests managed for mushrooms maintain non-commercial

forest values while providing some economic opportunities. These forests provide not only the value of the food source, but also the value of the experience of foraging for mushrooms. This value may not currently be realized in terms of dollars, but as part of a lifestyle attraction to prospective residents and tourists, it could have real economic value.[11]

Conclusions

Future development of the wild chanterelle industry on Vancouver Island will depend on global market conditions that dictate prices, a capable labour force (harvesters), and ultimately on the sustainability of wild chanterelle crops. Advancements in cultivation techniques might eventually supplement world supplies, but not in the immediate future. And even if available, plantation-grown chanterelles will not diminish the appeal of hunting for mushrooms in the wild. A British Columbia chanterelle industry has to compete with European industries that have lower production and shipping costs. However, as wild mushroom production has been declining in European forests (Pilz and Molina [editors] 1996), British Columbia might become a more important world supplier of wild chanterelles. As the European and Asian populations, who traditionally eat mushrooms, increase in North America, so too are the domestic markets. With higher prices, there will be a willing labour force to harvest British Columbia chanterelles, as evidenced during the boom years of the pine mushroom industry.

The chanterelle industry on northern Vancouver Island and elsewhere in British Columbia is currently functioning in the absence of any formal management strategy. Recognition for chanterelle and other wild mushrooms in forest planning will help ensure future supplies. Management strategies to enhance wild production and optimize chanterelle and timber yields are needed. Recently some of these information needs are beginning to be addressed. Research examples discussed in this article reflect a growing interest in addressing issues surrounding sustaining wild chanterelle harvests.

Policy proposals

Most picking is done on Crown land, approximately 94% of the land base in British Columbia, although on Vancouver Island there is proportionately more private land. Crown forest land is under the jurisdiction of the B.C. Ministry of Forests and Range. Currently, no tenure or property rights are granted in relation to harvesting wild mushrooms on Crown land.

Future development of the wild chanterelle industry on Vancouver Island will depend on global market conditions that dictate prices, a capable labour force, and ultimately on the sustainability of wild chanterelle crops.

As with other NTFPs in British Columbia, a lack of any formal property rights, regulations, or policy framework results in few investments being made to sustain or enhance the industry. A large land base coupled with increasing numbers of tourists could, for instance, feasibly support more development in ecotourism involving both the experience of harvesting chanterelles in forest environments and the marketing of locally-harvested mushrooms to visitors and the restaurants they patronize.

Tedder et al. (2002) recommended that the state retain its prescriptive role in administering NTFP resources, but minimize any operational role. Intervention possibilities include harvester education to encourage sustainable harvesting practices and levies against companies who profit from distributing chanterelles with levies re-invested to ensure sustainability of the resource.

Future management strategies should also consider planning, regulation, and enforcement to protect interests of recreational harvesters as conflict between commercial and non-commercial harvesters may increase. Northern Vancouver Island, with its low population, existing forest road network, and large land base capable of producing chanterelles is particularly well-suited to successful commercial development of chanterelles. Economic declines in the primary industries of timber and fisheries could help stimulate interest and investment in other forest resources, including chanterelles. Very little investment is required to harvest chanterelles and there are few barriers to participating in the harvest. Greater attention needs to be focussed on inventory, mapping, technology, and compatible management with timber resources to address future chanterelle supplies.

[11] For example, there are guided mushroom hunts on southern Vancouver Island that combine foraging for mushrooms with a gourmet meal.

Note

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

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Test Your Knowledge . . .

The chanterelle mushroom harvest on northern Vancouver Island, British Columbia: Factors relating to successful commercial development

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

1. Over 70 species of chanterelles (*Cantharellus* spp.) are recognized worldwide but only three occur in British Columbia.
   A) True
   B) False

2. Like other forest mushrooms, chanterelles grow quickly and are susceptible to rot.
   A) True
   B) False

3. Chanterelles require host trees for survival. What is the best age for a stand to provide a suitable host habitat for chanterelles?
   A) 10–30 years
   B) 40–80 years
   C) Old growth

ANSWERS

1. A 2. B 3. B