Innovative Biological Technologies for Lesser Developed Countries
Chapter X
Mycorrhiza Agriculture Technologies

July 1985

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Recommended Citation:
Innovative Biological Technologies for Lesser Developed Countries— Workshop Proceedings (Washington, DC: U.S. Congress, Office of Technology Assessment, OTA- 13P-F-29, July 1985). Library of Congress Catalog Card Number 85-600550

PAGE 189 Ectomycorrhizal fungi have been reported to provide resistance to plant disease in many plants (48). Although mycorrhizae never confer complete immunity, they often appear to reduce the severity of disease or symptom expression. Resistance of ectomycorrhizae to disease may result from (48):
• mechanical protection by the mantle,
• better plant nutrition,
• production of antibiotics by the mycorrhizal fungus,
• competition for infection sites,
• formation of phytoalexins, and
• alteration of root exudates.

Evidence is accumulating that VA mycorrhizal fungi exert similar effects on plant pathogens. Schenck, et al, (91), has reported mycorrhizal resistance to root-knot nematodes. Schonbeck (93) has examined a variety of foliar and root pathogens on mycorrhizal plants and concluded that root pathogens *(Thielaviopsis, Fusarium,* nematodes, etc.) are usually inhibited by mycorrhizal fungi while foliar pathogens (viruses, rusts, etc.) are often more severe on mycorrhizal plants. Davis, et al. (21,22), and Davis and Menge (20) concluded that the VA mycorrhizal fungus *Glomus fasciculatus* produced little resistance to Phytophthora root rot in citrus and indeed increased Phytophthora root rot in avocado and Verticillium wilt in cotton. VA mycorrhizal effects on disease may result from improved phosphorus nutrition because of the increased absorbing surface of the mycorrhizal hyphae. This effect is magnified when the roots' normal absorbing capacity is reduced because the roots are partially decayed.

PAGE 191 Fumigation with biocides or pesticides such as methyl bromide (56), chloropicrin (72), dazomet (50), 1,3-D (72), vapam (71), and vorlex (71) may destroy or inhibit root infection by mycorrhizal fungi, Application of many soil fungicides such as arasan (71), banzot (95), benomyl (96), botran (71), carbofuran (3), chloramformethane (37), dichlofluanid (37), ethirimol (37), lanstan (71), mylone (71), PCNB (96), sodium azide (3), thiabendazole (37), thiram (96), triademifon (37), tridemorph (37), and vitavax (96) have also been reported to be harmful to mycorrhizal development, Flooding, planting non-my corrhizal crops, or removing topsoil, may also reduce the population of mycorrhizal fungi to a level requiring reinoculation (7,78).

Fumigation with the biocide methyl bromide to remove soil-borne pests is required by regulation for the production of many nursery crops. It is also regularly used in many field agricultural situations. This chemical is extremely toxic to mycorrhizal fungi and most field fumigations are sufficient to destroy the native mycorrhizal inoculum (56). Stunting of crops following fumigation with methyl bromide is common and is due to the destruction of mycorrhizal fungi. Although a relatively small amount of land is treated with this chemical, less than 100,000 acres annually in the United States, stunting following fumigation with methyl bromide has been reported in the United States, Africa, Spain, Peru, Venezuela, and many other countries (52). Crops that are routinely grown in methyl bromide fumigated soils include strawberries, tomatoes, tobacco, nursery crops, tree crop replants, and some vegetable crops. For many of these crops the addition of mycorrhizal fungi following fumigation with methyl bromide is not only recommended but is imperative.

15 Mycorrhizal Specificity and Function in Myco-heterotrophic Plants

D.L. Taylor, T.D. Bruns, J.R. Leake, D.J. Read

Taylor DL, Bruns TD, Leake JR & Read DJ. 2002. Mycorrhizal specificity and function in myco-heterotrophic plants. In: The Ecology of Mycorrhizas. Ecological Studies vol. 157. Ian R. Sanders and Marcel van der Heijden, eds. pp 375-414. Berlin: Springer-Verlag. (NOTE: this pdf is from the page proofs, and is not identical to the published version)

Page 395-396 The only quantitative, belowground study of the fungal community surrounding a MHP revealed an immense diversity of ecto-mycorrhizal fungi and an intriguing fine-scale spatial patterning of these fungi (Bidartondo et al. 2000). ITS RFLP analysis revealed the presence of 80 different species of ecto-mycorrhizal fungi colonising red fir roots in only 36 soil cores harvested near *Sarcodes sanguinea* plants (Monotropoideae) at a single site.Within *Sarcodes* root balls, and in soil cores 10 cm away from the root balls, the exclusive *Sarcodes* symbiont, *Rhizopogon ellenae*, was the dominant fungus colonising fir roots (by mycorrhizal biomass). In contrast, *R. ellenae* was not a dominant fungus on fir roots in cores 100 cm from *Sarcodes* and was never found in cores 500 cm away. The authors argue that the *Sarcodes* plants must be promoting colonisation of fir roots by *Rhizopogon*, rather than occupying microsites already containing dense *Rhizopogon* mycorrhizae, due to the fact that the fir ecto-mycorrhizae occur surrounding the expanding *Sarcodes* root ball, rather than in its centre. This surprising observation is consistent with Bjorkman’s finding that extracts from *Monotropa* plants stimulate growth of the *Monotropa* fungus, in vitro

(Bjorkman 1960). Even more striking is the observation that fir root densities increase dramatically very close to *Sarcodes* plants (Bidartondo et al. 2000), suggesting that these plants are able to locally stimulate the growth of both the autotrophic host tree and the fungus. It would appear that these plants are able to significantly alter ecto-mycorrhizal community structure, at least on a fine spatial scale.

What the Natives Know Wild Mushrooms and Forest Health

By Rebecca Templin Richards
Journal of Forestry September 1997

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PAGE 5-6 What is often missing from ecosystem management is the knowledge that local people have about their forests. Native American communities in particular may possess exceptionally long oral records of ecosystem components and functions and have strong traditions for using the resource. Native Americans' knowledge of ecological dynamics is often reflected in prescribed ways of digging edible corms and bulbs to increase production, for example, and pruning shrubs to encourage shoots for basketweaving (Blackburn and Anderson 1993).

Determining the relationships between ecological dynamics and Native American cultural practices is especially important for managing the plants that tribes have gathered for generations. Since many species are now commercially collected for the floral, herbal, or culinary markets (Schlosser and Blatner I994), forest managers need to understand the ecological requirements for sustaining these plants.

Traditional tribal practices of the Karuk tribe, whose ancestral lands follow the Salmon and Klamath Rivers, included sustainable harvesting of tanoak mushrooms.

Western Forest Fungi
The harvesting of forest products for culinary, household, and medicinal purposes by Native American tribes has been documented in pioneer diaries and by anthropologists and ethnobotanists. Despite the vast number of plant species known to have been used by western Native Americans, however, few accounts mention tribal use of wild mushrooms (Tevis 1952; Weber et al. 1992). Many edible species of mushrooms fruit during late fall or early spring, when other wild plant foods-berries, acorns, roots, greens-are not available. Raw mushrooms are rich in niacin and provide some protein and carbohydrates; they are also

exceptionally high in such trace minerals as phosphorus and potassium (Watt and Merrill 1963). Nevertheless, in western North America, only a few mushroom species have been documented as an important component of tribal diets *(table 1, p.* 7). The lack of anthropological records may reflect phobias about wild mushrooms (Arora 1991) more than the degree to which tribes actually harvested and used them.

Many edible fungi grow in western North America (USDA-FS 1993). In recent years, these mushrooms have attracted commercial pickers who supply domestic and international markets (Lipske 1994). The boom may pose risks to forest health, since fungi serve critical ecosystem functions as mycorrhizal associates that extend tree root systems and provide water, nutrients, and other benefits (O'Dell et al. 1992). Ecological concerns over commercial harvesting have not been thoroughly addressed because of the lack of longterm scientific studies on fungus regeneration and forest ecology (USDAFS 1993). In particular, research has not identified how fruiting is initiated in most species, how the fruiting bodies are distributed in time and space, or what ecological role edible mycorrhizal fungi play in maintaining forest health and productivity (USDA-FS 1993, 1996).

Native American elders' knowledge of fungus fruiting patterns and fluctuations, habitat conditions, and responses to disturbance over many decades may be useful. The objectives of this study were to describe Karuk use of tanoak, or matsutake, mushrooms and indicate how the tribe's knowledge could benefit forest ecosystem management.

The Tanoak Mushroom

Of the wild mushrooms harvested in the Pacific Northwest, the white or North American matsutake (7% *choloma magnivelare),* known locally as the tanoak or pine mushroom, is the most commercially valuable (Schlosser and Blatner 1995).

Few ecological studies have been conducted on the North American species (Hosford and Ohara 1994; Hosford et al. unpubl.). Although tanoak mushrooms form mycorrhizae with a wide range of hosts, commercial harvesting has been concentrated in the lodgepole pine *(Pinus contorta)* and red fir *(A&es magnz!ca)* forest community types in the higher elevations (4,000 to 5,000 feet) of the Cascade Range of Washington and Oregon and the Siskiyou and Klamath Mountains of southern Oregon and northern California. The latter area includes the ancestral land of the Karuk people. Much Karuk ancestral land became part of the Klamath National Forest in 1905 (Davies and Frank 1992). The earliest documentation of Karuk use of tanoak mushrooms dates from the 1939 ethnobotanical field studies of Schenck and Gifford (1952), who reported, "A certain mushroom, found in November, is cooked on coals and eaten."
Among the Karuk, Yurok, and Hupa peoples, *Tricboloma magnivelare* is known as the tanoak mushroom because it is associated with tanoak *(Lithocarpus densiforus)* hosts. The ***6*** September 1997 Karuk consider the tanoak mush*room-baiwish* in the Karuk language- an important traditional food. It is undoubtedly the

mushroom to which Schenck and Gifford (1952) referred.
Until about 1991 there was little commercial harvesting on Karuk ancestral lands. As commercial pickers arrived in greater numbers, local tribal members complained that their traditional gathering sites, many on Forest Service land, were being overharvested. In early 1993, the Karuk appealed the Klamath National Forest's decision to allow a commercial mushroom season, and forest managers issued no commercial permits for autumn 1993. As part of a study to identify the different resource values assigned to *Eicholoma magnivelare* and the basis for the resource conflict on the Klamath National Forest (Richards and Creasy 1996), I conducted interviews to document Karuk tribal knowledge and use of the mushroom.

PAGE 6 Scheduled, semistandardized interviews (e.g., Berg 1995; Marshall and Rossman 1995) were held with 10 Karuk men and women who had grown up on the Karuk ancestral village lands near Happy Camp, Ti Bar, Somesbar, Orleans, and Forks of the Salmon. The five men and five women ranged in age from early 30s to late 80s and most of them were considered elders.
PAGE 7-8 The Karuks I interviewed confirmed that they had picked tanoak mushrooms either continually or at regular intervals since childhood. Several of those interviewed were in their 80s and said they had picked tanoak mushrooms every year since c h i l d h o o d .

The tribal members interviewed were consistent about where tanoak mushrooms fruited. Mushroom habitat was described as ridges, usually facing north, with moist but well-drained soils. One elder summarized this pro- file: "You look for places where they are buried in red dirt or shale. Someplace where it is not real damp but where it doesn't dry out. They come in after it rains where the soil holds the moisture."

Interviewees noted that specific fungus successional patterns were associated with tanoak mushrooms. One said, "When the grandmas *[Ramaria* then a period of clear weather: sp.] came in, the tanoak mushrooms "They're not in snow, but they need initial rain and then clear weather. With a lot of rain they rot. The season would fruit a week later. Mom looked for the granny mushrooms first. That would be a sign that the tanoaks would be up." One tribal member believed Ramaria mushrooms were called grandmas or grannies because they were the generation before the tanoak mushrooms.

Several people thought the tanoak mushroom was fruiting less abun-' dantly than in the past, and no one suggested that the mushroom was fruiting more. They said they had not found as many mushrooms as in the past and generally attributed the scarcity to increased harvesting. "I've picked since I was a little girl," said one. "I didn't have to go far from home up the hill. Now I go to the same places and the same areas and can hardly find any." Another commented, "We've been out and seen areas with signs of raking. We saw commercial pickers before I987 but no buyers. I saw people picking the last few years since

I989 by big carloads. We used to pick by the roads because the elders couldn't walk far. . . . now we have to go further into the woods." She added, "They aren't as plentiful as they were before but then the weather is different, too. We've had milder winters." Some people said the tanoak mushroom did not fruit as heavily after severe fires, such as those of 1989.
All interviewees noted the importance of leaving some mushrooms, and all believed, as one put it, "They should come back every year if you pick them right. They always came back where we were picking."

Page 8-9 Lessons from Ethnoecology
The knowledge of Native American mushroom gatherers may help answer critical questions about the role of edible fungi in forest health. Tanoak mushrooms are associated with numerous tree species in a wide range of habitats, and these local ecological adaptations and specific habitat requirements need to be better understood (Hosford et al. unpubl.).
Long-term documentation of ecological conditions for these mushrooms has been confined to midelevation grand fir *(Abies* grandis) and western hemlock *(Tsuga heterophyLLa)* sites in the Cascades of central Washington (Hosford and Ohara 1994). Here, the mushrooms are found on gentle slopes or benches, often with a southwest aspect, after relatively warm rain from early September to mid-November. Understory vegetation, generally sparse, includes vine maple *(Acer circinatum)* and five ericaceous species. Soils at these sites are sandy and well drained with less than 25 percent organic matter (Hosford and Ohara 1994; Hosford et al. unpubl.). Differences in seasonal production are directly related to rainfall and temperature. Fruiting occurs when annual accumulated rainfall reaches I4 centimeters or more and temperatures average above 5" C (Hosford et al. unpubl.).

Harvesting Patterns
The Karuk people traditionally ate tanoak mushrooms in the late autumn and early winter, when other foods were limited. Their observations of deer eating tanoak mushrooms indicate that they recognized the nutritional value of the mushrooms to wildlife; as some interviewees believed, the observation may have inspired human consumption. Similarly, the fruiting habits of the mushroom were probably carefully observed, and these observations may have shaped Karuk mushroom management practices.

Spores were cast downhill to enhance the fruiting line that many mushroom pickers said occurred naturally (Richards 1995). Spore removal has generally been considered detrimental to sustaining productivity, and in Japan, older matsutake are replanted in the same site to ensure regeneration (Hosford et al. 1994). In the Klamath, replacing the leaf litter may provide the necessary insulation for fruiting of immature "buttons."

All the Karuks I interviewed had gathered the tanoak mushroom since they were children and had been taught common gathering practices. They believed these practices-especially twisting the mushroom so as not to disturb the mycelium and leaving small mushrooms to continue to fruit-sustained the mushroom. Their practices are consistent with those of other Native American tribes in the Sierra Nevada, where other species of wild mushrooms were harvested by Miwoks, Yokuts, and Paiutes: “We used to gather mushrooms under the pines. The dirt would puff up under pine needles. We’d use a knife to slice it so the root would stay in the ground. Mother said it was important to leave starters for other mushrooms” (Anderson 1993).

Tribal gathering practices may show modern pickers a way to harvest sustainably. Many commercial pickers debate cutting versus twisting, saying that certain species, like chantrelles *(Cantbarellus* sp.), benefit from cutting, but others, such as matsutake, produce more from twisting. Since heavy raking and overharvesting by some commercial pickers allegedly destroy the mycelium, prevent regeneration, and curtail future production (Richards 1995; Hosford et al. 1994), forest researchers need to study the effects of cutting versus twisting, leaving old mushrooms and young buttons, and replacing the leaf litter.

Implications for Management

Although the Karuks whom I interviewed indicated that mushrooms did not fruit abundantly after severe fires, the effects of light fires, timber harvesting, and other disturbances were not reported. Several people recalled the exceptional size of mushrooms they had collected in the past. Their memories are confirmed by an old newspaper article given to me by a tribal member: “Lottie [a Karuk woman] has just completed her mushroom gathering for the year. Each year, she and her sister.. . pick and can at least 40 quarts of mushrooms. This has been a good year, probably due to the warm August rain which caused rapid growth. These large, flat mushrooms which grow near tanoak, measure up to nine inches in diameter and a large specimen can weigh as much as two pounds” (Chamberlain, date unknown). A recent decline in the abundance or size of the mushrooms might indicate landscapelevel changes in disturbance patterns, such as forest management practices and fire regimes, or even global changes, such as climate or atmospheric shifts.

In fact, disturbance regimes have changed considerably in the Klamath bioregion since the arrival of miners in the 1850s brought an end to traditional Karuk tribal life. Fire suppression has increased in this century, and clearcutting, widely practiced in the 195Os, ended only in the 1970s. That the mushrooms do not abundantly fruit after severe fire may suggest that leaf litter, which may retain moisture at the soil surface as well as insulate it, is important to production. Clearcutting would also remove the forest litter and thus suppress mushroom growth. Both fire and logging remove tall conifers, allowing the host hardwoods to sprout quickly. When fire was suppressed and the logging ended, the hardwoods were succeeded by conifers. More recently, however, because of the lack of selective harvesting of conifers, reverse succession has allowed the hardwood species to dominate many mixed evergreen stands (USDA-FS 1995).

PAGE 10 Because the dominant host trees in the Klamath bioregion are tanoak and madrone, forest management practices that select for conifers inhibit mushroom production. Selective timber harvesting of mixed evergreen stands to retain large overstory hardwoods, however, could promote mushroom . growth. In particular, thinning practices that foster hardwood crown expansion prevent transpiration loss and ensure sufficient leaf litter to insulate the soil during the hot summers and maintain the host tree nutrient pool.

How tanoak mushrooms respond to methods of harvest, soil compaction, fire regimes, and timber management practices needs additional study. Qualitative research with the Karuks is urgent: since 1993, when my interviews were conducted, one of the oldest Karuk elders has died, and with her has passed not only cultural knowledge but invaluable ecological information as well. The traditional knowledge of Native American plant gatherers is a resource for forest researchers and managers concerned with sustaining biodiversity and forest health through ecosystem management. Increasing public participation opportunities so that Native Americans can contribute their tribes' knowledge of forest species will ensure better adaptive management and more sustainable forests.

NON-WOOD GOODS AND SERVICES OF THE FOREST

(Report of ECE/FAO team of specialists)
ECE/TIM/SP/15
by Linda L Langner
* Type: English : Book : Non-fiction
* Publisher: New York : United Nations, 1998.
* ISBN: 9211166918
Sales Number: E.98.II.E.12
ISBN: 9211166918
Pages: 50pp.

Contents: At head of title: United Nations Economic Commission for Europe, Food and Agriculture Organization of the United Nations, Timber Section., "Written by Linda Langner (USA), team leader, on the basis of national reports by team members for 7 countries"—P. v., "ECE/TIM/SP/15.", "United Nations publication sales no. E.98. II. E12"—T.p. verso.

ABSTRACT
The report is a synthesis of country reports on the status of non-wood goods and services in seven countries: Austria, Canada, the Czech Republic, Finland, Sweden, Switzerland and the United States, with quantitative information on non-wood goods (food, fodder, plant products etc.), environmental services (protection, water, global climatic effects, biodiversity, local environmental functions) and social and cultural services (hunting and fishing, leisure and

tourism, aesthetic and scenic values, cultural and spiritual values, scientific and historical values).

Preface by the secretariat

The "non-wood goods and services of the forest", include non-wood goods, such as berries and mushrooms, resins or Christmas trees, environmental services such as soil and water protection, biodiversity, or contribution to the global carbon balance and social and cultural services such as recreation and cultural or aesthetic values. The great importance of these goods and services, for policy makers and for forest managers, has long been recognised, in theory and in decision making practice. However the low availability and generally poor quality of quantitative information on these goods and services, especially when compared with the information quality for wood, has definitely hampered rational analysis and policy formulation. The reasons for this unsatisfactory situation are many and include the following:

- conceptual problems, notably for many of the services
- technical difficulty and cost of measurement
- where measurement is possible at the local or stand level, it is frequently difficult or prohibitively expensive to expand the coverage to wider areas, notably whole countries
- wide variation in the relative importance of the various non-wood goods and services has meant that most measurement efforts have been very local in scope
- the non-market nature of many of the goods and services means not only that the value is difficult to estimate but that their importance, and thus the importance of measuring them, is underestimated.

ECE/FAO has since 1952 carried out regular studies of European timber trends and prospects: the most recent, *European Timber Trends and Prospects: into the 21st century*, was published in 1996. It was considered desirable to devote a similar study to the structural trends and outlook for demand and supply of non-wood goods and services. The Joint ECE/FAO Working Party on Forest Economics and Statistics formed a team of specialists to carry out the study. However, it rapidly became clear that it was not realistic, given the data and methodology limitations, to aim at a comparable level of analysis for non-wood goods and services as for timber supply and demand. It was therefore decided to prepare country case studies, according to an agreed common format (see annex 2), and then to make a synthesis of results. The present study has been written by Ms. Linda Langner (USA), team leader, on the basis of national reports by team members for 7 countries: Austria, Canada, the Czech republic, Finland Sweden, Switzerland and the United States, and shows that there are considerable amounts of data on non-wood goods and services available, often in sources which are not well known to conventional forest resource analysts. The quality and comparability of these data vary widely, but they are sufficient to give a good picture of non-wood goods and services in these countries.

PAGE 2-3 CONCLUSIONS

1) Most countries do not have national level information on the quantity or value of the majority of nonwood goods and services. Much of this type of information is collected at a sub-national level, e.g., by provinces, cantons, states, or local municipalities. Aggregating such information creates problems of both format and consistency. Even if data is collected in comparable measures, collecting data across multiple government or other organizations can be difficult.
2) Non-wood goods and services cover a wide range of disciplines. Relevant information may reside with agencies or organizations not traditionally associated with forestry. As a result, an inquiry should be extended beyond traditional forestry sources, which can add to the difficulty in both data collection and interpretation.
3) The quantity and value of some of the non-wood goods and services are not necessarily separable by the “forestry” component. For example, reports of recreation or hunting are often provided in total, not for activities that take place in forest environments.
4) Success in reporting on non-wood goods and services requires commitment at the highest levels. Most team members for this undertaking attempted to complete their country reports in addition to usual duties. The exceptions were the Czech Republic, where a grant from the Ministry of Agriculture supported the work, and support from the Austrian Ministry for Agriculture and Forestry for translation of the Austrian report. Given the breadth and complexity of the assignment, it is not surprising that many team members were not able to complete reports.
5) The information from this effort provides useful information for evaluating the possibility of collecting data on non-wood goods and services. The preliminary results were used as input to developing the final questionnaire for the Temperate and Boreal Forest Resource Assessment (TBFRA).
6) The inquiry for the TBFRA is a further test of both data availability and countries’ willingness to commit resources to collect information on non-wood goods and services. Another potential source of information is thereports being developed in many countries on the criteria and indicators for sustainable forest management.

RECOMMENDATIONS

1) Publish the team report after revisions based on comments from Team members, the Secretariat, and Joint Working Party on Economics and Statistics. The report could be expanded if additional country information is provided within a specified time-line.
2) Take no further action with the ToS until the results of the Forest Resource Assessment have been collected and evaluated.
3) Call upon team members to assist in the evaluation of the non-wood goods and services component of the TBFRA 2000. Consider recommendations for further actions on the basis of that response.

PAGE 7 The United States has very limited data on food products. The data for mushrooms presented in Table 2 are based on a special study conducted in three states of the Pacific Northwest region. Approximately 25-30 species of wild edible mushrooms are harvested in this region on a commercial scale. The four most important species are morels (*Morcella* spp.) , chanterelles (*Canthrellus* spp.), matsutake (*Tricholoma* spp.) And boletus (*Boletus* spp.). No estimate of harvest for personal consumption is available. No data was available on harvest of berries, although several species are collected from forests. Maple syrup is an important product from the forest, particularly in the northeastern United States. National data exist on the harvest of fish for commercial use. The species most closely associated with forestland are the salmon species. Forested headwater provide critical spawning habitat for salmon. Total harvest of salmon has increased dramatically since the early 1970s, although the average value per pound has decreased in real dollars. The total in Table 2 is from 1995. Recreational fishing also provides food, but is covered in the section on hunting and fishing.

PAGE 11 Estimated values were provided for most of the non-wood products quantified in Switzerland. The United States data include the value of edible wild mushrooms in the Pacific Northwest purchased by the mushroom industry in 1992. This value reflects the prices received by the original collectors; the wholesale value was estimated at $41.1 million. The value of decorative materials is also limited to the Pacific Northwest. Value of fur harvest includes all furbearing species.

PAGE 16 Protected Areas
To the extent possible, protected areas were reported by IUCN classes I through VI: Class I: strict nature reserves/wilderness areas managed mainly for science or wilderness protection.
Class II: national parks managed mainly for ecosystem conservation and recreation.
Class III: natural monuments managed mainly for conservation of specific natural features.
Class IV: habitat/species management areas managed mainly for conservation through management
intervention.
Class V: protected landscape managed mainly for conservation and recreation.
Class VI: managed resource protection areas managed mainly for the sustainable use of natural ecosystems.
PAGE 20 According to IUCN classification, the United States has a total of 1,585 protected areas in IUCN classes I to V, including slightly over 130 million ha. About 71 million ha are in classes I-III and another 60 million are in classes IV and V. These areas include federal and state lands, but are not limited to forest land. The other classes include both federal and state lands. Aside from NWPS lands, none of the lands managed by the Forest Service or Bureau of Land Management are included because multiple uses are allowed.

PAGE 23 Forest area in the United States has remained relatively stable since the 1920s. However, specific forest communities have been reduced significantly. Eighty percent of the bottomland hardwoods of the lower Mississippi River delta have been converted to other land uses. Riparian forest in the arid and semi-arid West are considered the most altered land type in the western U.S. Area declines of greater than 10% between 1963 and 1987 have occurred in southern pines, aspen-birch, and elm-ash-cottonwood communities. Mature and oldgrowth softwood stands are becoming increasingly rare in the Pacific Northwest and the South. An assessment of forests in eastern Washington and Oregon indicate that over the last 40-55 years, the number of acres in early and late successional stages has declined, while the area in mid-seral stages has increased. In the eastern hardwood forests, disturbance has not kept pace with forest growth, resulting in an increasing proportion of area in older hardwood stands. Stand size class distribution can be used to describe forest structure and age. Eastern timberlands are composed of about 23% seedling-sapling stands, 28% poletimber stands, and 47% sawtimber stands. Only about 1% of the area is non-stocked. In the western U.S., seedling-sapling stands are found on 13% of timberlands, 15% are poletimber, and 70% is sawtimber. About 2% of the area is nonstocked. In the eastern U.S. forests, the area of forest types in later stages of succession has increased over the last 20 years, leading to a more mature forest. Other forest types are decreasing, mainly forest types such as aspen-birch that require harvest or other disturbance to maintain. A maturing forest results in increasing average age and size class. Without increased levels of natural or human disturbance, this trend is likely to continue into the future.

PAGE 39 Certain forest lands in the United States are held in trust for Native American people. In 1990, forestland as part of those holdings totaled almost 6.5 million ha. The United States has a trust responsibility to protect, conserve, use, manage, and enhance Native forestlands. However, these lands are analogous to private lands, since only members of the Native American tribes have access. Through various treaties, Native Americans also have rights to natural resources on the federal estate as well.

PAGE 43 The information provided in the summary was used as input in finalizing the questionnaire for the Temperate and Boreal Forest Resources Assessment. Additional information is available from reports on the criteria and indicators for sustainable forest management that numerous countries have produced. The timing for addressing nwgs could not be better. The international interest in forestry issues and the benefits of forests provides a strong impetus for moving forward in this effort.

Inventory of non-timber forest product plant and fungal species in the Robson Valley

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BC Journal of Ecosystems and Management Volume 4, Number 2, 2003
http://www.forrex.org/jem/2003/vol4/no2/art2.pdf

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Abstract
Increasing interest in non-timber forest products (NTFPs) has led to their greater recognition in sustainable forest management planning. This is evident in local resource management plans for the Robson Valley in east-central British Columbia, where public input shows strong support for the sustainable development of NTFP harvesting. However, information needed to develop sustainable management guidelines for NTFPs is currently lacking. We, therefore, undertook an inventory of non-timber forest product plant and fungal species in the Robson Valley. The distribution and abundance of NTFP plant species was determined by ecosystem types as described by the Biogeoclimatic Ecosystem Classification system used in British Columbia. Species with a relatively high abundance and commercial potential included the valuable medicinal plant Devil's club (*Oplopanax horridus*), berry-producing species such as black huckleberry (*Vaccinium membranaceum*), and the edible ostrich fern (*Matteuccia struthiopteris*). Plants used for floral greenery that are relatively abundant in certain ecosystem types included falsebox (*Paxistima myrsinites*), tall Oregon-grape (*Mahonia aquifolium*), pearly everlasting (*Anaphalis margaritacea*), and conifer boughs, especially from western redcedar (*Thuja plicata*). We identified a number of fungal species noted for their food, medicinal, wildcrafting, industrial, or traditional uses. Among the important food mushrooms we recorded in the Robson Valley were pine mushroom (*Tricholoma magnivelare*), hedgehog mushroom (*Hydnum repandum*), and black morel (*Morchella elata*). Several information gaps were identified. We recommend that future research focus on gathering detailed information about selected NTFP species. Information describing habitats, growth requirements, production levels, and response to harvesting is needed to develop sustainable management strategies.

KEYWORDS: non-timber forest products, Robson Valley, inventory, biogeoclimatic ecosystem classification, plants, fungi.

PAGE 2 Because no standard methodologies exist for conducting inventories of

NTFPs, we explored an inventory protocol in the Robson Valley that may be applied elsewhere in British Columbia. Inventory techniques vary according to the life form, and spatial and temporal distributions of the species of interest. For small parcels of land with relatively few species, it may be feasible to complete an inventory by sampling the entire area. However, for large and diverse areas where information on a wide range of NTFP species is desired, a statistically rigorous inventory would be prohibitively time-consuming. A more feasible approach is to relate the occurrence of NTFP species to information in existing inventories. British Columbia uses the Biogeoclimatic Ecosystem Classification (BEC) system to delineate sites across the landscape with potential for similar vegetation, according to climatic and environmental properties. Ecosystem mapping, combined with forest cover inventories that show the current distribution of the dominant vegetation communities, can provide a framework for building an inventory of NTFPs.

PAGE 3 Study Area
The Robson Valley Forest District covered approximately 1.4 million hectares of mostly steep mountainous country. The Fraser River runs through the main valley, which consists of wide, open farmland. Alpine and subalpine ecosystems dominate the landscape, with significant areas of forested land occurring on mid- to lower slopes. A wide spectrum of climatic conditions results in a diversity of ecosystems associated with the valley's topography.

PAGE 8 Non-timber Forest Product Fungal Species List Similar to the NTFP plant list, we developed a list of NTFP fungal species known to occur in British Columbia. Approximately 50 species are reportedly purchased by mushroom buyers in British Columbia (Berch and Cocksedge 2003). These fungi can be grouped into four categories according to their value for:

- food, medicine, and nutraceuticals (deGeus 1995; Wills and Lipsey 1999);
- wildcrafting materials, including natural dyes (Arora 1991);
- industrial applications; or
- traditional uses by Indigenous peoples, such as using woody polypores for carving and as tinder (e.g., Arora 1986; Blanchette *et al.* 1992).

Food mushrooms currently account for the largest volume and value of NTFP mushroom harvests. Of these, pine mushroom (or American matsutake: *Tricholoma magnivelare*), Pacific golden chanterelle (*Cantharellus formosus*), and hedgehog mushroom (*Hydnum repandum*) account for the largest volumes reported by buyers in British Columbia (Berch and Cocksedge 2003).

PAGE 11 The most commercially important NTFP food mushrooms that we found included black morel, pine mushroom, hedgehog mushroom, and winter chanterelle (*Craterellus tubaeformis*). Black morel was reportedly harvested in commercial quantities following a large fire that swept through the Dore River Valley (B.C. Ministry of Forests staff, Robson Valley Forest District, pers. comm., 2000). We found it in minor amounts across a range of age classes on relatively dry, mostly disturbed sites from valley bottom to subalpine locations (Table 3). There were no reports of commercial harvesting of hedgehog mushroom or winter chanterelle. These species were found in relatively high abundance on some sites in association with mature (> 80 years) forests primarily in the ICHmm and ICHwk3 (Table 4). Another NTFP species on our list was the false morel, or brain mushroom (*Gyromitra esculenta*), which has been commercially harvested in the province (primarily for eastern European markets). It contains a deadly toxin when raw that is eliminated through drying or cooking (Arora 1991). This species was notably abundant in evenaged, mature lodgepole pine-dominated forests in the SBSdh at lower elevations within the study area (Table 3).

Most commercially important mushrooms are associated with trees in mutually beneficial associations called mycorrhizae. Mycorrhizal mushroom species stop fruiting after timber harvesting because their mycorrhizal partner has been removed. Although these mushrooms often recolonize regenerating stands, it takes 40– 80 years or more for the fungi to regain abundance. To manage a landscape for timber and NTFP mycorrhizal mushrooms would require the development of plans that integrate the most productive habitat types for the species involved. The Robson Valley LRMP (Robson Valley Round Table 1999) recommends that pine mushroom habitat be identified, mapped, and managed within designated areas. From our investigations, we now have initial pine mushroom habitat information for the Robson Valley to begin an integrated management process. Table 5 summarizes pine mushroom habitat attributes in the Robson Valley.

PAGE 12 Mushrooms present a unique set of challenges to inventory. Fungi are very diverse, occupying a wide variety of microhabitats and serving many different functional roles in the ecosystem. Their fruiting is often ephemeral, and varies both spatially and temporally. Our knowledge of the distribution and habitat relationships for British Columbia fungi is limited—less than 1% of the macrofungi have been documented through formal systematic study for over 90% of British Columbia (Redhead 1997).

PAGE 13 Conclusions
For NTFP fungal species, our results are limited because existing inventory information linking fungal species distributions to BEC classification and age class is sparse. Our investigations confirm that some valuable NTFP fungal species are available for harvesting in the Robson Valley, but we have no data for commercial abundance at this time. This inventory provides baseline information for harvesters wishing to explore commercial opportunities with NTFPs in the Robson Valley. The species reported here cover a broad spectrum of products and a corresponding diversity of markets. Not all of the species we identified are commercially viable for harvest in the valley. For most people involved in harvesting NTFPs, it is an enjoyable activity that connects them with nature and supplements their income.

An Economic Strategy to Develop Non-Timber Forest Products and Services in British Columbia

Forest Renewal BC Project No. PA97538-ORE
Final Report March 15, 1999

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PAGE V Executive Summary
This report describes some of the most economically-valuable non-timber forest products and services emerging from BC wildlands and analyses their associated industries, production technologies and markets. It then presents an economic strategy for rapid development of these industries. The products and services highlighted are:

• wild food mushrooms
• nutraceutical and medicinal mushrooms (*mycomedicinals*) and fungi
• nutraceuticals and pharmaceuticals from plants, bark, lichens, insects, soil organisms, and wood waste
• biocides (non-toxic insecticides) from the same sources
• anti-phytovirals (medicines *for* plants)
• floral greenery
• ecotourism

1. Wild Food Mushrooms—The most valuable BC wild food mushroom export (almost entirely to Tokyo and Osaka) is our species of pine mushroom, *Tricholoma magnivelare.* No one to date has been able to culture pine mushrooms artificially to achieve levels of commercial production, but as the demand and *in-situ* cultivation technologies improve, both pines and mycomedicinals will be grown in dedicated cultivation forests, in mushroom plantations or in commercial agroforestry operations which seek to maximize both timber and pine mushroom production.

PAGE VI C In an “average-to-good” year such as 1996, around 392,000 kgs. of *T. magnivelare* were harvested in BC, but in a less-than-average year such as 1995, this figure falls to around 250,000 kgs. C The Pacific Northwest (BC, Washington and Oregon) supplies around 15% to 20% of the annual Japanese consumption of around 5,000 tonnes of pine mushrooms, which represent a luxury market (and a fall from the mid-1800s when the smaller population consumed around 12,000 tonnes annually.)

In the foreseeable future Japanese consumers will absorb all the pine mushrooms which BC can export; therefore, the limits to export become the limits of sustainable harvesting plus cultivation. These general market prognoses point toward:

• intensive forest-based cultivation of pine mushroom areas to increase the export volume;
• targeting forest types best suited to enhanced commercial yields (coastal and alpine stands of lodgepole pine);
• implementing agroforestry projects in appropriate productive stands;
• more extensive marketing and market research support for the private sector effort in Japan and the US.

Estimating the market value of naturally-occurring pine mushrooms vs. commercial timber in one area of the Nahatlatch watershed, we found that over a 120 year cycle, the value of the pines was about 17% of the market value of the timber. However if pine productivity were increased through the agroforestry technologies used in the Asian cultivation forests, over the same cycle the value of the pines rises to roughly twice that of timber.
To summarize current market activity:

PAGE VII

• there are sixteen active companies harvesting, buying or selling wild food mushrooms from BC, with over 90% of all exports by weight from Vancouver to Japan controlled by seven companies, six of which are Canadian.
• In a good fruiting year for pines, these seven companies have before-tax revenues from pines and from other wild food mushrooms of approximately $45m but in a bad year this figure falls to around $25m.
• Although over the past decade the BC pine harvest has approximately doubled, the average price paid to exporters has remained static - US $l9.00/lb to US $20.00/lb.

Other wild food mushrooms harvested in BC include: chanterelles (around 750,000 kgs. in a good year), boletes (l00,000 kgs.), morels (around 225,000 kgs.) and other species such as lobster, secondary boletes, cauliflower, hedgehog, and such (about 50,000 kgs. together). These other wild food mushrooms are generally sold in Europe, the US and other parts of Canada.
In the bolded items of figure 5, we have attempted to identify Abest bet" wild BC food mushrooms which could be harvested and exported to the US, Europe and Asia.

2. Wild Nutraceutical and Medicinal Mushrooms—Dwarfing the markets for wild food-mushrooms, the 1997 world market for wild nutraceutical and medicinal mushrooms (and extracts and derived products) was US $l.3 billion. BC is one of the world's most economically-valuable, environmentally-pristine sources of nutraceutical and medicinal mushrooms. These include: (a) relatives of species used for centuries in Asia for treatment of specific illnesses and immune

stimulation, and presently used in conventional Japanese medicine. (b) other species being consumed by an aging North American boomer population to maintain good health.

PAGE XIV-XV A. Sectoral Measures
1. Increased Production of Pine Mushrooms - Given the growth potential for pine mushrooms from BC, the underdeveloped state of the industry, a continuing strong price in spite of the Japanese recession and an expanding market in the US, *the provincial government should move aggressively to economically develop the pine mushroom resource*. Provincial government policies can increase both the demand for, and supply of, BC's premium wild food mushroom, *T. magnivelare,* by addressing product quality, export volumes, product price and market size.
Measures to increase volume and productivity include:
• gradually establishing mushroom cultivation forests;
• extending the areas where pine mushrooms fruit;
• adapting technologies prevalent in the cultivation forests of Japan, China and South Korea.

2. Asian Cultivation Techniques - Asia's cultivation forests for pine and other mushrooms offer successful commercial models, technologies and techniques which can be adapted to improve the quality and quantity of BC's pine and mycomedicinal harvest. Cultivation techniques include:
-cutting shrubs and selected trees as a forest ages for aeration and sunlight on the forest floor;
-changing the litter thickness and adding wood pulp waste, artificial irrigation tunnels or small plastic hoods over colonies of pines (called *shiros*) to control soil humidity and temperature;
-pest control, fertilization and a host of other technologies to entice more pine production *in-situ*.

We therefore suggest that:
• The provincial government should direct its chief mycological expert to assemble a team to conduct adaptive research tours of the cultivation forests and pine mushroom research facilities in Japan, China and South Korea.
• With findings from these tours, the government should publish an initial simple language document aimed at buyers, exporters, growers, pickers, and new ventures describing the techniques and technologies successfully used with related species in Asia and associated productivity gains, the applicability of these techniques for BC conditions and species, and specific agricultural techniques to maximize pine production here. C The Ministry of Forests should then initiate a program of adaptive research designed to increase pine mushroom production in BC and contract much of it out to the private sector and research institutions.

PAGE XVI 4. Research on Sustainable Harvests - As we still do not have the most basic information about quantities of pine mushrooms or mycomedicinals growing in BC, research is necessary to create baseline estimates of fruiting to ensure that harvests are sustainable. These adaptive research areas hold the greatest short-term potential for new jobs and products.

5. Promotion of BC Pine Mushrooms in Japan - The provincial government should increase Japanese consumer awareness of BC pine mushrooms. A provincially-funded exhibition of industry participants touring four or five smaller Japanese cities would receive extensive media coverage and be well-attended. This should be repeated about every four to five years.

6. Introduction of “Stemage” **-** If cultivation forests for pine mushrooms are to be made available to the private sector through a variety of arrangements, we must rethink forest land tenure and introduce the notion of *stemage*—the forest botanical equivalent of stumpage: a small amount paid to the provincial government per unit of forest botanical gathered from Crown land. Eventually it will be appropriate to set up a system for botanical stemage, but given the nascent nature of the non-timber industries, the government should forego such revenues for a decade or more.

7. License Buyers of Pines - The 1995 recommendation of the Pine Mushroom Task Force, that buyers of pines from crown lands be licensed, should be immediately implemented. A fee should be charged to purchase the license with appropriate fines for non-compliance, and a condition of licensing should be the bi-weekly provision of information about: the species bought; date of purchase; weight and grade purchased; price paid per grade, and the buying station location. Most buyers keep this type of information anyway, and to lessen the data burden, this information could be summarized. Given the potential value of pine mushrooms to BC, data on the gathering and sales should be tracked. There is currently no way to obtain even approximate data. As the problems in this system are ironed out, licensing of buyers should be gradually extended to other botanicals.

PAGE XVII

8. Support Local Processing and Preparation Facilities - The provincial government, through its agricultural and technology support programs, should help the private sector to build pine mushroom processing and preparation facilities near some of the prolific gathering areas, starting with the north-west region. The lack of such facilities both inhibits growth and drains away employment opportunities. For example, a major factor limiting growth of the Nass region industry is the absence of proper processing facilities. Since much of the gathering is done by transient efforts of large Vancouverbased companies, most wealth produced by the industry leaves the community, and northern businesses are not able to generate jobs. Both primary and secondary processing of pine mushrooms can be done locally, with job opportunities for local communities and first nations. Benefits include:

• better-paying jobs and value-added employment in poor regional economies. (Harvesting is often seasonal, low-paying and devoid of benefits; better jobs exist in processing and marketing the mushrooms.)
• greater efficiency, if activities such as eliminating infested produce, processing for specific orders, and preparing shipments for delivery are done locally.
• time savings. Local processing could shave half a day off of the transition time to Japan and enhance product freshness, a major price factor. If the infrastructure for pine mushroom processing also included mycomedicinals, new job sources could be created for small communities in several parts of the province.

PAGE 4
III. Wild Food Mushrooms
Introduction
Many wild forest mushrooms are commercially harvested in BC. The most valuable of these are typically ectomycorrhizal such as the pine mushroom, (*Tricholoma magnivelare)*, chanterelles, boletes, truffles and hedgehogs. At the present time truffles are the only ectomycorrhizal food fungus which is in widespread cultivation in the Pacific Northwest (only in Washington and Oregon states).

PAGE 8 Since pine mushrooms are obligate mycorrhizal partners with trees, to date no one has been able to culture them artificially to the levels of commercial production.

PAGE 10-11 Market Values for Pine Mushrooms vrs. Timber
Freeman's data also allows us to perform a crude estimate of the comparative market value of the pine mushrooms versus the value of the timber in one area of the Nahatlatch Watershed. The timber in this area is mainly open stands of H Class 7-8 Douglas Fir which are approximately l40- 250 years old, plus Hemlock and Balsam. Excluding non-commercial cottonwood, aspen, birch and maple, Figure 4 presents volume estimates of the main commercial species growing in 27,683 ha. of the Nahatlatch Watershed. These prices in Figure 4 are averaged from six months of prices during l998. The average market price used for pine mushrooms in these calculations was US $20/lb, a three year average.

Freeman's figures for the pine mushroom crop were taken in a good year. If we conservatively assume:
(l) on average that annual yearly fruiting of pine mushroom volume on this 5,988 ha parcel of land is half of his value;
(2) that all of the logs are harvested and sold after the accepted maturity cycle of l20 years and that all of the mushrooms are harvested annually;
(3) that all of the timber in figure 4 is currently mature and evenly distributed over the entire 27,683 ha, then we can do an area conversion and compare the crude market value of timber growing on the smaller parcel over a l20 year maturity cycle with the value of the pine mushrooms. Thus assuming that this land is

clearcut now and again after l20 years, and also assuming that prices for timber and pine mushrooms remain stagnant or rise proportionally, the timber will fetch approximately Can. $426 million with two harvests. But if only pine mushrooms are harvested, they will fetch approximately Can. $73 million in constant l998 dollars over the 120 year cycle, or around l7% of the market value of the timber.

This comparison is, of course, based on a wild productivity level of around l.65 kgs./ha harvest. If we assume that Asian agroforestry techniques could be rapidly introduced into this area, then the percentage quickly increases. Assuming, for example that half of the 5,988 ha achieves half of the anticipated 35th year productivity level at Kyoto, that is, 50 kg./ha, then over two timber harvests or l20 years, the value of the pines is roughly twice the value of the timber.

PAGE 11 BC Industry Structure
We were able to identify sixteen active companies exporting wild food mushrooms (of several species) from BC. Over 90% of all exports from Vancouver to Japan of pines are controlled by seven companies, (six of which are Canadian-owned). In a good fruiting year for pines, these seven companies have collective before-tax revenues from pines and other mushrooms of approximately Can. $40-$45 million but in a bad year this figure can fall to around Can. $25 million. Individual mushroom revenues of these seven companies ranged in a good year from Can. $22 million to under Can. $l million. We have identified only three BC companies involved in the export of nutraceutical and medicinal mushrooms, however there are dozens in Oregon and Washington states.

PAGE 12 Comparatively little is known about the biology or ecology of our species of pine mushroom, *T. magnivelare.* Most of what we know is based on inferences from Japanese research on a sister species, *T. matsutake.* In spite of the fact that *T. magnivelare* is our most valuable wild food mushroom with apparently guaranteed markets, little research has been performed in BC. S. Berch (l996) has conducted a year of field work with the Nisga’a Tribal Council in the Nass Valley developing procedures to assess pine productivity and ecology, and F. Fogarty through Master’s work (l999) has investigated the saprophytic and mycorrhizal capacity of pine mushrooms and has also correlated timber harvest methods with pine production (l998).

The mycelial biomass of these isolates is presently being expanded on both solid and liquid media for use as inoculum for pine mushroom enhancement trials in the Sunshine Coast Forest, and Fogarty is currently examining a number of field inoculation methods in both first and second growth forests including:
1) Spores isolated from pine mushrooms and directly applied to specific candidate trees in Douglas fir/ western hemlock stands.
2) Sporocarps (whole mushrooms) ground up and incorporated as a slurry to soil.
3) Vegetative mycelium-tissue cultures isolated from young #1 mushrooms (buttons or primordia) applied both in the field and laboratory inoculation trials.

4) Spawn-increased mycelial biomass (both on solid and liquid media) applied as above.
5) Seedling transplants - select species of tree seedlings planted into the colony or shiro in the field and resulting colonized seedlings transplanted to new sites in both first and second growth stands.
6) Shiro transplants- prior to timber harvest pine mushroom colonies are located, and removed (literally dug up) and relocated to adjacent stands (F. Fogarty personal communication).

PAGE 13 Other Wild Food Mushrooms (Chanterelles, Morels, and Boletes):
Chanterelles
In a good year, approximately 750,000 kgs. of chanterelles are harvested in BC, although in a bad year, this harvest can fall to a quarter of this number. (Experienced pickers believe that the main factors effecting fruiting are the amount and timing of air and ground temperature and moisture). The main regions where chanterelles are harvested (in decreasing comparative quantities) are Vancouver Island, Haida Gwaii, Powell River, the Sunshine Coast and the areas around Chilliwack, Hope and Pemberton.

PAGE 17 IV. Medicinal and Nutraceutical Mushrooms
The medicinal and nutraceutical mushrooms, extracts, and products built on these have greater economic potential for BC than the wild food mushroom crop.

Many anti-tumour components have been developed from mushrooms in Japan and commercialized into products (Mizuno l995). In addition to general immune-boosting properties, many mushroom and mycelium derivatives have also been found effective, to varying degrees as anti-viral, anti-bacterial and anti-parasitic agents and in alleviating certain side effects of acquired immune deficiency syndrome (Mizuno *et al.* 1995).

PAGE 18 Polysaccharides and other ingredients in fungi such as terpenes and steroids have also been found to have antibiotic and antiviral properties, to reduce the levels of lipids in blood and to lower blood pressure. Ingredients in medicinal mushrooms have clinically been found to stimulate the production of white blood cells, antibodies and interferon (an anti-viral protein) and to inhibit the synthesis of prostaglandins (locally acting hormones which regulate blood vessel size). Other fungal extracts such as those from *Lentinula edodes* have been found to inhibit HIV infection of *in vitro* cultured human T cells in clinical trials (Iizuka *et al.* l990, l990a) and in a variety of cases have been found to extend the survival rate of patients with illnesses ranging from Hodgkin’s disease to lymphosarcoma, and pancreatic cancer (Hobbs l995). Although polysaccharides are a broad and common type of molecule present in the majority of the food we eat, specific polysaccharides such as PSK, which are present in a wide variety of BC fungi, are thought to have the medicinal properties described above.

(Many of the fungal extracts which are classified as drugs in Canada are classified as food supplements in Japan. This fact is taken up in the policy sections).

PAGE 19 Certain adaptogenic mushrooms (together with many other health herbs such as *Panax ginseng)* also contain large amounts of the element germanium (Reynolds l993, see also Hung-Cheh and Mieng-Hua l986) which both increases the absorption and use of oxygen in body tissue and protects from damage arising from free radicals which are generated by such extra oxygen.

PAGE 26 2.The Japanese and Asian markets for medicinal fungi and extracts - The Japanese market in l997 for nutraceuticals (of all types, not just mushrooms) was approximately US$ 4 billion. (KPMG l997). In Japan and other Asian countries, regulatory health claims are permitted, healthcare reimbursement for nutraceuticals is allowed and nutrition is stressed in medical curricula.

PAGE 79 In spite of a large potential BC land base compared for example to Korea for the cultivation of pine mushrooms, the industry is nascent here in relation to that small country's production, and the entire Pacific Northwest export of pines reached around 500 tonnes only in l995. In a good year, Korea exports over l,000 tonnes. Secondly, infrastructure investments in pines in relevant areas will substantially increase the value of stands with marginal value timber; for example, stands of coastal and alpine lodgepole pine are appropriate for pine mushroom cultivation forests and not much else commercially.

PAGE 84 Of all the species suggested in Figure 7, we need to know which will prove to be the most economically valuable in the markets of Japan and the US over the next few years, and of these, the species' biological productivity, the species' reactions to harvesting techniques and the best harvest practices, the processes according to which the species grow, timing of optimal harvest and sustainable harvest levels. (Virtually all of these issues are being examined for pine mushrooms by Oregon's Forestry Research Station, which is why, in the context of pine mushroom research, we have suggested that this work not be duplicated but rather that BC researchers mainly concentrate on adapting agroforestry productivity techniques from Asian operations for pines). Several of our Canadian mycomedicinals such as *Ganoderma applanatum and G. tsugae* may contain equivalent therapeutic ingredients as such Asian "best-sellers" as *Ganoderma lucidum*, and could therefore be promoted world-wide as the BC Reishi. The government therefore should fund laboratory analysis of the ganoderic acids, triterpenes, polysaccharides and other ingredients in selected BC medicinal and nutraceutical mushrooms and, since consumer awareness of research partially drives markets, help popularize the results.

PAGE 85 The nutraceutical and medicinal mushrooms raise the problem of the commons. We are currently treating non-timber forest products such as pines as if they were non-market goods. They are market goods and it is reasonable that the provincial government eventually collect a small fee from each unit volume or unit weight of forest botanicals gathered on Crown lands.

Commercial harvests of edible mushrooms from the forests of the Pacific Northwest United States: issues, management, and monitoring for sustainability

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Abstract
Widespread commercial harvesting of wild edible mushrooms from the forests of the Pacific Northwest United States (PNW-US) began 10–15 years ago. A large proportion of suitable forest habitat in this region is managed by the Forest Service (US Department of Agriculture) and Bureau of Land Management (US Department of the Interior). These lands are managed under an ecosystem management philosophy that entails multiple-use, sustainable forest product harvesting, resource monitoring, public participation in forest management issues, and holistic planning. Managing the harvest of edible mushrooms engages every aspect of this management philosophy. We examine a variety of issues raised by mushroom harvesting and how these issues interact with forest ecosystem management choices. We discuss regulations currently being used by managers to conserve the mushroom resource while further information is gathered, unique challenges and considerations inherent to sampling fungi, and current research and monitoring activities in the Pacific Northwest. Although current scientific evidence suggests that harvesting likely will not harm the resource in the short term, no statistically-based monitoring information exists about the cumulative impacts of intensive and widespread commercial harvesting over long- time periods. We outline a three pronged approach to long-term monitoring of the resource: (1) tracking harvest quantities in areas with intense commercial harvests; (2) sampling productivity in areas with no mushroom or timber harvests; and (3) conducting research to model the relations between forest management and mushroom productivity. Public participation and a broad collaboration among public land management agencies, private forest landowners, forest managers, researchers, and research organizations will make this approach cost effective and the results widely applicable.

Keywords: Ecosystem management; Edible mushrooms; Fungi; Monitoring; Mycorrhizae; Nontimber forest products; Pacific Northwest

PAGE 1 Some Native American tribes harvested mushroom for various uses, but we lack evidence of widespread consumption.

PAGE 5 Does harvesting, per se, diminish subsequent fruiting? Insofar as mushrooms are the reproductive structures of mycelial colonies, the picking of mushrooms has often been compared to picking apples from a tree; that is, the organism itself is thought to be only minimally impacted. Indeed, two studies with chanterelles indicate that, in the short term and on small scales, this is likely true. The Oregon Mycological Society Chanterelle Study (Norvell, 1995) examined harvesting per se and methods of harvest (plucking or cutting the mushrooms); after 10 years, no declines in productivity were noted. Egli et al. (1990) report that in Switzerland, 10 years of harvesting had no significant effect on the continued fruiting of 15 different ectomycorrhizal mushroom species. Trampling, however, dramatically reduced chanterelle (Cantharellus lutescens Fr.) fruiting for a year. This impact was attributed to damaged sporocarp primordia, because fruiting returned to previous levels the following year when trampling stopped.

Although it appears that harvesting is unlikely to harm ectomycorrhizal mushroom species in the short term, the long-term impacts of widespread intensive harvesting are not known. Concern might be greater for saprobic species that colonize coarse woody debris than for ectomycorrhizal species. Examples of edible saprobic mushrooms from the PNW-US include chicken of the woods or sulfur shelf (Laetiporus sulphureus (Bull. ex Fr.) Murr.), lion’s mane (Hericium abietis (Weir ex Hubert) K. Harrison), angel wings (Pleurotus porrigens (Pers. ex Fr.) Kummer), and the cauliflower mushroom (Sparassis crispa Wu¨lf. ex Fr.). Several saprobic medicinal species are also collected commercially, namely Ganoderma tsugae Murr. and Ganoderma oregonense Murr. (Hobbs, 1995), and more species are likely to be identified.

PAGE 6 They also might be more dependent on repeatedly colonizing new substrates than ectomycorrhizal species, because the wood they decompose could be depleted of usable nutrients within a decade or two, while ectomycorrhizal species might persist for the life-time of their arboreal symbionts or longer if compatible host trees regenerate quickly after a stand replacement event. If wood decay species are dependent on regular spore dispersal for colonizing new substrates, or if they have fewer opportunities to reproduce due to timber harvests that do not leave coarse woody debris, then their reproduction might be hampered by widespread harvesting of their sporocarps. Saprobic species are easier to propagate than ectomycorrhizal species and increased cultivation could ameliorate concerns about harvesting wild populations (Stamets, 1993).

Clearcut harvesting, for instance, interrupts the fruiting of most edible ectomycorrhizal fungi for a decade or more while they become reestablished on new tree hosts and the trees grow large enough to provide the fungi with sufficient carbohydrates or appropriate metabolites to support fruiting. By contrast, some of the tree hosts for ectomycorrhizal fungi are usually retained when stands are thinned. Thinning intensity influences to what degree and for how long fruiting is affected. Thinning also influences fruiting conditions by allowing rain and sunshine to penetrate the forest canopy more easily than in nonthinned stands, resulting in more rapid wetting and drying of the forest floor. Unpublished data from a thinning study on the Willamette National Forest in Oregon shows that heavy thinning (from 615 to 125 trees per ha) of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) reduces chanterelle fruiting by 90% in the following year. We do not yet know how quickly mushroom productivity will rebound as remaining trees reoccupy the site, but recovery rates are needed to understand the effects of thinning on total mushroom production during a timber rotation. Frequent light (few trees removed) thinning during a timber rotation might maintain mushroom productivity better than infrequent heavy thinning because the mycorrhizal host trees would retain nearly full photosynthetic occupancy of the site. Conversely (depending on logging systems) frequent light thinning could also result in more soil compaction than infrequent heavy thinning, thus impairing mycelial growth of the fungi in the soil and reducing long-term mushroom production (Amaranthus et al., 1996).

Ground-based logging systems cause more soil compaction than cable or helicopter suspension, or logging on top of snow, hence are more likely to diminish long-term mushroom productivity. Ground-based logging systems also cause more disruption of litter layers than suspension systems, potentially resulting in short-term effects similar to raking. The long-term effects of this disturbance on microenvironments for mushroom formation and growth are not known.

PAGE 6-7 Ectomycorrhizal fungi exhibit varying degrees of specificity for host tree genera (Molina et al., 1992), therefore tree species selection during planting or thinning influences mushroom occurrence and production. PNW-US tree genera, such as Abies, Alnus, Arbutus, Castanopsis, Larix, Lithocarpus, Populus, Picea, Pinus, Pseudotsuga, Quercus, and Tsuga form ectomycorrhizae with fungi that produce sporocarps, whereas other genera, such as Acer, Calocedrus, Chamaecyparis, Sequoia, Sequoiadendron, Taxus, and Thuja form a different type of mycorrhizae (arbuscular mycorrhizae) with fungi that reproduce primarily with individual spores in the soil rather than sporocarps. Stand composition and dominance of ectomycorrhizal host trees relative to arbuscular mycorrhizal trees likely affects the quantity of carbohydrates available to ectomycorrhizal fungi for fruiting.

Fires that kill trees are known to shift the composition of ectomycorrhizal fungal communities (Visser, 1995; Horton et al., 1998; Barr et al., 1999). When soil litter layers are consumed, the abundance of ectomycorrhizae at the interface of organic and mineral soil layers is reduced (Stendell et al., 1999) but the effects of

less intense fires are not as dramatic (Jonsson et al., 1999). Tree seedlings that establish in burned areas can be colonized by ectomycorrhizal fungi through persistent spores in the soil (Horton et al., 1998) wind blown spores, or residual mycelia associated with surviving trees or brush species (Amaranthus and Perry, 1994). Little is known, however, about the influence of forest fires on the productivity of edible ectomycorrhizal mushrooms other than the fact that stand replacement fires inhibit fruiting until a new stand develops.
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.

PAGE 7 We know of no studies investigating the relations between pesticide applications and edible forest mushroom production or consumption. Herbicides are sometimes used to release newly planted conifers from competition by broadleaf trees and shrubs, but commercially harvested ectomycorrhizal mushrooms usually begin fruiting 5–15 years later as the conifer stand develops, so that only persistent compounds or recent drift from nearby areas are potential hazards.

We are not aware of any research investigating the influence of grazing on edible mushroom production, but if compaction becomes severe, hyphal growth near the soil surface could be inhibited. In the PNW-US, grazing occurs in drier forests where few edible mushrooms, other than morels, are commercially harvested.

PAGE 7-8 Given the numerous mushroom species harvested, the diversity of forest types they inhabit, and the wide range of silvicultural systems that foresters use, many opportunities remain to improve management of mushrooms through better understanding of their biology, ecology, and ecosystem functions. Additional information is needed about sexual and asexual modes of reproduction, spore dispersal mechanisms, and factors influencing colony establishment, health, growth, senescence, and death. Fungi have complex breeding patterns that complicate their population dynamics. Forest conditions that facilitate reproduction differ on time scales from days (favorable weather) to centuries (episodic disturbance events such as forest fires that create new habitats). Recent research (Dahlberg and Stenlid, 1994; de la Bastide et al., 1994; Bonello et al., 1998) is just beginning to characterize ectomycorrhizal colony sizes, longevity, and population structures, but species-specific investigations are needed to understand how colonies and populations of edible mushrooms will respond to forest management activities. Forest fungi, including edible mushrooms, contribute to healthy forests and food webs in ways too numerous to discuss here (Carroll andWicklow, 1992; Molina et al., 1999; Read et al., 1992), and managers should consider these ecosystem roles and functions when developing mushroom harvest regulations or management plans.

PAGE 8 Complete ecosystem management plans must incorporate economic information too. Many forest-associated rural communities have suffered economically and socially from reductions of timber harvesting on federal lands. Development of NTFP enterprises can play a role in ameliorating these impacts, especially if companies can depend on reliable resource supplies from federal lands to support local processing and value-added activities.

PAGE 8-9 As another example of economic issues, the value of annual mushroom harvesting has been used by conservation organizations as an argument for appealing timber sales. Although clearcut harvesting will arrest the fruiting of ectomycorrhizal mushrooms for a decade or more and thinning can suppress fruiting, mushroom harvesting and timber growing can be compatible activities during much of a timber rotation. We lack adequate information for accurate assessments of discounted present net worth for mushrooms, but several illustrative scenarios comparing timber and mushroom values have been developed (Liegel, 1998; Pilz et al., 1999) Using these methods, managers can modify assumptions or insert site-specific data to analyze the economic consequences of local decisions. Importantly, the harvest of mushrooms benefits different individuals, companies, and customers than does timber harvesting, and many other NTFPs and amenities are derived from any given forest.

PAGE 9 Avariety of measures have been adopted on federal lands to ensure conservation of the resource until more is known about the long-term impacts of intensive commercial mushroom harvesting. For instance, in the Winema and Deschutes National Forests, the commercial matsutake harvest season begins in mid-Sep- tember, after the first hard frost. Matsutake that fruit earlier in the season are often riddled with insect larvae and have little commercial value. This arrangement allows the first flush to disseminate spores without greatly reducing the potential value of the commercial crop (Pilz et al., 1999).
Page 10 With the advent of molecular techniques of DNA analysis, fungi can be identified from ectomycorrhizal root tips (Goodman et al., 1996; Bruns et al., 1998) a development that is rapidly advancing ecological studies of ectomycorrhizal fungi.

Because weather patterns can cause large annual variations in mushroom productivity, many years of sampling are needed to estimate the average or potential productivity of a site or habitat over time (Luoma and Frenkel, 1991). Potential long-term productivity might be more precisely estimated if a covariate, such as the percentage of ectomycorrhizae colonized by the fungal species of interest, was also estimated. Processing individual root tips for genetic analysis is time consuming and labor intensive but, if marker systems using monoclonal antibodies were developed, quick counts of how many ectomycorrhizae were formed by a targeted species of fungus could be obtained from soil cores. Currently estimates of mushroom productivity are still derived from sampling the sporocarps.

PAGE 11-12 Abundant mushroom habitat, a diversity of forest landowners, extensive mycological expertise, and avid public interest have provided a broad base of support for edible mushroom research in the PNW-US. University researchers and mycological societies have undertaken ecological (Largent and Sime, 1995; Hosford et al., 1997), harvest impact (Norvell, 1995), taxonomic (Redhead et al., 1997), sociological (Richards and Creasy, 1996; McLain et al., 1998; Liegel, 1998) and economic (Schlosser and Blatner, 1995; Blatner and Alexander, 1998) studies. Scientists with the Pacific Northwest Research Station (a branch of the USDA-FS) and Oregon State University (OSU) have conducted productivity (Liegel, 1998; Pilz et al., 1999), resource valuation (Liegel, 1998; Pilz et al., 1999), and forest management (Liegel, 1998; Weigand, 1998) research on edible fungi. Ongoing research (Pilz and Molina, 1996) includes the impact of raking soil litter layers to find young matsutake; the effectiveness of silvicultural treatments designed to enhance matsutake fruiting; how wildfire and other disturbances affect morel production; how thinning of young stands influences subsequent chanterelle production; revised taxonomic distinctions among species of chanterelles and morels; and describing the population genetics of morels, chanterelles, and matsutake.

PAGE 12 Concern about the sustainability of large-scale commercial mushroom harvesting in the Pacific Northwest is partly based on declining crops in traditionally harvested areas of Europe and Japan (Arnolds, 1991; Arnolds, 1995; Hosford et al., 1997). Air pollution, climate change, industrial timber management, native and exotic diseases and pests, conversion of forest lands to other uses, road building, and intensive mushroom harvesting all have the potential to affect habitat and long-term production. To address these concerns, we have outlined a collaborative regional research and monitoring program based on tested sampling protocols (Pilz and Molina, 1998). One component will consist of measuring commercial productivity on highly productive sites by cooperating with selected commercial harvesters to record what they collect in discrete areas where they have exclusive access. A second component entails estimating productivity in natural areas where neither mushroom nor timber harvesting occurs (hopefully with field assistance from mycological societies); these sites will be used to discern trends associated with pollution, climate change or habitat degradation and to interpret trends noted in commercially harvested areas. Both components require commitments by participating landowners to long-term, albeit frugal monitoring activities. A third component will create predictive models relating edible mushroom occurrence and productivity to habitat factors, such as site fertility, climate, or plant association, and906 silvicultural characteristics, such as stand age, density, growth rates, and species composition. This modeling component is a short-term project (approximately 7 years) and should help managers predict how their silvicultural activities can affect edible mushroom crops over long periods as the mosaic of forest conditions shifts across the landscape. 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.

Plants Our Living Resources

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PAGE 189 This section describes trends in two of the major kingdoms of life on earth: the green plants of the Kingdom Plantae and the molds, lichens, and mushrooms of the Kingdom Fungi. Members of the plant and fungal kingdoms have both economic and ecological importance. Plants transform solar energy into usable economic products essential in our modern society and provide the basis for most life on earth by generating oxygen as a product of photosynthesis. Fungi not only mediate critical biological and ecological processes including the breakdown of organic matter and recycling of nutrients, but they also play important roles in mutualistic associations with plants and animals. Members of the Kingdom Fungi also produce commercially valuable substances including antibiotics and ethanol, while other fungi are pathogenic and cause damage to crops and forest trees. Because fungi and plants play such fundamental roles in our lives, it is important to have a comprehensive knowledge of the taxa comprising these groups. However, at a time when we are increasingly recognizing the importance of these groups, we are impoverishing our biological heritage. Rates of species loss are reaching alarming levels as ecosystems are degraded and habitat is lost. This erosion of biological diversity threatens the maintenance of long-term sustainable development and protection of the earth's biosphere.

Microfungi: Molds, Mildews, Rusts, and Smuts

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PAGE 190 Fungi are a group of organisms that exist as a vast network of tiny threads growing in and out of all kinds of organic matter. As they grow, the threads secrete enzymes that break down the substances around them, releasing nutrients into the environment. Without fungi, the world would be completely covered with organic debris that would not rot, and nutrients would not be available for plant growth. All plants would die.

Among the multitudinous molds are humble servants such as *Penicillium notatum*, the source of penicillin, and *Tolyposporium niveum*, a producer of cyclosporin, the immune-system suppressant used for organ transplant operations. In sustainable agriculture the fungal performers are agents of biological control and crop nutrition, helping the environment through the reduced use of chemical pesticides and fertilizers. Fungi can stop a hoard of locusts by attacking the chitinous insect exoskeleton or control nematodes that destroy the roots of crop plants (CAB 1993). Although strains of fungi can degrade plastics and break down hazardous wastes such as dioxin (Jong and Edwards 1991), only a fraction of these fungi have been screened as beneficial organisms.

PAGE 191 Within the United States, information has been published about 13,000 species of microfungi on plants or plant products (Farr et al. 1989), probably only a fraction of the species thought to exist. Specimens of microfungi are housed in the U.S. National Fungus Collections and other institutions that serve as reservoirs of information and documentation about our nation's natural heritage. By comparing the species reported in the literature with those represented in the collections, one can estimate the number of microfungi known in the United States at 29,000 species (Farr et al. 1989). In areas of the world where fungi have been well studied, the ratio of vascular plants to fungi is about 6 to 1, suggesting that there may actually be 120,000 species of fungi within the United States.

Although the numbers and kinds of fungi in the United States are not known, information about the microfungi associated with plants and plant products in the United States is available over Internet at this telnet address: FUNGI.ARS-GRIN.GOV. After the word *OK* appears on the screen, type *login user;* when prompted for a password, type *user*. By doing this, anyone can find out what fungi might occur on the flowers in his or her own backyard.

A program to inventory and monitor microfungi in the United States does not exist at present; thus it is impossible to determine if species of microfungi are increasing or declining. Efforts to document the biodiversity of microfungi in the United States are limited to reports by plant pathologists who encounter disease-causing organisms or search for useful biological-control organisms. Information about the occurrence and biology of microfungi will increase the ability to make accurate decisions about the importation of agricultural products, to control microfungi already present, and to determine if beneficial microfungi are being lost because of habitat destruction. With increased knowledge the unexplored world of microfungi can be put to work to solve our most pressing environmental and agricultural problems.

Macrofungi

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PAGE 192 Considering the human, ecological, and economic importance of these organisms, it is somewhat surprising that there is not a good estimate of the number of species of macrofungi that occur in North America.
Better estimates exist for species diversity of the other groups of North American macrofungi. Gilbertson and Ryvarden (1986, 1987) treated more than 400 species of polypore fungi, Smith et al. (1981) listed nearly 300 species of puffballs and relatives, and Seaver (1942, 1951) covered more than 350 species of cup fungi and other macro ascomycetes. Based on these data, it is reasonable to predict that there are 5,000- 10,000 species of macrofungi in the United States. A compilation of herbarium records in U.S. and Canadian museums and universities would provide a good first step in predicting the diversity of these organisms.

PAGE 193 Intensive collecting of edible fungi such as chanterelles, *Hydnum*, and boletes might also be negatively affecting fruiting patterns of these fungi, but additional data are needed to document this. In any case, the observed change in fungal fruiting is correlated with a decline in forest health, but cause and effect are hard to document. Rigorous studies to determine if similar trends in macrofungi fruiting patterns have occurred in the United States do not exist.

PAGE 194 Satellite imagery has been combined with a long-term mapping program of fungal fruitbodies to assess the relative health and growth of particular tree-mycorrhiza fungus pairs in southern Mississippi (Cibula and Ovrebo 1988). This approach shows great promise for directly investigating the effect of certain fungi on tree health. These data, however, are based only on aboveground information, and there is still some question about how well the appearance of fruitbodies growing under a particular tree predicts what fungi are forming mycorrhizae with that tree at that time. To address this question, researchers have developed molecular techniques using DNA amplification procedures to compare the mycorrhizae on the roots of certain trees with fungal fruitbodies occurring near the tree (Bruns and Gardes 1993). The preliminary data documented that there is not always a one-to-one correlation between fruitbodies and mycorrhizae, and that caution must be used when using fruitbodies alone.

More work is needed to document the status and trends of macrofungi in North America. These data are vital because of the integral role that macrofungi play in forest systems as decomposers and recyclers, plant pathogens, mutualists, and food for small mammals, and because of the growing commercial importance of these fungi.

Truffles, Trees, and Biodiversity

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PAGE 193 Truffles (ascomycetes) and the similarappearing false truffles (basidiomycetes) play a major role in determining the structure and function of forest ecosystems by providing nutrients to many economically valuable trees in exchange for carbohydrates from the trees. This mycorrhizal (fungus root) symbiosis is obligate; that is, truffles and trees, especially conifers, cannot survive without each other. One of the problems in reforesting large areas of the Southwest is identifying ectomycorrhizal fungi suitable for inoculation of tree seedlings destined for sites with calcareous soils.

Truffles and false truffles are food items for many animals, including many endangered or threatened species. In old-growth Douglas-fir (*Pseudotsuga menziesii*) forests, truffles not only provide soil nutrients to the trees controlling forest structure, but they also are an important link in the food web supporting the endangered spotted owl. Northern flying squirrels (*Glaucomys sabrinus*) glide down to the forest floor at night to feed on truffles. While feeding on truffles, flying squirrels become vulnerable to predation from the northern spotted owl (*Strix occidentalis caurina*), coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and other predators.

Given the undeniably important role of truffles in determining the structure and function of forest ecosystems, how much is known about the distribution of truffles and false truffles? The paucity of information and potential impact of surveys on our knowledge base can be illustrated by an ongoing National Science Foundation-funded survey of the Great Basin, an area of 712,250 km2 (275,000 mi2) between the Sierra Nevada and Wasatch mountains and including most of Nevada and parts of California, Idaho, Utah, Wyoming, and Oregon. No truffles or false truffles had been reported from the area before the survey. Over three summers, the survey produced 1,119 collections of truffles and false truffles from 40 mountain ranges.

In addition, the survey produced evidence for extinction of many truffles in the Great Basin. A few truffles obligately associated with a single tree species outside the Great Basin have switched within the Great Basin to new tree species, providing supporting evidence for extinction of local tree species. New endemic species have been found and the geographic ranges of some species greatly expanded. Populations of some endemic species are restricted to a single mountain range.

Knowledge of truffles is important to the biodiversity in the United States. Without such knowledge, there is a danger of losing or degrading ecosystems through ignorance about the status of keystone fungal species. If ecosystems are lost, then species dependent on specific ecosystems will also be lost.

Seeing the Forest Beneath the Trees: The Social and Economic Potential of Non-Timber Forest Products and Services In the Queen Charlotte Islands/Haida Gwaii

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This is the final report to the South Moresby Forest Replacement Account
Funding for this project was provided by the South Moresby Forest Replacement Account, a joint initiative of the Government of Canada and the province of British Columbia

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4.1.2 Age class relationship to mushroom productivity and timber rotation
The most productive sites for edible wild mushrooms depend on various forest conditions, one of which is the age class of the forest. Studies and anecdotal information from harvesters indicate that chanterelles, for example, are most productive on younger sites where the trees range in age from about 25 or 30 years to 80 years (Pilz, Molina et al., 1998b; pers. com. Brian Eccles). The chanterelle does not appear to be abundantly productive in old growth stands. On the QCI/HG, this is apparent by examining one of the Island's most productive sites located around Skidegate Lake, which has stands of close to 45 years of age, and in numerous other sites of similar ages where the chanterelle is most productive. In contrast, pine mushrooms in northwestern British Columbia appear to be most productive in stands between the ages of 60 to 160 years (Trowbridge et al., 1999). This suggests a complimentary relationship between

timber harvesting and mushroom productivity over the long-term: chanterelles thrive in younger forests and timber harvesting ensures a constant supply of young forests.

In the short-term, however, timber harvesting precludes any further site specific mushroom production for at least 20 years, depending on the silviculture system used (i.e., subsequent light penetration).11 Depending on the value of the timber and its end use, forest companies begin to include second growth stands in their development plans when the trees approach 45 to 80 years of age. On the QCI/HG, cut blocks on some highly productive mushroom sites in the Skidegate Lake area have been or are selected to be harvested.12 In this case, mushrooms and second growth timber have become competing uses as the desire to harvest both products converge during some of the mushroom's most productive growing period. After the trees reach approximately 80 years of age and mushroom productivity declines, the uses generally revert to being complimentary.

FOOTNOTE: 11 While timber harvesting will affect mushroom production, studies have not been conducted on QCI/HG to examine the differing effects of alternative silvicultural systems, such as partial retention or selective logging.

PAGE 41 Does society derive greater benefit from an early timber harvest that invariably affects the production of mushrooms, or would society be better served if the minimum timber harvesting age were greater than 80 years for the specific site type that produces the greatest volume of chanterelles? Further biological, productivity and economic research is required for an answer,13 but the question highlights the need to better understand these relationships and learn more about NTFPs. To achieve a process of land management that incorporates NTFPs into the planning process, mapping the location of productive mushroom sites will be necessary. Without this knowledge, it is doubtful that a large area, such as Skidegate Lake, will be protected from further logging development.

PAGE 44 Multi-year baseline biological, economic and social information is needed to make informed decisions on how best to manage the harvest of NTFPs. Several issues, many of which have been raised elsewhere in this report, point to the need for monitoring:

• Ecological concerns, such as potential effects of over-harvesting, the natural productivity of the resource, garbage and other environmental effects related to the influx of harvest labour; and
• Socio-economic concerns, such as the value and commercial productivity of the non-timber resource, the labour it supports, the income it derives through sales and export, and the tradeoffs between non-timber products and the timber resource.

Many of the issues raised during the meetings with community leaders, industry participants, and residents of the QCI/HG talked of the need to know what exactly is going on in the forest. Who is out there and what are they doing? What are the effects of that activity? One of the likely reasons for the negative attitude towards the development of any NTFP is that we do not know the answers to these very basic questions.

PAGE 49 As was found in the QCI/HG, NTFP harvesters in the Pacific Northwest believe themselves to be excluded from land and resource management decisions. McLain and Jones (1999:5) observe that: Some harvesters have extensive knowledge of both the products they harvest and the ecosystems in which those products are located. Many commercial and subsistence harvesters have been found to regularly experiment in their daily work to identify stewardship practices that would ensure the long-term productivity of the resources from which they derive their livelihoods (Love et al., 1998; McLain and Jones, 1997). Yet few NTFP harvesters or buyers perceive themselves as having a voice in making new rules regarding NTFP allocation mechanisms. (Kantor 1994; Robinson, 1994; Love et al., 1998). On-going research of wild mushroom policy suggests that NTFP harvester/buyers also have little voice in defining and selecting more general forest management options, such as size and locations of timber sales, timing and locations of controlled burns, or location of road closures (McLain and Jones, 1998). Yet these types of decisions also can greatly affect both NTFP productivity and people's ability to access key NTFP gathering grounds.

PAGE 50-51

1. Trinity Bioregion NTFP Partnership: Northern California

This project began in the late 1980s with a group of NTFP harvester/buyers and small farmers in Northern California. With financial support from Trinity County and the United States Department of Agriculture-Forest Service, the partnership now includes two wildcrafting cooperatives (Trinity Alps Botanicals and the High Mountain Herb Cooperative), US Forest Service managers from two national forests, the US Forest Service Pacific Southwest Research Station, the Watershed Research and Training Center (a local NGO) and members of the Hupa tribe. Results of the partnership include (McLain and Jones, 1999:8):

- Expanded marketing opportunities for independent wildcrafters and coordination in filling orders between cooperatives;
- Training workshops for NTFP harvesters;
- A pamphlet which provides guidelines for sustainable harvesting of certain NTFP species (Everett, Y., 1997);
- NTFP regeneration trials on public lands;
- Development of a field inventory method and geographic information system (GIS) based inventories of NTFPs (based on the Forest Service's existing GIS system); and
- Development (in progress) of a Forest Service permit that will include information that harvesters can use to increase the price of their products (e.g., official notice that local forests have been pesticide free since 1984) and that will request information from wildcrafters that can be used for ecological monitoring. Silviculture and agroforestry trials are also planned.

2. Forest Workers/Harvester Network Program. Pacific Northwest
In the mid-1990's, the Jefferson Center, a small NGO based in Oregon, began sponsoring a series of forest worker/NTFP harvester gatherings in Washington, Oregon and California. The gatherings are intended to bring together people with different forest-based occupations and of different ethnic backgrounds to begin talking about the problems that affect them all. Participants include those of Cambodian, Mien, Latino, European-American and Native American (First Nations) background. In 1998, the group formed an Alliance of Forest Workers and Harvesters and sponsored a series of meetings between wild mushroom harvesters and the US Forest Service. Results of these meetings included lengthening the wild mushroom season on four National Forests in central Oregon and a series of mushroom camp meetings that provide some harvester input into Forest Service wild mushroom regulations and policies. The Jefferson Center program links several groups with similar concerns, including the Trinity Bioregion partnership discussed above.

3. Northwest Special Forest Products Association
This association was formed by several floral greens buyers in 1992. In 1994, the group received a grant from the Oregon Economic Development Department to assist it in developing the NTFP industry, which had been designated as one of Oregon's key industries in rural areas. Full membership is available only to licensed NTFP companies, although anyone with an interest in NTFPs could be a non-voting associate member.
The association attempts to improve relations between the NTFP industry and public and private landowners, to lobby for legislation to protect the interests of NTFP industries, and to provide linkages between NTFP companies and federal agencies.

McLain and Jones (1999) report that the first two groups described above seem to be effective and are attracting growing support and involvement. The NW Special Forest Products Association, however, has had difficulty in achieving consensus among its members on policy recommendations and other issues, including membership criteria. They attribute part of the organization's difficulties to its unwillingness to fully involve harvesters in the organization.

PAGE 55 Where regulation attempts to improve the way in which NTFPs are managed by making and enforcing government rules, property rights can provide incentives for holders of those rights to manage the resources for long-term benefits. For example, if an individual or community "owns" the rights to pick mushrooms in a particular area, the individual or community will probably create rules about how to pick the mushrooms, when and where to pick them, and who may pick them in an effort to ensure the long-term economic viability of the harvest. In this situation, there is less incentive to "cut and run" and more reason to invest in ways to improve the resource.

The timber industry is currently the dominant user of the forest and is granted rights to the timber through the *Forest Act*. This right does not come for free, however. The timber industry pays stumpage on the timber it cuts, pays royalties and rents on the land and volume of timber over which it has rights, designs, constructs and maintains roads, and must be fully involved in each silvicultural component from harvesting to reforestation. The non-timber forest product industry, on the other hand, has expanded substantially over the past decade and is virtually free of government intervention and control. The industry pays no rents to the province for the benefits it receives from public forest land and bears no costs of access to the forest. Government and the forest industry also bear costs related to the NTFP industry, for example the clean-up of mushroom picker camps. Should the forest industry be required to assume more planning and operating costs by incorporating non-timber forest products into its cut block planning and harvest requirements? At the same time, should the non-timber industry continue to benefit from public forest lands at no cost to itself?

PAGE 62-63 6.1.4 Finance

- Gwaii Trust Society administers a substantial endowment fund established for the benefit of QCI/HG peoples. An extract of its web page states that: “For the first three years of operation the Gwaii Trust fund will research and develop ways and means to assist small business, and if practical will be added to the loan and guarantee programs.” Entrepreneurs intending to adopt any of our recommended ‘best picks’ and who require start up capital should explore the possibilities of obtaining such guarantees.
- Community Futures is an excellent source of information about various funding programs available and in certain cases is able to assist in obtaining those funds.
- HRDC has substantial funds available through various programs, many of which apply to the QCI/HG region.
- Tribal Resources Investment Corporation (TRICORP), an Aboriginal Capital Corporation of Prince Rupert, offers loan guarantees and operating loans, as well as technical and advisory services. We understand that they have invested on the Islands.
- Aboriginal Business Canada (ABC) offers financial and technical support (lending and business services) to Aboriginal business. Forgivable and non-forgivable loans up to $75,000 are available. Joint ventures with non-FN peoples may qualify for funding.
- The First Nations Forestry Program (FNFP) is comprised of national management committees and advisory groups. FNFP provides $5 million per year in funding for proposals relating to forest management.
- The Ministry of Aboriginal Affairs (BC) First Citizen’s Fund includes a Business Loan Program for new and expanding businesses. Loans of up to $75,000 are received from a financial institution and the government will repay 50% of this loan after the client pays the first 50%.

PAGE 113

Exporters/Distributors

Great Canadian Mushroom Co. Ltd.
Contact: Pierre Brulot
PO Box 2554
Sidney, BC
Phone: 250-519-1038
• Product: Almost solely chanterelles (99% of mushroom purchased) some Lobster and blue chanterelles are purchased, but very little.
• Buyers: Usually has two, based at Skidegate Lake and Port Clements. Buyers are locals.
• Destination: Warehouse in Richmond, then shipped directly to Europe.

Ponderosa Trading Company Ltd.
Contact: Joe Nadeau
Vancouver, BC
Phone: 604-273-8308
• Products: Most wild mushrooms.
• Buyers: Usually has two to three buyers in the QCI during the peak of the season.
• The buying done from Port Clement and Sandspit.
• Destination: Mushrooms are shipped by plane or truck to Vancouver to the processing plant where they are graded and sorted. Ponderosa Trading services most of the restaurants and hotels in Vancouver. Some mushrooms are shipped directly to wholesalers in the United States (names not released). Many of the mushrooms are shipped to wholesalers and distributors in Europe.

St. Jean's Cannery
Contact: Gerrard St. Jean
242 Southside Dr.
Nanaimo, BC.V9R 6Z5
Phone : 250-754-2185
Fax : 250-754-5923
Email : stjeans@island.net
http://www.stjeans.com/
• Product: chanterelles
• Buyers: Usually has one during peak season. To buy chanterelles, the buyer is usually set up in the south (Sandspit area).
• Destination: Mushrooms are exported both fresh and canned. Recommends a processing plant on the QCI, to decrease the cost of transport.

Emperor Specialty Foods Ltd.
Contact: Bob MacDonald
Vancouver, BC
Phone: 604-276-0035
• Products: The main NTFP from the Queen Charlottes is the yellow chanterelle.
• Buyers: Usually has two to three buyers acting under the Arrow label in the QCI

during the peak of the season. The buying tends to be done from Port Clement and Sandspit.
• Destination: Mushrooms are shipped by plane or truck to Richmond to the processing plant where they are graded and sorted. Emperor Mushrooms services many of the restaurants and hotels in Vancouver and Western US. The company has focused more on shipments to the US where it finds the market is growing and there is less competition from lower cost Eastern European product. The company has a range of dried mushrooms under its own label, which it markets in Western Canada through the SuperValu chain and other outlets. It plans to expand into the US. Not all its dried product is BC sourced.

Betty's Best Mushrooms
Betty Ann Shore
Brittany Beach, BC
(819) 896-2231

Mo-Na Foods
Otto Holzbauer
Edmonton, Alberta
(403) 435-4370

Tsunami Mushroom Co. Ltd.
Contact: Steven Mills
Now currently located on QCI
Email: smills@osg.net
http://www.tradezone.com/tradesites/Tsunami.html

SilviShrooms: Predicting edible mushroom productivity using forest carbon allocation modelling and immunoassays of ectomycorrhizae EDIBLE MYCORRHIZAL MUSHROOMS AND THEIR CULTIVATION

Proceedings of the Second International Conference on Edible Mycorrhizal Mushrooms, 3-6 July 2001

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Summary
Foresters could better evaluate habitat conditions for edible ectomycorrhizal mushroom production across a wide range of forest types if they had a mechanistic model that predicted how stand conditions and alternate silvicultural choices affect mushroom productivity. We hypothesise that the average potential of a site to produce the sporocarps of chanterelles and matsutake can be reasonably well predicted by (1) the food resources available to ectomycorrhizal fungi in a stand, and (2) the occupancy of a site by these particular fungi (as measured by the percentage of ectomycorrhizal root tips they colonise). A recently refined and widely applicable forest carbon allocation model allows the amount of net primary productivity in a forest stand that is allocated to fine roots and mycorrhizae to be predicted. The model will be modified to calculate the fraction of net primary productivity produced by ectomycorrhizal host tree species that are symbionts with chanterelles or matsutake. Immunoassay tests will provide quick and inexpensive evaluation of ectomycorrhizal root tips extracted from sample soil cores to determine the percentage colonised by the fungi of interest. Field trials will test the model's predictions across a range of climate, stand age, and edaphic factors believed to influence the quantity of net primary productivity allocated belowground.

PAGE 2 Well known edible EM fungi include chanterelles, matsutake, boletes, and truffles (Figures 3-7). Some edible EM fungi occur in the tropics and in inoculated plantations in the Southern Hemisphere, but most grow in temperate and boreal forests of the Northern Hemisphere with tree species in the Pinaceae and Fagaceae. Work is underway to cultivate edible EM fungi in plantations (Hall et al. 1998), but inoculation and establishment of most EM species has proven difficult (Danell 1994). Even if widely cultivated, forest mushrooms are likely to remain a viable commercial product for the foreseeable future.

PAGE 3 Pilz & Molina (1998) have described a three-pronged regional research and monitoring program for tracking potential long-term or broad scale mushroom harvest impacts in the forests of the Pacific Northwest United States. To date, the monitoring program has not been implemented, but here we describe in greater detail our pursuit of the research component of this regional program.

PAGE 4 Stand and silvicultural choices
Sustaining appropriate forest habitat is essential for sustaining associated EM mushroom crops. EM fungi exhibit varying degrees of specificity for arboreal host species, so tree species selection controls the fungi that can occur in a stand. Clear-cutting a forest interrupts the fruiting of edible EM fungi for up to three decades as the new stand becomes established. Less well understood is how site conditions (soil fertility or climate), stand conditions (age, density, or growth rate) or management activities (commercial thinning or fertilisation) affect mushroom productivity over time, and how mushroom values compare to timber or other resource values. Because many mushroom crops are harvested from the same forests that are managed for timber or other forest products and amenities, forest managers need a better understanding of how their choices will influence the size and value of mushroom crops if they are to optimally manage for multiple resource values (Figures 8-13).

PAGE 5 Investigative approaches
Biological, ecological, and physiological research have provided hypotheses for the influence of factors affecting mushroom productivity, but testing hypotheses with replicated experiments on a stand or at landscape scales is very expensive and inferences derived from the results are limited to the stand conditions and forest types where the experiments were conducted. For instance, the Young Stand Thinning and Diversity Study (http://www.fsl.orst.edu/mycology/youngstndthin/Yss.html) on the Willamette National Forest in Oregon is an example of a landscape level silvicultural experiment, but chanterelle productivity is only one of many dependent variables. A much more cost-effective and broadly applicable approach will be the development of a quantitative ecosystem process model that predicts mushroom productivity over a broad range of forest types, stand conditions, and site factors. Fortuitously, we believe that a confluence of scientific advances has made the development of such a model possible.

PAGE 6 Our central hypothesis
Average site productivity of selected edible EM mushroom species can be usefully predicted by:
1. the amount of net primary productivity (NPP) allocated belowground by EM trees in a stand, and
2. the site occupancy of that stand by the fungus of interest.

The 3PG model

3PG is an acronym for Physiological Principles Predicting Growth. It is a generalised forest carbon allocation model, published by Landsberg & Waring (1997), that works with any forest biome and can be run as an Excel spreadsheet by practising foresters given a few days of training. The model uses relatively simple and readily available inputs such as species growth tables, latitude, aspect, weather records, edaphic variables, stand age, and stand density to derive monthly estimates of gross primary productivity, carbon allocation, and stand growth. The model has the capacity for specifying thinning regimes, although the function needs further refinement. In recent iterations, the 3PG model has been linked to satellite imagery of canopy photosynthetic capacity to model forest growth across landscapes (Coops et al. 1998). Intended as a practical management tool, the model is under constant revision to incorporate new research data, simplify application, and broaden its usefulness. Belowground processes and allocation are one of the least developed aspects of this model and we hope to contribute to the model's development with our research and application (Figure 14).

PAGE 7 Carbon allocation

A variety of factors are known to influence the allocation of carbon belowground. For instance, trees are known to allocate a larger proportion of their NPP belowground on infertile sites than on fertile sites. Much of this allocation goes to mycorrhizal fungi to enhance their ability to obtain nutrients. The same is true of old forests, and of boreal or high elevation forests growing on cold soils, where nutrients are often tightly bound in accumulated organic matter. Taller trees are more prone to drought-related stress than shorter trees because they experience greater hydraulic resistance moving water to a more distant canopy, hence, they allocate a greater proportion of NPP belowground to obtain water in dry seasons (a process also facilitated by mycorrhizal fungi).

PAGE 7-8 The cryptic realm

Of the NPP allocated belowground, the proportion allocated to large structural roots is about 25% of the NPP allocated to stem wood. The remainder is available for fine roots and mycorrhizae. Although carbon allocation patterns are relatively well known for most structural and functional components of tree growth and metabolism, the allocation and use of NPP among fine roots and mycorrhizae are not yet well quantified. Likewise we have little information about how EM fungi compete for arboreal carbohydrates or how various species of EM fungi allocate acquired carbon to growth, metabolism, function, or the production of sporocarps. Because so little quantitative information exists about carbon allocation in this realm, we start with two simplifying assumptions: (1) the amount of carbon each EM species obtains from trees in the stand will be correlated with site occupancy of that EM species, and (2) site occupancy will be correlated with average site productivity for each EM species. Although we expect these correlations to be robust, we also expect parameter values for the correlations to vary between fungus species.

PAGE 8 Olfactory surveys of matsutake mats
Chanterelle mycelia grow diffusely in the soil so directly estimating their mass or volume is not currently feasible. Matsutake mycelia, however, grow in dense mats near the surface of the mineral soil and the mats exude the distinctive odour of matsutake (Figure 15). Charles Le Fevre, as a part of his graduate thesis, has developed, tested, and refined olfactory sampling procedures for estimating the areal extent of matsutake mycelia in a forest stand.

PAGE 8-9 Mushroom species to be modelled Chanterelles and matsutake were chosen for this project because they are among the most widely collected and traded species in international commerce, and both are widely distributed in temperate and boreal forests of the Northern Hemisphere (Danell 1999; Bergius & Danell 2000). They occur in sufficient abundance to facilitate site selection and reliably sample. We have used these species for comparative evaluations of mushroom and timber values, so economic analyses can be readily extrapolated to mushroom and timber productivity estimates derived from our model. Immunoassays will be designed for specificity to the genus Cantharellus, and for matsutake we will plan reagents specific to the unique odour molecule produced by the several species of Tricholoma that are harvested as “matsutake” around the world.

PAGE 9 Selection of field sites
We plan to select field sites that cover the range of climatic and edaphic conditions that we hypothesise are important to mushroom productivity. Factors driving site selection will include sufficient fruiting of chanterelles or matsutake, high versus low soil fertility, temperate versus boreal climates, and old versus young forests. The correlations we develop and the predictions of our resulting model will be tested on other sites where long-term mushroom productivity estimates already exist, such as the Young Stand Thinning and Diversity Study.

Economic valuation
Timber values are thoroughly understood, but mushroom values are harder to estimate and most attempts are relatively recent (Pilz et al. 1998; Pilz et al. 1999; Alexander et al. submitted). These preliminary analyses include many economic assumptions about mushroom prices and harvester costs, but they also include uncertain assumptions about how timber management choices affect mushroom productivity. Coupling analyses of mushroom values with predictions of mushroom productivity under varied forest management scenarios will allow managers to better evaluate resource trade offs and synergies.

Scaling from stands to landscapes
Evaluating commercial mushroom crops and their values at the scale of landscapes would enable planners or policy analysts to anticipate how regional mushroom crops might be influenced by changes in climate, pollution, exotic forest pests, forest age class distributions, timber management regimes, or

landuse patterns. Satellite sensing of canopy conditions for scaling the 3PG model to landscape estimates of mushroom productivity will be ineffective, however, unless we better understand the range and habitat preferences of the modelled mushroom species. After the core modelling research is underway, we plan to survey mushroom experts (mycology club members, agency botanists, and commercial mushroom harvesters) about the habitat preferences of commercially harvested mushroom species. By incorporating summaries of this habitat information into geographic information system (GIS) databases, we will be able to select appropriate habitat strata for application of remotely sensed canopy data. This approach will allow us to more accurately calculate mushroom productivity and crop values at watershed, landscape, or regional scales.

SOIL ORGANISMS: BACTERIA; FUNGI, PROTOZOA, NEMATODES, AND ROTIFERS

1995
INTERIOR COLUMBIA BASIN
ECOSYSTEM MANAGEMENT PROJECT

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INTRODUCTION

Two measures of ecosystem processes are discussed in the appropriate sections in this report: the ratio of fungal to bacterial biomass (Ingham and Horton 1987) and the Maturity Index for nematodes (Bongers, 1985). Both appear to be useful predictors of ecosystem health, although they must be properly interpreted given the successional stage being addressed. For example recently disturbed systems have nematode community structures skewed toward: opportunistic species and genera, while the less-opportunistic, more K-selected species of nematodes return as time-since-disturbance increases. Thus, healthier soils tend to have more mature nematode community structures. However, as systems mature, nutrients tend to be more sequestered in soil biomass and organic matter, and thus the maturity index reflects an optimal intermediate-disturbance period in which greatest ecosystem productivity is likely to occur.

PAGE 1 OF 12 COLUMBIA RIVER BASIN - WATERSHED INFORMATION
Date: December 29, 1994 Panelist Name: Elaine R. Ingham
Species or Species Group: Relative Fungi / Bacteria

PAGE 7 OF 12

5. CLEARCUTTING
Not a factor in grassland systems. In forests, the removal of the trees results in the loss of many of the ectomycorrhizal species from the soil, especially matformers. With *every* clearcutting event so far examined, at least a ten-fold loss of fungal biomass has occurred. If some as-of now unrecognized factor causes continued loss of fungi, re-establishment of conifer seedling in the system becomes extremely difficult, if not impossible. If the funga component of the soil begins to recover within five to ten years of after clearcutting, re-establishment of trees appears to proceed without difficulty.

PAGE 9 OF 12
8. COMPACTION
In general, compaction reduces the size of pores within the soil, decreasing the amount of air capable of moving into, or carbon dioxide moving out of the soil. In addition, the ability of soil organisms to grow into the soil, to find soil nutrients and for water.to penetrate into the soil profile are reduced as compaction increases, The greatest effect is often seen on the populations of bacterial and fungal predators. Single compaction events, such as occur in offroad vehicle use, or in clearcutting, may result in an ephemeral reduction in bacterial or fungal activity *or* biomass, but may not compact the soil to the extent that continued reductions in bacterial or fungal growth are seen. However, if compaction is great enough to prevent movement of the predators of bacteria and fungi into the soil long-term effects on decomposition and nutrient cycling processes are likely since N mineralization and stimulation of microbial growth will be reduced.

PAGE 11 of 12
Key Ecological Functions
1. Decomposition of intermediate and recalcitrant C:N substrates
2. N retention in soil u
3. Substrate for nematode predators
4. Source of N for mineralization; most plant available N must cycle through, the fungal biomass is forest soils.

Key Assumptions
Soil conditions must be appropriate for saprophytic fungi to grow and perform their functions. present in soil, Because there are many, many species of fungi present in the soil, the argument is that because there are many fungi that perform the same or highly similar functions, there is little worry about depleting this functional group.

However, the principle of Competitive Exclusion says that no two species occupy exactly the same niche or perform exactly the same function in an ecosystem. Therefore, each species of saprophytic fungus occupies a unique niche, and if enough species are deleted from an ecosystem, some critical function will be lost. Critical functions performed by these fungi are decomposition of all types of organic material in various conditions.

Controlling factors for saprophytic fungal function are predator grazing, by nematodes and arthropods' root exudates production, litter and wood production, soil structure, and abiotic factors, such as temperature and moisture. Once these fungi are deleted from a system, they must be spread from existing sources by microarthropods, small mammals, and birds.

COLUMBIA RIVER BASIN - PANEL SPECIES INFORMATION
Date: December 29, 1994 Panelist Name: Elaine R. Ingham
Species or Species Group: Vesicular Arbuscular Mycorrhizal Fungi
Glomus
Giqaspora

PAGE 3 OF 5
Key Ecological Functions
1 . VAM mine the soil for P, N, micronutrients and water in return for C fixed by plant photosynthesis. The cost to plant may be minimal, given the competitive edge the fungus gives to most plants.
2. Competes with pathogens for colonization sites on roots and may prevent root disease.
3. May de-toxify certain types of pesticides, herbicides, and pollutants
4. May sequester heavy metals in fungal hyphae, preventing heavy metals from damaging or killing plants.
5. Food source for fungal-feeding nematodes, arthropods.

COLUMBIA RIVER BASIN - PANEL SPECIES INFORMATION
Date: December 29, 1994 Panelist Name: Elaine R. Ingham
Species -Or Species Group: Ectomycorrhizal mat-forming fungi
Hvsteranaium
Gautieria

PAGE 1 of 6 Recent investigations have established that these mat-forming fungi occur in high densities in Grand fir, Douglas-fir, Ponderosa pine, and larch stands in the Blue Mountains around LaGrande, OR. They have been found in Yellowstone National Park in these same vegetative types. Mat-forming fungi have not yet been found on juniper.

Mat-forming fungi appear to dominate during the most productive years of conifer stand development, from 30 to 150 years old trees and increase both total and labile N in the forest floor (Aguilera et al, 1993). Significant portions of the forest floor are colonized by mat-forming fungi even in old growth conifer stands, however, and contribute to system productivity (Ingham, unpublished data, Aguilera et al, 1993).

Forested habitat forms:
If shelterwood trees are left, these fungi are found (between 5 and 15% of the forest floor covered depending on density of shelterwood trees) during stand

initiation. If older trees do not remain, then the mat-forming fungi disappear and must be re-established.

PAGE 2 of 6 Mats are always found in stem exclusion open canopy (5 to 15% coverage of forest floor), stem exclusion closed canopy (15 to 30% coverage), understory reinitiation, young forest multistrata (30 to 45% coverage), and old forest multistrata (30 to 100% forest floor coverage) in most conifer species. Exceptions appear to be juniper, which has not been shown to support mat-forming fungi, although juniper stands have not been extensively investigated. Disturbances: Clearcutting appears to be the one disturbance that can completely remove mat-forming fungi from the forest floor. Mat-forming fungi benefit their hosts when soil moisture is low (apparently improve plant water use efficiency in drought conditions) or when soil moisture is high (mats produce hydrophobic materials, preventing saturation of the soil profile, increasing aeration for the plant roots). The mats themselves are perennial structures and appear highly resistant to changes in soil moisture, as long as their host plants remain. Temperature. In areas where the forest floor is snow-covered during the winter, mats continue to function throughout the winter (Ingham, pers. comm). Areas where the soil undergoes freeze-thaw throughout the winter have not been investigated for the effect on mats-forming fungi. Studies are being performed on the effect of available N on mat-forming fungi. Intense fire can remove the organic layers of the soil. In Yellowstone National Park, where the temperature was intense enough to melt the mineral soil and form glass pellets, the soil was essentially sterile, although re-colonization by airborne organisms was rapid on the surface of the soil. However, these matforming fungi do not survive in such organic matter depauperate areas, and it will likely be hundreds of years before mat-forming fungi will reestablish in these intensely burned areas. There is a direct relationship between the intensity of impact on the soil organic layer and the loss of any fungus from the soil. If the soil is only slightly warmed, and the overstory trees are not lost, there will be only a stimulatory effect on these mat-forming fungi. The effect of arazing, especially compaction, is under investigation in the Blue Mountains of Oregon (cooperative effort with Jim McIver, Art Tiedeman, Torge Torgeson of the Blue Mountains Natural Resource Institute). Pesticides undoubtedly affect mat-forming fungi, although no field studies have been performed. Plowing destroys matforming fungi, although each spring in natural systems, mats can be nearly demolished by small mammal feeding (a major food resource for small mammals). Mats, however, recover from this disturbance rapidly, and by the next fall, regain their original extent. In forests where small mammals have been removed, mats may continue to increase in size, sequestering greater and greater amounts of nutrients, and may possibly be detrimental to continued forest productivity. Further studies are required.

PAGE 4 of 6 Key Ecological Functions
1. Mat-forming fungi mine the soil for P, N, micronutrients and water in return for C fixed by plant photosynthesis. The cost to plant may be minimal, given the competitive edge the-fungus gives to the plants.

2. Competes with pathogens for colonization sites on roots and may prevent root disease.
3. May de-toxify certain types of pesticides, herbicides, and pollutants.
4. May sequester heavy metals in fungal hyphae, preventing heavy metals from damaging or killing plants.
5. Major food source for small mammals, fungal-feeding nematodes, arthropods.

PAGE 5 of 6 Key Assumptions
Lack of mat-forming fungi clearly restricts the presence of conifers, oaks, and eucalyptus. All seedlings which survive for more than a year in closed canopy conditions must be associated with a mat. All dominant forest trees are associated with at least several mats.

Truffles formed by mat-forming fungi are an important food resource for small mammals, and for other organisms on which higher level predators feed. Without these organisms present in high numbers, the entire forest ecosystem will have reduced productivity.

COLUMBIA RIVER BASIN - PANEL SPECIES INFORMATION
Date: December 29, 1994 Panelist Name: Elaine R. Ingham
Species or Species Group: Saprophytic Fungi
Penicillium (r-selected)

PAGE 3 of 5 Key Ecological Functions
1. Decomposition of intermediate and recalcitrant C:N substrates
2. *N* retention in soil
3. Substrate for nematode predators
4. Source of N for mineralization; most plant available *N* must cycle through the fungal biomass is forest soils.

Key Unknowns and Monitoring or Research Needs
Research is required to determine species required in different abiotic conditions, with different vegetation types and in different soil types. Rapid decomposition rates in forest systems rely on the presence of saprophytic fungi. Decomposition by fungi can be slowed to extremely low levels if arthropod grazing is extremely high, thus reducing nutrient cycling once decomposition is slowed.

Disturbance affects saprophytic fungi. Intense fire depletes fungal biomass, drought reduces their activity, pesticide applications can reduce their biomass and activity, and plowing will increase bacterial competition, reducing fungal biomass. Speed of re-colonization from outside sources once local extinction has occurred is not known.

SPECIAL FOREST PRODUCTS
Species Information Guide for the Pacific Northwest

Nan C. Vance, Melissa Borsting, David Pilz, and Jim Freed

United States Department of Agriculture Forest Service Pacific Northwest Research Station General Technical Report PNW-GTR-513 September 2001
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Abstract
Vance, Nan C.; Borsting, Melissa; Pilz, David; Freed, Jim. 2001. Special forest products: species information guide for the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-513. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 169 p.

This guide is a collection of information about economically important vascular and nonvascular plants and fungi found in the Pacific Northwest that furnish special forest products. Many of these plants and fungi are also found in Alaska, northern Idaho, and western Montana. They contribute to many botanical, floral, woodcraft, and decorative industries and to the rapidly growing medicinal, herbal, and natural foods industries. Internet commerce has made these products available to consumers worldwide and expanded interest in medicinal plants, decorative floral products, and edible wild fruits and mushrooms. This guide provides a consolidated information resource that briefly describes biological, ecological attributes of over 60 plants and fungi, and their wild harvest methods, alternatives to wild harvest, and uses. The harvest techniques described in the guide are based on the recommendations of experienced harvesters and experts who have worked with these botanical resources and support sustainable practices. Information for this guide was gathered from various documents and other sources. The technical areas of expertise consulted spanned a wide range of knowledge including plant biological and ecological sciences, ethnobotany, horticulture, mycology, and forest ecology. Keywords: Special forest products, nontimber forest products, medicinal plants, edible fungi, botanical industry, herbs, wildcraft, Pacific Northwest, sustainable forestry.

PAGE 1 Abundant biotic resources of North American forests have provided not only recreational and personal collecting opportunities but also profitability in products that come from various plants, lichens, fungi, algae, and micro-organisms. These special forest products are the basis of many botanical, floral, woodcraft, and decorative industries; they also contribute significantly to the rapidly growing medicinal, herbal, and natural foods industries (Schlosser et al. 1992, Schlosser and Blatner 1994, Vance and Thomas 1997).
Native Americans regarded the use and often the maintenance of the many species found in forests and prairies as a fundamental part of their world and life,

and would take exception to the concept that they are “special.” It is important therefore to acknowledge that the species we are discovering to be beneficial today were already intimately known by people who lived on this continent and who collected and used these fungi and plants for thousands of years.

PAGE 1-2 How do all these pieces fit together? As people collect plants and fungi for commercial products, how do they ensure that these species are not overexploited, that their habitats and environments are not being damaged, and that they are not adversely influencing important ecological functions such as critical interactions with insect and animal pollinators, other mutualisms, and the provision of food and habitat for wildlife. Many of the species being collected in commercial quantities have not been thoroughly studied, yet there is considerable information in the literature and among practitioners that collectively is informative and educational. This guide is a compilation of the information we found to date about selected species in the Pacific Northwest. It is incomplete because new information is continually being generated. We have focused on that information most relevant and useful to sustainable management and conservation of these valuable biological resources growing in the wild.

Based on the information compiled for this publication, we list in table 1 the vascular plants covered in this guide noting species that are exotic, species that can be cultivated, and species deemed vulnerable because the plant and or its habitat may be jeoparized by harvest. Of the 76 vascular plant species, 59 species or about 78 percent are available commercially as plant or seed; 10 species or about 13 percent are exotic weeds. About 32 percent are considered vulnerable based direct and indirect effects of harvest. The nonvascular byrobphyes (mosses and liverworts) and the lichen *Usnea* are not cultivated and are also considered vulnerable. Harvest pressure on these byrophytes continues while similar species in other parts of the world are disappearing or threatened by habitat loss, environmental pollution, and overharvest.
Although this guide is a collection of information about economically important plants and fungi species found primarily in the Pacific Northwest, many of these species also are found in Alaska, northern Idaho, and western Montana. The species lists were developed with the input of local harvesters, botanists, land managers, and researchers. This is not a comprehensive list of all plants with medicinal, edible, or decorative uses. It is a compilation of species that commonly are harvested for commercial purposes and found on Forest Service lands. Many of these species were and are important to indigenous people, and many tribes today have first rights to collect and use these species. We hope the user of this guide will be sensitive to tribal and treaty rights and the feelings of others who care about these species.

PAGE 5 The harvest techniques described in this guide are those recommended by local harvesters who have worked with the plants for years developing techniques that promote sustainable harvest. These techniques have not been, for the most part, field tested, monitored, or scientifically evaluated. Most of these harvest recommendations are locally specific. Changes in climate or the environment can result in different reactions from species being harvested. Therefore, always consider the environment when collecting.

PAGE 6

General Harvest Guidelines

Know the species that is to be collected.

Be sure of its identification before harvesting a plant or mushroom. Many plants look similar but do not necessarily have the same properties. There are species in the same genus that look similar to the more common species but may be rare, at risk, or federally or state listed as threatened or endangered. Another reason for careful identification is that certain plants and fungi have poisonous look-alikes! If you are uncertain, take a small sample and consult a qualified botanist. You may find one at most colleges and universities, or you can call your forest or agriculture extension agent who will know where to refer you. Native plant societies have local chapters and provide excellent opportunities to identify plants and fungi, and discover and learn the local flora as well.

Know the end use.

If collecting plants to sell, you should first contact the buyer and a discuss what criteria and quality standards are to be met. Many buyers will only take products that have been collected, dried, or processed in a certain way. Many plants are sensitive enough that just a few days or even hours of improper handling can result in unusable products. Know how to handle collected material properly and use proper storage facilities or materials.

PAGE 7

Pay attention to the environmental conditions.

Avoid harvesting during extreme conditions. After heavy rain, the soil will be more prone to compaction or slippage. When harvesting plants that grow in riparian areas, avoid taking plants that are critical to maintaining the integrity of the streambanks. When it is particularly dry, some plants may become stressed. Harvesting parts of a plant at this time may add to stress and negatively impact regeneration. In addition, be aware of plants or plant parts that are diseased or infested with insects so as not to spread contamination.

Learn about the life cycle of the plant you are harvesting.

Plants need to be able to reproduce or regenerate to continue to exist. For example, if you are collecting roots and the plant reproduces by seed, is it possible to collect in fall after the seeds have dropped? This type of awareness will help assure there are plants in the area to harvest again next year.

PAGE 8 Monitor and observe a patch over time.

Notice what impact your harvest is having. Take notes with map locations so you know how to return to the same area. Evaluate harvest recommendations for your area. Surprisingly, some plants may actually increase if harvested in the right quantities and if the right techniques are used.

Always secure permission to harvest on anyone's land.
This applies to public land as well as private. In Oregon, a permit is required to carry commercial quantities of product in your vehicle. This can a handwritten permit from a private landowner. Other states in the Pacific Northwest have or are now enacting similar laws. Know the requirements set forth in these laws. Public lands also require permits for harvesting. Some public lands are off-limits to harvesting (such as national parks and many special management areas on national forest lands). Presently, public land managers will sell permits for many of the species listed in this guide. They often want to know generally where harvesting is occurring so that they can track areas of heavy use in order to balance impact across the landscape. Personal-use permits are available for noncommercial harvest. Even if you do not like the current permit systems, getting involved with them is the best way to have input into future changes.

Use harvest techniques that minimize disturbance**.**
This means using the right tools and using them correctly. If you are collecting leaves and stems, gently clip them off of the plant. Do not simply break them off or pull them out of the ground, as you tend to get more of the plant than you can use. Also, breaking stems may produce more extensive injury and create sites for pathogens. With roots, dig gently with a small shovel, trowel, or your hands (depending on the conditions). Avoid disturbing surrounding vegetation. Fill in any holes you make after you finish collecting. Take out litter and trash with you.

Sustainable harvest does not come with a formula.
There are no bottom line numbers that work for each species. Think of the species in context, as part of the ecosystem. For some species, ecological function or importance has already been documented and is described in this guide. Many species, however, have not been thoroughly researched. Draw conclusions about the sensitivity of a patch by using observation and the information contained here. Harvest conservatively. Then watch the results. Over the next few seasons, observe what impact harvesting had on the species collected as well its surroundings.

PAGE 10 The commercial value of the special forest products industry to the Pacific Northwest has been reported in excess of $190 million (Schlosser and Blatner 1992). It is estimated that the value of the personal-use sector exceeds the commercial value by 3 to 1. Today, as in the past, a major value of special forest products from native plants and fungi of the Pacific Northwest is their use by the ordinary person. Over 85,000 people enter the public forest each year to collect plant material and mushrooms for their own personal use. Also 65 percent of 90,000 nonindustrial private forest land owners stated that a primary reason for owning forest property was for other products besides timber. These products represent the full range of commercial, educational, environmental, and aesthetic uses for the owners, their families, friends, and others. Protecting plants and fungi helps maintain forest complexity and is an inclusive activity not only for ecosystem and species diversity but also for engaging people who represent all of the values for which public forest lands are managed.

THERE ARE VII PARTS OF THIS GUIDE IN PDF FORM – THIS REVIEW COVERS PART I

Special Forest Products: Integrating Social, Economic and Biological Considerations Into Ecosystem Management
Chapter 21 Section IV: Forest Economics: Products and Policies pgs. 315-336

Randy Molina, Nan Vance, James F. Weigand, David Pilz, and Michael P. Amaranthus

PAGE 315-316 As societies modernized and depended less on the diversity of wild products from forests, many of these traditional uses diminished, some were forgotten, and others remained useful to only subsistence forest dwellers or native inhabitants. Forest management in the 20th century increasingly emphasized growing and harvesting trees for timber and fiber products as its primary objective. Despite that emphasis, a small entrepreneurial segment in forest-based communities continues to commercialize nontimber products from the forest, including foods, medicinal plants, and floral greens. Forest managers designated these as “minor” forest products, thereby reflecting an attitude that they were less important than timber in the overall scheme of forest management. But the economic impact of this industry and the quantities of products harvested can no longer be viewed as minor. In the Pacific Northwest, special forest products account for over $200 million in revenue (Schlosser et al. 1991). This amount is substantial when compared to the $2.63 billion generated from stumpage receipts to all landowners in Oregon and Washington in 1989 (data derived from Warren 1995). Thousands of tons of biological materials from dozens of species are removed annually from forest ecosystems.

PAGE 316 The two largest public land agencies in the United States, the Bureau of Land Management of the U. S. Department of the Interior and the Forest Service of the U.S. Department of Agriculture, recognize this importance and are developing regional and national strategies for managing special forest products. These strategies emphasize four themes: (1) to incorporate harvesting of special forest products into an ecosystem management framework with guidelines for sustainable harvest, species conservation, and protection of ecosystem functions; (2) to involve the public, including industrial, Native American, and recreational users of these resources, in making decisions about the future of special forest products on public lands; (3) to view the management of and accessibility to special forest products as major factors in assisting rural economic diversification in formerly timber-dependent communities; and (4) to develop and implement inventory, monitoring, and research programs to ensure species protection and ecosystem health.

The complex biology and lack of information on harvesting of special forest product species also present a significant challenge for integrative ecosystem management. Numerous federal and state laws exist to protect forest resources, including the National Forest Management Act, National Environmental Policy Act, and the Endangered Species Act. Under strong environmental regulations and in a litigious climate, resource managers require substantial data to support management decisions. Unfortunately, baseline data on the effects of harvest, on markets, and on the biology, ecology, and productivity for many special forest product species are either shortterm, incomplete, or nonexistent. Also lacking is information on responses by harvesters to economic incentives and conservation measures set in place by land managers. Many of these species also play important ecosystem roles, such as providing food for wildlife and capturing and cycling nutrients. Yet, we poorly understand these complex dependencies, and the consequences of harvesting special forest products on ecosystem function and integrity are largely unknown.

PAGE 317 Global Perspectives and History
Over the ages, indigenous peoples acquired an understanding of the basic ecology and usefulness of flora and fauna and explored the various foods and medicinal properties of plants and fungi. Stored in the memories of elders, healers, midwives, farmers, and fishers in the estimated 15,000 remaining indigenous cultures on Earth is broad knowledge about useful products from naturally diverse ecosystems. This knowledge has been passed on through ancient but fragile chains of oral tradition that will be broken when younger members of a society leave the traditional lifestyles. Today, much of the expertise and wisdom of these cultures has already disappeared; our understanding of special forest products gleaned from thousands of years of trial, error, and observation is consequently diminished.

PAGE 318 Special forest products will play an important role in sustainable development and are perceived as essential links to sustaining rural communities and contributing to economic diversification. At the same time, wild species that are special forest products contribute to the diversity and function of forested ecosystems. Thus, strategies must be developed that both supply and conserve these valuable species.

Regional Perspectives from the Pacific Northwest
Pacific Northwest forests were essential to the lives of aboriginal people that migrated to North America with the receding glaciers as early as 10,000 years ago. Various forest species were important for food, tools, structures, transportation, and medicine. Large conifers were used for housing, and understory species such as Pacific yew, willows, and red alder were used for many purposes, including hunting tools, bowls, masks, and medicines (Pojar and

MacKinnon 1994). Many plants and fungi were part of native traditions and mythology. Medicinal use and spiritual value were linked in medicines derived from trees, forbs, and fungi (Molina et al. 1993, Pojar and MacKinnon 1994, Smith 1983); for example, devil's club was used by Northwest tribes to cure a variety of illnesses and to ward off evil spirits.

Use of plants by indigenous people in the Pacific Northwest for food and aboriginal technology is well documented (see, e.g., Colville 1897, Gunther 1973, Reagan 1935, Turner et al. 1990): Aboriginal people not only gathered species, they also burned and selectively harvested to maintain productivity of important food plants. Use of fire promoted bracken and camas, staples of aboriginal diets, before fire was suppressed by settlers and the land agencies that followed (White 1980). The use of fire to promote berry species and forage is also well documented (Boyd 1986, Gottesfeld 1994, Norton 1979, Robbins and Wolf 1994, Turner 1991). Thus, indigenous people introduced management techniques long before the arrival of other people to the region and may have used over 100 different species (Turner et al. 1983). Indigenous people do not now rely on wildland plants as a primary food source as in the past. However, certain plant products such as berries are harvested extensively, and many traditional uses of plants as herbals, tonics, and medicines are maintained in tribal culture (Turner et al. 1983, 1990). When settlers came to the Pacific Northwest, they too relied on wild, native species as important supplements to food, medicines, and clothing.

PAGE 319 Several hundred native plants, including trees, shrubs, forbs, and vascular and non-vascular plants (but excluding those used in the timber industry), are currently harvested for personal and commercial use in the Pacific Northwest (see Table 21.1): The use of these plants is diverse, falling into five general areas: (1) foods, (2) decoratives, including floral greenery and dyes, (3) herbals, (4) medicinals, and (5) specialty products such as aromatic oils and wood products. The Pacific Northwest probably leads all other regions in North America in active use of public lands as a source for diverse floral greens and botanicals (Thomas and Schumann 1993). Commercial harvesting is expanding concurrently with recreational wildcrafting. Gathering plants and plant parts for personal use as ornamentals, foods, or herbals is important to traditional rural wildcrafters, but these activities have widened to include more diverse groups of people. Renewed interest in wildcrafting appears to accompany an emerging ecological ethic. Books such as Tilford (1993) and Moore (1993) include information designed to raise environmental awareness and encourage low-impact harvest of wild plants.

PAGE 321-322 Socioeconomic Considerations

Unknown Supplies

A basic gap in knowledge results from the lack of an inventory of the type and amount of existing and potential special forest products in the Pacific Northwest. Such ignorance can have negative economic effects. Without an awareness of changes in stock lev- els, managers cannot implement adaptive measures to adjust stocks so that a desired and sustainable level of product is available to developing markets. A reliable supply is also essential to wholesalers of special forest products (Handke 1990) and for building enduring commercial relationships that provide steady income to suppliers. For instance, loss of the German market for Washington State chanterelles was the result of a sudden and unpredicted collapse of the supply (Russell 1990). With the growth in world-wide markets for special forest products from the Pacific Northwest and elsewhere, concerns about resource depletion arise even before management of special forest products begins (Foster 1991). Field inventories are crucial tools for (1) calculating existing stocks of special forest products, (2) identifying existing areas of overharvest, (3) analyzing the possibility of intensified management for expanded commercial production, and (4) providing the scientific database for research on ecological and economic constraints to production (Grochowski and Ostalski 1981). For example, evidence from Europe, where mushroom picking has been intense for much longer than in North America, suggests that environmental changes and increased mushroom collection are leading to declines in mushroom populations (Arnolds 1991, Cherfas 1991, Jansen and de Vries 1988). However, few published articles document the effects of economic harvesting on special forest products (e.g., Benjamin and Anderson 1985, Geldenhuys and van der Merwe 1988, Smirnov et al. 1967). A global information system is needed to register changes in natural populations of special forest product species (Cunningham 1991). Countries such as Bulgaria, Lithuania, and Poland already incorporate national inventories of such species (Budriuniene 1988, Economic Commission for Europe 1993).

PAGE 323 Balancing Management Costs and Benefits
The American public has concerns about both sustainability of special forest product resources and the equitable distribution of benefits derived from special forest products. Rapidly growing public awareness of special forest products as a source of income has been swelling the ranks of product suppliers at all levels of the market supply structure. The growth of Oregon and Washington’s population to 7.7 million by 1990 and projections for its continued rapid increase preclude the practicality of open and unrestrained harvesting on public lands. The Pacific Northwest also lacks a locally evolved tradition for regulating harvests.

Private gain from collectively owned resources, such as federal forest land, should require compensation for any deterioration and for subsequent management costs for site restoration or monitoring.

PAGE 324 The Bureau of Land Management and the Forest
Service are now exploring a uniform appraisal system for special forest products. Uniformity of legislation, regulations, and enforcement is important to develop coherent market responses from collectors and to increase returns to the land management agencies. There is the chance that regulations will not be effective if their basis and intent are not apparent. Agencies can use regulations to

encourage harvest practices consistent with the goals of ecosystem management. One option might be to assign custodial harvest rights in a designated extractive reserve for a single resource for a specified term on the basis of competitive bidding (Fearnside 1989). Ecosystem management would rely on the self-interest of the permitted harvester to ensure the broader societal objectives of sustainable resource use.

PAGE 325 Primary considerations for management of special forest products include: (1) understanding the unique biology and ecology of special forest product species; (2) anticipating the dynamics of forest communities on a landscape level, delineating present and future areas of high production potential, and identifying areas requiring protection; (3) developing silvicultural and vegetation management approaches to sustain and enhance production; (4) integrating human behavior by monitoring and mod- eling people's responses to management decisions about special forest products; and (5) conducting necessary inventory, evaluation, and research monitoring.

PAGE 326 Forest fungi form a third group of special forest product species with unique biological features and ecosystem attributes. The body of most fungi consists of one-cell-wide threads, or hyphae, (collectively know as mycelium) that grow in soil, organic matter, or host organisms, where they are hard to observe without destructive sampling. The mushrooms or truffles (collectively called fruiting bodies or sporocarps) are the reproductive portion of the fungus. Many of the commercially valuable edible fungi depend on and are important to the health of host trees because they are mycorrhizal-that is, they form distinctive fungus-root structures. The fungus transfers water and mineral nutrients to the tree, and the tree provides the fungus with carbohydrates as an energy source produced through photosynthesis. When all trees are harvested, the associated fungi die in the soil and sporocarp production ceases (Amaranthus et al. 1994). Complete removal of all host trees therefore will have immediate impact on commercial harvests of mycorrhizal fungi such as chanterelles and American matsutake.

PAGE 327 In coniferous forests, most species occur in the early successional, shrub-forb-sapling stage and in the late successional, old-growth stage; the fewest species find suitable habitat in the middle, the closed canopy stages (James and Warner 1982, Meslow 1978, Thomas et al. 1979). Intensive forest management for wood production focuses on the middle, least-diverse stage. Achieving full site occupation by commercial timber species shortens the time in early succession, although. with short rotations the total amount of early successional habitat may actually increase at the landscape scale. Young stands furnish the stocks for the Christmas greens market. Dense canopies of short-rotation forests, however, can hinder development of many understory species harvested as special forest products. Harvesting trees when the mean annual increment culminates eliminates the unique ecological conditions of the old-growth stage. Species such as Pacific yew and mosses occur in greatest

.numbers and reach full development under the multiple canopy layers and big trees of old-growth forests.

PAGE 328 An important first step in considering special forest products at the landscape scale is identifying areas with high commercial production potential or that require protection from harvesting. For example, areas with high production potential and convenient harvester access might be managed for intensive special forest product production to relieve harvesting pressure on sensitive areas. Wetlands or habitats of rare plants or animals may need harvest restrictions. Areas prone to surface erosion or mass failure might need protection. No-harvest areas may be needed to monitor effects of harvesting, and rotated harvest areas could be used to avoid unsustainable harvests and resource depletion. The inventory, monitoring, and research activities discussed below will be essential to identify specific areas for enhanced production or protection.

PAGE 329-330 Conducting Necessary Inventory, Evaluation, and Research Monitoring

We are still learning how ecosystems work, and we will be for the indefinite future. Thomas Berry (1988) summed it up succinctly: “What is needed on our part is the capacity for listening to what nature is telling us.” It would be a much shorter list to mention aspects of managing special forest products in a sustainable way that do not need monitoring and research rather than those that do. We do not attempt either. Most forestry research during the past decades has focused on forests managed intensively for wood, while most ecological research has focused on pristine forests. Our ability to sustain harvests and populations of special forest product species will require increased research on the ecology of managed forests. Similarly, because socioeconomic research in forestry has focused on timber market forces and timber-dependent communities, new socioeconomic research efforts are needed on specific special forest product markets and publics. Thus, ecological research will determine the role of special forest product species in an ecosystem context, and product market research will define the role of special forest products in society. The final section of this chapter provides a detailed example of integrating research and monitoring approaches for these disciplines.

PAGE 330-331 Adaptive Ecosystem Management of Commercial Mushroom Harvests

Good information and the logical organization of it are the bases for human decisions on complex phenomena. Commercial mushroom harvesting exemplifies how information required for ecosystem management of a special forest product can be obtained in a stepwise, logical manner. This example presents a conceptual framework for (1) identifying concerns of managers and the public about commercial mushroom harvesting, (2) choosing appropriate studies to address those concerns, (3) designing those studies, and (4) adapting information thus obtained to, the needs of management. This approach generally

applies to any special forest product. The effort expended should be commensurate with the anticipated harvesting impacts.
The first step in adaptive management of a specific special forest product is estimating whether harvesting activities are sufficiently extensive (widespread) or intensive (concentrated) to be economically or ecologically significant. For example, the demand for wild mushrooms is large and the impact of harvest on ecosystems significant (Molina et al. 1993, Schlosser et al. 1991, Schlosser and Blatner 1993, Schlosser and Blatner in preparation). Many edible species are mycorrhizal, and their symbiotic association with tree roots plays a key role in forest productivity and nutrient cycling. Commercial collection of mushrooms is also socially significant because substantial competition exists among harvesting groups, such as local residents, transient harvesters, Native American tribal members, and recre- ational pickers (Lipske 1994). Managers must sort out the interests of these competing groups to anticipate problems, reduce conflict, and provide equitable use of the resource.

Only a portion of knowledge about forest fungi applies to managing commercial harvests. Few mycological studies in North America have focused on marketable species. Incorporating monitoring activities into ecosystem management offers one way to ensure that good science feeds rapidly into the decision-making process. Studying harvests of commercial mushroom species informs both users and managers about the impacts of harvests on ecosystems and on economies. Several considerations apply to commercially collected fungi, especially to the predominant commercial species in the Pacific Northwest: American matsutake, morels, chanterelles, Boletus mushrooms, and certain truffles.

The following questions confront ecosystem managers as they regulate commercial mushroom harvests.

1. Production and distribution of mushrooms as special forest products. How many fruiting bodies are being produced? How are they distributed across the landscape or within certain habitats? How does production differ during a season and from year to year? What is the actual or potential commercial productivity of a given area? What proportion of forest habitat is available and accessible for economically efficient harvesting? What factors determine productivity, and how might they be managed? What managerial actions can alter accessibility of the resource to meet management objectives? How does landscape design promote or impede ecological sustainability of biological production and economic harvest?

2. Mushroom harvesting by people. How can the sustainability of mushroom harvesting be assured? What proportion of the crop can be harvested without unacceptable impacts on the fungus itself or other resources? What techniques will mitigate those impacts? Does mushroom harvesting increase or decrease subsequent production? Is spore dispersal reduced by removal of immature mushrooms, and does it impair reproductive success? Are fungal mycelia and

subsequent mushroom production affected by search and harvest techniques such as raking, moving woody debris, or digging? Are mushrooms harmed by numerous harvesters trampling the forest floor? How important as food for wildlife are commercially valuable species, and is human contpetition for the resource significant? What is the demand from various markets for wild mushrooms? How will various management scenarios affect jobs, income, and revenue? How does commercial harvesting affect the relationships (for example, competition and potential conflict) between recreational and commercial harvesters?

3. Land management decisions. How do various timber harvesting methods (clearcutting, thinning to various densities, selection of host species) affect subsequent mushroom production over time? How does soil compaction or disturbance from logging activities affect fungal populations? How does the intensity and timing relate to subsequent mushroom production, especially for morels? How do grazing, fertilization, or pesticide application affect production? Can mushroom production be improved through habitat manipulation-for example, planting tree seedlings inoculated with specific fungi, thinning understory brush for sunlight and rainfall penetration, prescribing burns, and irrigating? Can production be increased across the landscape by managing forests to attain tree age class, structure, and composition optimal for fruiting? What types of cost-benefit analyses are needed to help managers decide about managing for special forest products within broad multiple-use objectives? Can ecologic-economic models be developed to support socially acceptable land management decisions?

4. Biology and ecology of mushrooms as ecosystem components. What are the important reproductive events in the life cycle of a particular species? How are new colonies or populations established and maintained? What causes them to diminish or perish? How important is spore dispersal to reproductive success, population maintenance, genetic diversity, and adaptability to unique microhabitats? How much genetic diversity exists within and among populations? Are there endemic, narrowly adapted, or unusual populations of otherwise common species? What are the growth rates of fungal colonies in soil and the degree of mycorrhizal development by specific fungi on root systems? To what degree do other mycorrhizal or saprophytic fungi compete with desired fungi for colonization sites on host roots or for space in the forest soil?

Seasonality and Abundance of Truffles from Oak Woodlands to Red Fir Forests1

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USDA Forest Service Gen. Tech. Rep. PSW-GTR-183. 2002.

1 An abbreviated version of this paper was presented at the Symposium on the Kings River Sustainable Forest Ecosystems Project: Progress and Current Status, January 26, 1998, Clovis, California.

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Abstract

Truffles are an important food source for many small mammals in forest ecosystems; however, we know little about the seasonality, abundance, or diversity of the truffle community in the Sierra Nevada. This study examined how truffle abundance and diversity varied between oak woodland, ponderosa pine (*Pinus ponderosa*), mixed-conifer, and red fir (*Abies magnifica*) forests. Species richness (number of species) and abundance of truffles were highest in ponderosa pine stands, but species evenness was greatest in mixed-conifer stands. Truffle biomass peaked in late spring and fall, tracking precipitation patterns with a 1-2 month lag. At least 65 species of truffles were identified in a 1-ha sample of the forest. This number is still only a fraction of the fungal species present, as many mycorrhizae rarely produce fruiting bodies. Truffle production depends on the condition of the truffle's mycorrhizal host trees. Natural or human disturbances, which affect the age and composition of the forest, will affect truffle abundance and the animals that depend on them for a substantial portion of their diet.

PAGE 92 Changes in forest composition resulting from succession, disturbance, or timber harvesting will affect truffle abundance and diversity because truffles are produced by mycorrhizal fungi, which rely on carbohydrates from their tree hosts (Harley and Smith 1983). Other site characteristics, such as local edaphic conditions (North and others 1997) and the size and the decay state of coarse woody debris, may also influence truffle production (Amaranthus and others 1994). North and Greenburg (1998) found a highly significant association between the most abundant truffle species in western hemlock (*Tsuga heterophylla*) forest and thick organic layers with a high density of fine roots. In stands that lacked these soil conditions because they had been clearcut and burned 60 years earlier, truffle biomass was only 20 percent of that found in adjacent old-growth stands. In the Sierra Nevada, forest managers need information on truffle biomass in different forest types and what forest conditions are associated with truffle production to assess the impact of their management decisions on truffle biomass and to evaluate the potential abundance of this food source for small mammals. This study was designed to answer two questions regarding truffles in forests of the Sierra Nevada: how do truffle abundance and species diversity vary among forest types and with seasons; and what are the biomass and species diversity of truffles in 1 ha of typical mixed-conifer forest?

PAGE 92-93 Methods

We selected two stands in each of four forest types in the Sierra National Forest: oak woodlands, ponderosa pine, mixed-conifer, and red fir. The two oak woodland stands were at 320 m in elevation and dominated by blue oak (*Quercus douglasii*), interior live oak (*Q. wislizenii*), and a mixture of exotic grasses. The two ponderosa pine (*Pinus ponderosa*) stands were at 1,400 m in elevation, dominated by ponderosa pine but with a substantial density of smaller white fir (*Abies concolor*) and incense cedar (*Calocedrus decurrens*) stems. The two mixed-conifer stands, within the Teakettle Experimental Forest at 2,200 m in elevation, had white fir, red fir (*Abies magnifica*), incense cedar, Jeffrey pine (*Pinus jeffreyi*), and sugar pine (*Pinus lambertiana*). The red fir stands were at 2,800 m in elevation and dominated by red fir and occasional lodgepole pine (*Pinus contorta*).

Beginning in February of 1996, all eight stands were sampled each snow-free month. In each stand, two parallel transects 10 m apart were randomly located, and 4-m2 circular plots were raked for truffles every 10 m along each transect. New transects and plots were sampled with each stand visit because raking disturbed soil structure and mycorrhizae. A total of 100 m2 was sampled in each stand during each sample period. All truffles were labeled, bagged, cut in half, and dried for 48 hr at 60o C. Truffles were identified to species using a combination of visual cues and microscopic spore patterns against published keys. Difficult identifications were sent to Dr. Jim Trappe at Oregon State University.

To investigate biomass, diversity, and stand conditions associated with truffles, we selected a 1-ha plot in mixed-conifer forest near Ross Crossing, at 1,500 m in elevation. All locations of truffles, trees, snags, logs, and shrubs were recorded using a surveyor’s total station. For weather data, we relied on records from two long-established weather stations. One, at the USDA Forest Service’s Trimmer Guard Station near Pine Flat Reservoir, was at the same elevation (300 m) as the oak woodland stands. The other was at Wishon Reservoir, about equidistant between the mixed-conifer and red fir sites, at an elevation of 2,400 m.

Results

The highest truffle abundance was in the ponderosa pine stands, where the biomass in June 1996 was 4.4 kg/ha (*fig. 1*). Truffle biomass, at 2.2 kg/ha, also peaked in the mixed-conifer at this time. All stands in oak woodlands and red fir forest had consistently low truffle biomass. The highest values for all sites occurred in the spring and late fall. Fluctuations in truffle biomass correlated with the abundance of precipitation. With a lag of 1-2 months, the peaks in truffle biomass during the spring and fall were closely and positively correlated with total rainfall at the Trimmer weather station (*fig. 2*). Species richness was highest in ponderosa stands (*table 1*), but species evenness was greatest in mixed-conifer stands, indicating a community in which no single species dominated truffle abundance.

In the 1-ha plot, we located 869 truffles of 65-71 species, with a total dry biomass of 573 gm (*table 2*). Several individuals were immature, precluding a determination of whether they were new species or one already tallied. Nine new, undescribed species collected from the 1-ha plot now await final taxonomic classification at Oregon State University.

PAGE 96 Discussion
Forest types with the highest densities of truffle consumers also contain the greatest truffle abundance. Ponderosa pine and mixed-conifer forests are home to most Sierra forest mycophagists, including the northern flying squirrel. Low truffle abundance in oak woodlands may correspond to long dry seasons or a low density of tree hosts. In red fir forests, long, cold winters probably reduce the duration of available soil moisture and may depress truffle production.

The 1-ha plot was searched in June of 1997, after an exceptionally dry spring. Even under these conditions, 65-71 species were collected from the plot. Much of the Sierra Nevada has not yet been sampled for truffles, so probably many new species of truffles are as yet undescribed. Furthermore, because truffles are produced by only a fraction of the fungal species in the soil, even the 65 identified species in this sample comprise only a portion of the species present. As such, the data suggest that the soil fungal community may have even more species than the invertebrate community. We have yet to identify many of these species and to understand their role in “healthy” ecosystem functions.

The observation that truffles are most abundant in the ponderosa pine and mixed-conifer forests is reason for extra care in planning for forest management, as most stand altering projects occur in these forest types. Further research is needed to understand the effects of thinning, burning, soil scarification, and compaction on this important below-ground food source.

SQUIRRELS CANNOT LIVE BY TRUFFLES ALONE: A CLOSER LOOK AT A NORTHWEST KEYSTONE COMPLEX

SCIENCE FINDINGS issue sixty / january 2004

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PAGE 1 I N S U M M A R Y

Tree squirrels in the Pacific Northwest are part of a keystone complex that includes ectomycorrhizal fungi, Douglas-fir, and spotted owls. All three squirrel species—the northern flying squirrel, the Douglas' squirrel, and the Townsend's squirrel—consume truffles produced by fungal partners of important tree species. The squirrels then spread the spores of these fungi throughout the forest in their feces.

The fungi are important to the growth and health of many Northwest tree species. Squirrels, in their turn, are major prey for vertebrate predators in the forest, including threatened and sensitive species such as the northern spotted owl. Thus, as an essential link in the web of interdependence, squirrels are good indicators of forest function and can be used to evaluate management effectiveness in promoting biodiversity and sustainability.

Management for habitat elements that contribute to truffle production—coarse woody debris, a variety of tree species, and ericaceous shrubs—has been proposed to benefit squirrels and consequently their predators. But there has been little research on the nutritive value of truffles, the relationship between truffle biomass and squirrel biomass, the importance of other food for the squirrels, or effects of management on truffle production.

Several research projects out of the Pacific Northwest Research Station's Olympia, WA, laboratory are beginning to answer preliminary questions in these areas.

PAGE 3 L A N D M A N AG E M E N T I M P L I C AT I O N S

• Management can have diverse effects on truffle diversity and abundance. In general, managing for biocomplexity—multiple tree species, understory diversity, decaying trees—at fine scales contributes to biodiversity and ecosystem resilience.

• Variable-density thinning can increase the diversity of both belowground (truffles) bodies and aboveground (mushroom) fungal fruiting bodies without impairing production in the mid to long term.

• A diverse deciduous understory of trees and shrubs that produce edible fruits, seeds, and nuts in conifer forests helps stabilize squirrel populations and those of the predators that depend upon them.

• Diverse overstories including some deciduous trees can reduce impacts on squirrels of variability in seed production by individual species of conifers, and by root rot infestations. Deciduous trees may also provide cavities in even young stands.

PAGE 4 Retrospective studies cannot demonstrate cause and effect, which are difficult to establish in most biological and social field studies, he notes. Instead, he has used his results to pose several hypotheses explaining differences in abundance of flying and other squirrels under differing forest conditions.

First, the activity, abundance, and carrying capacities of flying squirrels in dry Douglasfir forests in the western hemlock zone seem tied to coarse woody debris through its influence on production of truffles. The thinned forests almost entirely lacked coarse woody debris, and even legacy-retention forests did not carry as much of the debris as commonly found in old-growth Douglas-fir.

Second, closed canopies of legacy-retention forests provided the right microclimates in the canopy to support stick nest use by flying squirrels. Thinned forests had virtually none, and neither forest supported many cavities suitable for dens. Third, closed canopies and relatively open forest floors allowed efficient movement of flying squirrels through the canopies and quick location of truffles in the forest floors of the legacy-retention stands.
Diversity of truffles was similar in both forests, but species composition changed after thinning, potentially to the detriment of squirrels.

PAGE 5 It appears that neither forest management strategy was adequate to develop or maintain the complex trophic pathways that support the diverse vertebrate communities associated with old-growth forests within a 50- to 70-year time frame," Carey says.

One of Carey's hypotheses was that silvicultural manipulations of second-growth forests such as variable-density thinning offers could result in the messy complexity (which scientists call spatial heterogeneity) that would reproduce the biocomplexity and plant-fungal productivity associated with high squirrel populations.

Compatibility Between Wood Production and Other Values and Uses on Forested Lands: A Problem Analysis

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United States Department of Agriculture Forest Service Pacific Northwest Research Station General Technical Report PNW-GTR-564 November 2002
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Abstract
Peterson, Charles E.; Monserud, Robert A. 2002 Compatibility between wood production and other values and uses on forested lands: a problem analysis. Gen. Tech. Rep. PNW-GTR-564. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 51 p.

We provide background documentation for the Pacific Northwest Research Station's Wood Compatibility Initiative, a 5-year multidisciplinary research effort that began in response to 1997 Congressional direction. This problem analysis

was the initial effort to examine the state of knowledge regarding compatibility between wood production and other values and to develop a framework for directing a research initiative (Wood Compatibility Initiative) that examines the central question: Can we as a society produce wood commodities and other forest values in an environmentally acceptable and sustainable manner? Forest policy issues are often framed as two-dimensional debates such as “jobs versus the environment.” That framework assumes that forest management is a zero-sum enterprise, in which actions such as timber harvest inevitably mean substantial tradeoffs for other forest values such as wildlife habitat, clean water, and recreation. The debate ignores the possibility that instead of direct tradeoffs, opportunities exist for compatible changes that can provide more of both. The research challenge is to determine if, and at what level, timber harvest and other forest services and products can complement one another. Compatibility is seen as the degree to which we can manage for wood production without impairing other values.

Keywords: Compatible wood production, alternative silviculture, joint production, social acceptance, forest management, management options, biodiversity, aquatics, wildlife, economics.

PAGE 2 The Pacific Northwest (PNW) Research Station is undertaking a major research initiative in Alaska, Washington, and Oregon, in response to a national resource problem of increasing complexity. The research problem is that little if any scientific information is available on the compatibilities and tradeoffs between commodity production and other values (e.g., wildlife, water, aesthetics, recreation) that the public desires from our forests. A well-focused research initiative that integrates key scientific disciplines should provide sound research results that can enhance good stewardship of our forest lands, both public and private. Therefore, the PNW Station will focus its research efforts for this initiative on options that can increase the compatibility between commodity production and other important societal values from forest lands. The outcome will be scientific information that land managers can use to increase opportunities for producing compatible bundles of goods and services made up of wood, wildlife habitat, scenery, recreation, water quality (including water as a commodity), and riparian habitat in a manner that is socially acceptable and economically viable.

PAGE 5 Although forestry outputs have largely focused on wood production, a broad spectrum of additional products and values are available from the forest. However, given the limited resources, we have chosen to focus this initiative on a mix of four interactions that, taken together, include most of the major driving forces setting the public agenda on the future of forest management in the region:

• Wood production and wildlife needs
• Wood production and aquatics needs
• Wood production and biodiversity needs
• Wood production and social acceptance

PAGE 16 Silviculturists have studied the key steps in stand management with fruitful results. Nursery methods for efficiently raising healthy, superior planting stock are now common, including techniques for inoculating roots with mycorrhizal fungi to promote quick establishment and sustained growth (Castellano and Molina 1989). Effective methods have been developed for controlling competing shrub and nontimber vegetation, thus promoting rapid growth of established individuals (Walstad and Kuch 1987). A range of harvesting systems have been developed to reduce problems such as soil compaction (Warila and Boyle 1995).

PAGE 24 Recently, the meaning of biodiversity has expanded in the Pacific Northwest to include abiotic elements such as snags and woody debris, and structural elements such as multiple canopy layers, legacy trees from the previous stand, and a heterogeneous stand structure (e.g., Carey et al. 1996, Parminter et al. 1995). Processbased definitions such as IUCN (1991) and Reid and Miller (1989) are appealing in their generality but difficult to measure and index (but see Carey 1994). Zeide (1998) contends that the concept of biodiversity may be indefinable in principle and therefore meaningless because it encompasses the total abundance of organisms, species, populations, communities, and their environments, together with all their complex interrelations. The DEMO study (Halpern and Raphael 1999) is one systematic research effort at an operational scale that has as a primary objective the effects of green-tree-retention harvests on biodiversity (fig. 8). As a result of the external scientific review of the DEMO study plan, biodiversity components addressing canopy invertebrates (see Progar et al. 1999) and ectomycorrhizal fungi (Cázares et al. 1999) were incorporated to strengthen the study.

PAGE 27 Knowledge gaps—Vance (2002) describes the effort at addressing knowledge gaps by scientists in the Pacific Northwest at the PNW Research Station, listing among the outputs 49 publications between 1992 and 1997. The complex biology and lack of information on harvesting of special forest product species present a significant challenge for integrative ecosystem management (Molina et al. 1997). Numerous federal and state laws exist to protect forest resources. Under strong environmental regulations and in a litigious climate, resource managers require substantial data to support management decisions. Unfortunately, baseline data on the effects of harvest, on markets, and on the biology, ecology, and productivity for many special forest product species are short term, incomplete, or nonexistent (Molina et al. 1997, Vance et al. 2001).

Nontimber Forest Product Inventorying and Monitoring in the United States: Rationale and Recommendations for a Participatory Approach

Submitted to the National Commission on Science for Sustainable Forestry
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www.ifcae.org
March 2004

Abstract
This document explores the potential of collaborative approaches for nontimber forest product inventory and monitoring in the United States. It begins by reviewing results of a federal and state survey that documented inventory and monitoring efforts for nontimber forest products in the United States. The surveys show that the majority of NTFP-related inventory and monitoring on National Forests and state forests consists of nonscientific forms of monitoring, such as tracking permits, general site inspections, and informal visual checks of harvest areas. We argue that broadening participation in inventory and monitoring efforts can provide managers and policymakers with the data needed to develop and maintain sustainable NTFP management programs in an era of declining forest management budgets and staffing levels. Our fieldwork with NTFP harvesters identified several characteristics of harvesters and their work that could be compatible with or enhance inventory and monitoring efforts. In addition, harvester perspectives regarding incentives for participation are discussed. Profiles of eight participatory inventory and monitoring projects illustrate how this concept has already been put into practice. We then draw on our ethnographic research and results from four regional workshops to explore the barriers to involving harvesters in inventory and monitoring of NTFP species. In testing the idea of collaboration, we found that NTFP stakeholders are generally supportive of the concept. The benefits, potential incentives for participation, and potential barriers to participatory inventory and monitoring are described. Key recommendations include: 1) developing and implementing collaborative inventory and monitoring pilot programs; 2) modifying existing inventory and monitoring programs to explicitly include NTFPs; and 3) develop curricula and training courses for forestry students, managers and extension agents that focus on the current and potential role of nontimber forest products in ecosystem management.

This document is a companion report to: *The Relationship between Nontimber Forest Product Management and Biodiversity in the United States* and *Workshop Guide and Proceedings: Harvester Involvement in Inventory and Monitoring of Nontimber Forest Products*. All of these documents are available online at: www.ifcae.org/projects/ncssf1/ and www.ncssf.org

PAGE 5 Preface
In June 2002, the Institute for Culture and Ecology (IFCAE) received an 18-month grant from the National Commission on Science for Sustainable Forestry (NCSSF) to assess the relationships between forest management practices, nontimber forest products (NTFPs), and biodiversity in the U.S. The objectives of this research were to: 1) synthesize data regarding the impact of nontimber forest products management on forest ecosystem sustainability and biodiversity; and 2) directly support the ability of U.S. forest managers to assess nontimber forest

product sustainability.

To achieve these objectives, we developed five interrelated project components. The first involved the expansion of IFCAE's web-based NTFP species database for identifying commercially harvested NTFPs in the United States. The second component expanded IFCAE's web-based NTFP bibliographic database that catalogs references specific to NTFP conservation, policy, management, culture and ecology (See www.ifcae.org/ntfp for both databases). The third component consisted of updating state and federal NTFP management surveys to document managers' views on how management activities affect local biodiversity and to learn more about inventory and monitoring (I & M) efforts. The fourth component involved conducting ethnographic interviews in eight ecoregions of the United States to synthesize harvester knowledge about management and biodiversity (See Appendix 1 for map). The final component consisted of four regional workshops designed to bring together land managers, policy makers, scientists, buyers and harvesters to discuss multi-stakeholder approaches to biological monitoring.

PAGE 6 Nontimber forest products (NTFPs) have been recognized internationally and nationally as important elements in sustainable forestry and for their "contribution to environmental objectives, including the conservation of biological diversity" (FAO 2003). NTFPs represent the subset of biological diversity actively sought and collected by humans (Wong 2000:3). As such, they are of particular interest to inventory and monitoring efforts because: 1) they have cultural and/or economic value; 2) they face harvesting pressures in addition to other pressures, such as loss of habitat; and 3) their loss would have both ecological and cultural repercussions. Yet, NTFPs have been marginalized and largely ignored in modern forestry. The Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests for the Montreal Process States, the USDA Forest Service has acknowledged that more knowledge is needed on how harvesting of NTFPs affects species and ecosystems and that many NTFP species do not appear in monitoring and inventory databases (USFS 2001; Hyatt 1993).

PAGE 7 Research Focus
The National Commission on Science for Sustainable Forestry (NCSSF) initially requested research that would document NTFP management impacts on biodiversity. However, we found little evidence of land managers managing *for* NTFPs, except through the use of regulatory mechanisms such as permits. The impact of these NTFP regulatory mechanisms on forest sustainability and biodiversity appear to be largely unmonitored and unknown. Furthermore, we found that efforts to monitor the impacts of current forest management practices on NTFP resources are minimal or non-existent, as are efforts to monitor the impact of the harvest of NTFP resources themselves.

Without data about the density and distribution of NTFPs, population structure and productivity, and the impact of biomass removal (of timber and NTFPs alike) on ecosystem stability, it is difficult to determine sustainable harvest levels for NTFPs. To complicate the issue, managers and scientists have limited knowledge of the economic, political and cultural factors that drive NTFP use patterns. Moreover, cultural use patterns for NTFPs are diverse, and the decentralized nature of NTFP gathering presents a challenge to current forest management. In short, current ecological, cultural and economic understandings of the NTFP arena are insufficient to guide land managers and policy makers.

PAGE 9 To determine the extent to which NTFP inventory and monitoring occurs on National Forests and state forests, we administered two written surveys as part of this research. We emailed one version of the survey to all U.S. Forest Service Ranger Districts, and the other to the State Foresters of all 50 states. Both surveys included a section asking respondents about their administrative unit's use of NTFP inventory and monitoring efforts, as well as their views on barriers to and opportunities for effective NTFP inventory and monitoring. We also included a question designed to elicit information about ecological monitoring efforts of the impacts of NTFP management activities on forest ecosystems.

We received responses from 84 National Forests, or 78% of the National Forests in the U.S. Thirty-four state foresters completed the state survey, a response rate of 68%.

Lands Managed by the Forest Service

Respondents on 36% of the National Forests reported that NTFP inventories take place on their forests. The reported incidence of NTFP monitoring was much higher, occurring on 60% of National Forests (see Table 1). On 11 forests, or 55% of the 20 forests for which details on inventory programs were provided, NTFP inventories consisted of informal field checks or general surveys of prospective harvest sites. Six forests (30%) noted that they used inventory field plots and four (16%) gathered NTFP data as part of stand exams.
Similarly, descriptions of NTFP monitoring programs from the 29 National Forests who provided them suggest that much NTFP monitoring consists of permit compliance checks (52% of the monitoring efforts described by responding Forests) or informal visual checks of harvested areas (31%). Respondents from only 6 National Forests (21% of those describing NTFP monitoring programs) mentioned using scientifically designed field plots for NTFP monitoring.

We also asked survey respondents whether their administrative units conducted ecological monitoring to determine the effects of NTFP management activities on biodiversity.2 Respondents from slightly more than half (54%) of the National Forests indicated that ecological monitoring of NTFPs takes place on their forest. Respondents from 23 National Forests included a written description of their ecological monitoring efforts. On 65% of these National Forests, ecological monitoring focused on determining unspecified types of ecological impacts of NTFP management, and 44% noted that their ecological monitoring was aimed at determining the impacts of NTFP management on the NTFP species themselves.

PAGE 10 As with the NTFP-specific inventory and monitoring question on the survey, Forest Service respondents interpreted the term “ecological monitoring” to include a range of activities ranging from informal checks of harvest areas (listed for 52% of the National Forests), general site inspections (listed for 27%), and permit tracking (14%) to scientific field plots (5%) and surveys (5%). In short, the majority of NTFP-related inventory and monitoring on National Forests consists of informal, non-scientific forms of data collection.

Survey respondents mentioned a variety of barriers to implementing NTFP inventory and monitoring, ranging from lack of funding to limited commercial demand for NTFPs to the low prioritization of such efforts within the agencies. These barriers fell into the following three broad categories: 1) lack of internal capacity to develop and carry out inventory and monitoring programs; 2) lack of political will within the agency; and 3) limited or no perceived need due to either abundant NTFPs or a small number of harvesters relative to supply.

Among the participating National Forests, the most commonly cited barrier to NTFP inventory and monitoring was lack of funding (listed by respondents from 85% of the forests). The second biggest barrier for the Forest Service was lack of staff (listed by respondents from 73% of the forests). Both of these fall into the internal capacity category. The two other major barriers to inventory and monitoring—lack of political will within the agency and perceived lack of need for inventory and monitoring—were mentioned by respondents from fewer than 20% of the National Forests.

Lands Managed by States

The survey data for state forests suggest that NTFP inventory and monitoring is even less likely to take place on state forestlands. 9% of the state foresters reported that NTFP inventories took place on their forests, while 29% indicated that they monitored NTFP harvesting activities. Of the 10 respondents who provided details on monitoring programs, six stated that monitoring consisted either of visual exams or of informal checks as part of conservation officers’ regular duties. The remaining respondents didn’t provide enough information for us to determine whether monitoring consisted of informal or scientific procedures.

Four state foresters (12%) reported that ecological impact monitoring takes place for NTFP management activities on their state forestlands. The state foresters who mentioned ecological monitoring noted that it consisted of visual checks or inspections done as part of a forester’s other duties.

When asked about barriers to inventory and monitoring, state forest respondents mentioned lack of funding (76%) and lack of personnel (76%) as the major barriers to NTFP inventory and monitoring. Twenty-five percent of the state survey respondents mentioned other institutional capacity types of barriers, such as lack of agency knowledge and logistical difficulties, 14% listed lack of agency support, and 14% perceived no need for inventory and monitoring.

PAGE 11 While all these programs have projects that include species that may be NTFPs (e.g., berries, roots, bark), we could find no evidence that any of these programs specifically target data collection or analysis on species because they are NTFPs. In contrast, one the most important programs for forest inventory and monitoring information, Forest Inventory and Analysis (FIA), timber is the only natural resource product that serves as a central organizing concept in research designs and data collection.

Some individuals or teams in the Forest Service (e.g., Pilz and Molina 2002; Pilz et al. 1996; Vance and Kirkland 1997; Kauffman 2001, 2003) have conducted biological investigations of NTFPs. Likewise, the US Fish and Wildlife Service has commissioned studies to analyze the sustainability of ginseng and goldenseal harvesting (Gagnon 1999a, 1999b) and the National Park Service has initiated studies such as the All Taxa Biodiversity Inventory of the Great Smoky Mountain National Park (Francis et al. 2003; White and Morse, 2000). Such efforts have begun to provide a body of research specific to NTFPs at appropriate spatial and temporal scales and are critical for informing future research. These projects are helping define key questions and appropriate research design and methods for NTFPs. However, these researchers have few resources to work with and little agency support overall. Consequently, federal agency science is only minimally addressing the vast gap in NTFP research for federal lands.

PAGE 15 Potential Benefits of Collaborative I & M Approaches
Specific to NTFPs, Kerns et al. (2002:259) note, “Local harvester knowledge of where particular harvest techniques are used and have been used for long time periods can be incorporated into field inventories to develop relational inferences between harvest practices and observed productivity.” Everett (2001) presents a case study of participatory research from northern California, in which harvesters collaborated with the Forest Service, scientists and local NGOs to address ecological, economic and social aspects related to harvesting from public lands. In her work with the Biodiversity Support Program, Alcorn (1994:ix) notes, “If the who includes local people and other forest users in the roles of decision-making planners and results analysts, then biological information developed will provide critical material for constructing a sustainable system for harvesting NTFPs.” Indeed, community self-monitoring systems for NTFPs are appearing in many countries, including the Philippines, Sri Lanka, India, Vietnam, and Indonesia, in response to community concerns over depletion of NTFP resources (de Beer, pers. comm.). According to de Beer, Indonesian rattan harvesters see monitoring as a mechanism to “gain recognition and credibility for their ageold sustainable management practices and to serve as a useful foundation for certification.”

PAGE 16 Specific to NTFPs, inventory and monitoring data can help establish whether a system is ecologically sustainable and lead to the possibility of certification. Certification of NTFPs is an emerging practice on state and private forestland, and one benefit is the potential for increased market access and price premiums (Mallet 2002; Shanley et al. 2002). In addition, involving harvesters could help capture the geographic variability of many NTFPs, thus addressing what Kerns et al. (2002) call the frequent inadequacy of current I & M spatial grids and temporal scales.

PAGE 20-21 Profile #7: Matsutake Mushroom Ecological Monitoring In 1994, a unique collaboration began between a matsutake harvester and the NTFP coordinator for the Forest Service on the Umpqua National Forest that has resulted in several longterm and on-going monitoring studies. The objectives of the first collaborative effort, initiated on the Diamond Lake Ranger District, were to: 1) evaluate the effects of six harvest techniques on short and long term matsutake production, in terms of both the number of sporocarps (the fruiting body of fungi) produced and total biomass; 2) evaluate small and large mammal use; 3) evaluate sustainability; 4) evaluate variability of fruiting from year to year; 5) publish and communicate findings; and 6) to have fun. The Forest Service has funded this work periodically and volunteer effort has made the continuation of the project possible when no funding has been available. Other collaborators included Forest Service and OSU mycologists. The second monitoring effort, referred to as the "Boswell Study," is located on private land in Cave Junction, OR. The objectives of this effort were to: 1) monitor and record biomass produced on 400 acres; 2) determine economic value of the mushroom production; 3) monitor and evaluate environmental conditions conducive to fruiting; and 4) generate information to aid harvesters in efficiently locating fruit. www.matsiman.com/formalpubs/harvestmethodposter/harmethposter.htm

Profile #8: Chanterelle Mushroom Study
This profile illustrates the potential for integrating recreational pickers into I & M efforts. In 1993 an interdisciplinary and multi-stakeholder effort was initiated the Olympic Peninsula of Washington State to study the ecological and cultural impacts of chanterelle mushroom harvests (Liegel et al. 1998). Due to budget constraints, recreational harvesters from the Puget Sound Mycological Society were invited to participate in the project. Sixteen volunteers from the Society made single or multiple visits to collect data on four of the eleven monitoring sites over two field seasons (Liegel et al. 1998). The research team's biologist trained one of the volunteers who then helped train and supervise the other volunteers. Corresponding ethnographic fieldwork discovered that several commercial harvesters would have been willing to help harvest field research plots had they been asked. The US Man and Biosphere Program funded this three-year study and a variety of articles were published in an AMBIO special report.

PAGE 22 We now turn to our ethnographic research and workshop data that specifically address the opportunities and barriers to involving harvesters in inventory and monitoring of NTFP species in the United States. (For a discussion of the ethnographic fieldwork and workshop results in full, please see our companion reports.)

PAGE 23 Reasons to Involve Harvesters in Inventory and Monitoring
In talking with harvesters and accompanying them out in the forest, we identified numerous features of harvesting that could be compatible with or enhance inventory and monitoring efforts. These include: Harvester Characteristics

- Harvesters come from diverse ethnic, class, gender, age and cultural backgrounds.

Data sets obtained from a broader constituency have a better chance of accurately representing that constituency, ensuring that cultural use patterns are not missed or neglected in management plans.10

- Harvesters have diverse motivations.

People may gather NTFPs for a variety of reasons, including for subsistence, cultural, spiritual, commercial, recreational and educational purposes. They may gather for one or many of these reasons and harvesting activities often shift in response to economic conditions, season, need, weather conditions and NTFP availability. Although we often talk about 'harvesters,' as one category, harvesters are NOT homogenous. This diversity provides flexibility and options for I & M programs since each type of harvester can offer different insights. Active involvement of harvesters in I & M could give resource managers greater understanding of how these underlying motivations shape their interactions with the forest, which has a direct relationship to issues of sustainability.

- Harvesters are often in the forest on a frequent basis (often daily or weekly).

I & M efforts could be designed to take advantage of this, resulting in data being collected more frequently, over larger areas, and possibly at lower costs. Many I & M research designs require data collection only once or twice during a growing season, thus even harvesters who go out once a year could play a role in I & M.

- Harvesters often make regular empirical observations.

Harvesters who are out frequently and return to the same areas year after year, are able to make critical observations of changes that often go missed by others. A collaborative I & M process could help translate these experiences into useable data by creating a process for harvesters to keep systematic records.

- Harvesters can have valuable knowledge based on years of experience.

Variables that influence a harvester's knowledge include (but are not limited to): years gathering; from whom they learned to harvest; and years gathering in one particular location. This local knowledge could provide valuable insight into sustainable management of these resources.

- Harvesters can have an aptitude for the scientific method.

Some harvesters have developed sophisticated formal data recording systems, productivity models, and harvesting guidelines. This knowledge could be valuable in itself, but it also illustrates the potential compatibility of harvesters and formal scientists and the potential for these two groups to work together on ecological research aimed at understanding such factors as NTFP productivity

and regeneration rates.
• Harvesters often exhibited stewardship attitudes and a concern for protecting the resources they harvest.
Many harvesters have developed practices to conserve the resources they harvest and some have developed harvesting guidelines to ensure the long-term sustainability of the plants they gather. The existence of this stewardship ethic reflects the deep respect that many harvesters have for the resources they depend upon. 11 Pilot I & M programs could test for the ecological results of these practices and guidelines.
• Harvesters are directly affected by natural resource management decisions.
Democracy is based on the principle that those who have a stake should have a voice. Because harvesters are affected by resource management decisions, they should be involved in those decisions. Broader participation results in greater legitimacy for the decision-making processes and thus often reduces conflict, as well as law enforcement costs.

PAGE 25 Although the above characteristics seemed promising, we were unsure whether harvesters have sufficient incentives to get involved in participatory inventory and monitoring. Therefore, we asked harvesters directly why they might want to participate. Their responses ranged from the personal to the political, and are summarized below. These are not listed in any particular order.

Harvester Incentives
• Incentive 1: To maintain quality of life.
Many harvesters indicated taking pride in their ability to provide food and/or medicines for their family and friends. This is linked with valuing working in the woods, and enjoying the freedom to set their own hours and being their own boss. Many expressed the sentiment that harvesting provided a higher quality of life than a desk job and they willingly took the risks inherent in harvesting to be able to be in the woods on a regular basis.
• Incentive 2: To maintain family and cultural traditions.
Many harvesters learned to gather from their grandparents or parents, and it is important to them to maintain these family and cultural traditions. If I & M could be a mechanism to ensure the continuation of harvesting traditions, these harvesters were interested in participating.
• Incentive 3: Job opportunity.
Poverty and high unemployment rates plague many rural areas in the U.S. Many harvesters expressed interest in I & M if it represented a job opportunity with financial reward. Likewise, displaced workers from the timber and coal industries were looking for other opportunities. Some harvesters noted that participatory I & M could provide both economic development and conservation benefits in rural areas.
• Incentive 4: To promote local economic development.
Many harvesters have developed small NTFP businesses, and said that they would support I & M if it would ensure a steady supply of the raw materials they needed to ensure the long-term viability of their business. In addition, many

harvesters felt that supporting local businesses was important for promoting local economic development in impoverished rural areas where much gathering occurs. Some harvesters stated that supporting local business was their political stand against large corporations who they felt unfairly extracted local wealth.

• Incentive 5: To have a voice in how public lands are managed.

Many harvesters noted that they have felt invisible and that NTFPs have been basically ignored in forest management. Many harvesters reported extensive loss of harvesting locations and declines in forest biodiversity due to land conversion and development, logging, grazing, wildlife management (especially for deer in the eastern United States). Harvesters stated that they want managers to stop managing exclusively for timber or cattle and consider the other species that should be part of an ecosystem management approach.

• Incentive 6: To protect habitats where they gather.

Many harvesters return to the same locations year after year and have developed an intimate relationship with the ecosystems where they gather NTFPs. Many have lost their favorite and/or most productive spots to logging, grazing, development or road closures, and are motivated to get involved in I & M to protect their remaining harvesting locations.

• Incentive 7: To ensure long-term access.

Many harvesters felt that I & M would help ensure long-term access to favorite harvesting areas and possibly open up access to new areas since it would contribute to ensuring that harvesting was sustainable.

• Incentive 8: Regulatory fears.

The FY2000 Appropriations Act included a rider (known as Section 339), which requires the Forest Service to charge fair market value for permits and ensure that NTFP harvesting levels are sustainable. 12 The impending implementation of these regulations has created concern among harvesters that given the lack of ecological data, NTFP harvesting will be restricted or banned altogether. A number of harvesters (primarily in the PNW) noted that the passage of the rider has created an incentive for them to participate in NTFP monitoring efforts to ensure that managers have the ecological data needed to justify keeping access open.

PAGE 26-28 Potential Barriers

• Barrier 1: Concerns about data validity.

How to ensure data validity is a fundamental concern with any inventorying and monitoring system, whether it is collaborative or not. Adding a collaborative approach to inventory and monitoring tends to increase concerns about bias and other data inadequacies, especially if members of commercial interest groups are participating. To address this, third-party data verification systems should be considered a normal and desirable feature of any I & M program. Quality control mechanisms usually include training, field audits, and the collection of replicate samples. For example, in the case of permanent monitoring plots for the Forest Health Management program, a third party team randomly checks the work of data collectors. Another strategy used by NatureMapping (see Profiles above) is to create a separate public layer of information. Keeping data layers separate allows for scientists and others to crosscheck findings and see who contributed what data.

- Barrier 2: Integrating scientific and local knowledge systems.

Many scientific community members are biased against non-expert/local/indigenous knowledge systems (Chambers 1997). These “expert vs. non-expert” clashes can present a formidable barrier to collaborative I & M. But as Wong (2000:12) states, “Experience has shown that local perspectives often serve a practical purpose and are a sensible starting point for understanding and/or classifying the ecological environment.” Any collaborative approach should seek to integrate different knowledge systems and to assure participants that the project will incorporate the rigor of scientific method with local ways of knowing to strengthen overall understandings of ecosystems. (See Berkes 1999; Berkes et al. 2000; Shanley and Laird 2002; Michel and Gayton 2002 for more information).

- Barrier 3: Professional cultural differences.

The differences between harvester, manager, and scientist cultures may hinder communication and understanding among stakeholders. Each group and sub-group has its own norms, rules, language, etiquette and requirements that, if not understood by the others, could result in miscommunication and conflict. Cultural differences between natural and social scientists also hinder collaborative interdisciplinary work. Setting up a process that ensures multiple opportunities for communication and working with professional facilitators can help overcome this barrier.

- Barrier 4: Lack of experience with NTFPs and/or participatory processes.

Many NTFP stakeholders stated that they did not have enough experience with collaborative processes to know how to initiate them, let alone facilitate them. Additionally, many Forest Service staff conveyed that they did not know enough about NTFPs in general to be able to participate effectively in the process. This barrier can be overcome with educational workshops and trainings.

- Barrier 5: Logistical (budget/staff/time) constraints.

Resource managers are facing budget cuts, decreases in staffing levels, and increasing demands on their time. Many already feel overburdened and unable to take on additional projects, let alone take leadership for a new approach that is based on a more time-consuming process. Many managers must show immediate results or face further cuts, which discourages long-term collaborative approaches. Overcoming these large-scale political, institutional and bureaucratic barriers will be a formidable challenge. Starting with small, local pilots that produce useable data relatively quickly is one strategy to overcoming such barriers. Documentation of the ecological and social outcomes from collaborative efforts is another strategy for illustrating the benefits of a collaborative approach.

- Barrier 6: Ensuring Continuity.

Many harvesters face economic uncertainty and instability. This reduces their ability to commit to participating in inventory and monitoring projects over long periods of time. District Rangers and other staff are also frequently transient, often serving a two or three-year term before moving to another forest. I & M project design can address this by ensuring long-term financial incentives for harvesters for on-going participation, and creating mechanisms to handle changes in participants, including recruitment, orientation and training sessions. Ensuring long-term funding is a formidable challenge. For scientists, funding cycles typically define their research activities. Budget cuts and short budget cycles often reduce chances for longterm participation. Overcoming this barrier will require demonstrating the benefits (ecological, economic, political and social) of long-term projects.

- Barrier 7: Lack of immediate, tangible, visible results.

Participatory processes generally require more time than non-participatory processes. While this may lead to a deeper, more meaningful understanding of the situation, results are not always immediate, visible or easily quantified. This may hamper interest in participating, and may reduce the ability to secure continuing funding. One way to overcome this would be to develop “measures of success” collectively with all participants, in order to have a means to evaluate progress.

- Barrier 8: Information access, ownership and management issues.

Harvesters expressed concern that participation in I & M programs would reveal their harvesting areas to others and have a detrimental impact on the areas where they harvest and their ability to continue gathering. Similarly, scientists expressed concern with revealing the location of their experimental plots. One way to address this barrier would be to adopt data access/sharing agreements similar to those developed by the Heritage Program. These agreements include “buffering” the plant population/occurrence using a random grid, anywhere from 1 to 36 square miles depending on the sensitivity. In addition to these concerns over geographical data, buyers expressed concern over their financial privacy. Stakeholders should work together to develop and implement information management mechanisms that protect proprietary business information.

In addition, we also identified some barriers specific to harvester participation. These include: Barriers Specific to Harvesters

- Barrier 1: Lack of trust.

Some harvesters reported that they felt that federal land managers were not interested in their suggestions about managing NTFP resources and that their experiences and knowledge were not recognized. Some harvesters have had such negative experiences with resource managers that they do not have an interest in helping them with data collection. This attitude is compounded by the anti-government sentiment in many rural areas of the country. In addition, lack of trust may be intensified if the harvester is a refugee and/or has had negative experiences with governmental authorities in their country of origin and/or experienced discrimination or racism here in the U.S.

- Barrier 2: Lack of interest in participating in a group effort.

Some harvesters dubbed this the ‘loner factor,’ noting that many are involved in harvesting because they like to be outside, in the woods, alone. It may be difficult to get these harvesters to participate in a process that involves meetings and potential confrontations with other stakeholder groups. This barrier can be overcome through research design, such as developing small training workshops for data collection and/or independent data collection efforts (e.g., modeled along the lines of the Maine Marine Resources lobster project. See Appendix 2 for details).

- Barrier 3: Differences in experiences, knowledge, attitudes, values.

Not all harvesters are the same in terms of their experience in the woods or their knowledge of plants and plant ecology. Some harvesters have gathered for many years and are astute observers and may have deep knowledge. Others may be new to gathering and have less knowledge. Some people work well in groups, others don't. Thus, developing a selection process that is inclusive *and* results in the most qualified participants is challenging.

- Barrier 4: Welfare/disability status.

Some harvesters gather NTFPs to supplement social security or disability checks and do not want to jeopardize their eligibility for transfer payments by participating in an official I & M program.

- Barrier 5: Lack of experience with scientific review/critique process.

Harvesters may not be used to receiving critical feedback from scientists (whose job is to provide that critical feedback as part of the scientific process). The challenge is to create a program where this review/evaluation process is non-threatening and integrated in such a way that everyone goes through it, not just harvesters. It is critical to integrate adequate opportunities for communication between participants so any problems can be identified and corrected early in the process. Mechanisms for dealing with issues as they arise will help the project avoid misunderstandings that could undermine or destroy the trust necessary for collaborative projects.

- Barrier 6: Lack of legal work documents.

In many NTFP sectors (e.g., floral greens) the labor force is predominantly Latino, some of whom may not have legal papers. Given the current political climate, undocumented workers must be even more cautious and this would most likely limit their ability to participate.

- Barrier 7: Labor structure differences.

Some harvesters are self-employed, but others are hired as employees. The type of labor structure may affect how harvesters work in the woods (how often they go out, how much they harvest, stewardship practices, etc.) and their willingness or ability to participate in I & M.

- Barrier 8: Language and literacy skill barriers.

In some NTFP sectors, harvesters are immigrants whose first language is not English. Depending on the objectives of the I & M program and the data needed, translation of the training program, data forms, and protocols may be needed.

The results were further substantiated in the findings from our federal and state survey. When asked about barriers, managers questioned whether harvesters would have the skills to carry out I & M work and if they would have any incentive to participate. In addition, managers were concerned about harvesters producing biased results and had reservations about the Forest Service's ability and political will to implement I & M for NTFP species. The survey results are presented in the companion report, *The Relationship between Nontimber Forest*

Product Management and Biodiversity in the United States.
To conclude, our findings indicate that NTFP stakeholders—including harvesters, buyers, scientists, nongovernmental organizations involved in forestry and rural development issues, resource managers and policy makers—were generally receptive to the idea of a collaborative approach. Workshop participants and interviewees helped identify features of harvesting that could be compatible with or enhance inventory and monitoring efforts as well as potential barriers to implementation. Fortunately, as the profiles demonstrated earlier, models exist for collaborative I & M that indicate that these barriers can be overcome. The next section looks into how to develop a collaborative I & M program to overcome these barriers.

PAGE 37 Recommendations
Participatory NTFP inventory and monitoring programs could be a powerful tool for promoting NCSSF's mission to improve the scientific basis for sustainable forestry in the United States. A review of state, national, and international programs shows that involving local people in collecting social and ecological data about their environment often has benefits such as improved data collection ability, broader stakeholder relevance, and increased public support for science in general. Forest managers have expressed that their biggest barriers to inventory and monitoring NTFPs is funding and staffing. Ethnographic findings show that commercial and noncommercial nontimber forest product harvesters all across the country have a keen interest in the well-being of the resource, spend regular time in the forests, and would participate in a formal inventory and monitoring program if it were a mutually beneficial relationship. In fact, as we have described in the profiles, some harvesters have already begun to develop or participate in inventory and monitoring programs.

Continuing to neglect the interests and knowledge of NTFP harvesters has significant implications for biodiversity conservation. Humans all through time across the world have harvested NTFP species. They will continue to do so, even where efforts are made to limit access. Regulations and management perceived as unfair by harvesters will only serve to perpetuate secretive strategies and obscure understandings of what is happening on the ground. Active management for NTFPs, including inventorying and monitoring, can help recast NTFPs as an important tool for biodiversity conservation. Instead of being forced to struggle under forest management and policies that marginalize NTFPs, harvesters could be embraced as valuable proponents of sustainable forestry. Participatory NTFP inventory and monitoring is an important step toward that objective. Given these findings we have three main recommendations:
1. Develop and implement collaborative inventory and monitoring pilot programs.
Pilot programs are needed to reveal how local ecological and sociocultural factors shape appropriate research design. We recommend that a series of ten participatory inventory and monitoring pilot programs be funded across the country. Program lengths should be minimally five-years long and have third-

party ethnographic evaluation. Profiles of the projects could be used in creating a handbook for participatory inventory and monitoring and a long-term national strategy.

2. Modify existing inventory and monitoring programs to include NTFPs and expand opportunities for harvester participation.

Federal programs, such as the Forest Inventory and Analysis, need to work with harvesters and other stakeholders to better integrate NTFP species into current inventory and monitoring efforts.16 Integrating participatory I & M programs into ongoing agency functions will require a clear articulation of how they will contribute to the function of the agency, as well as demonstrate an understanding of institutional barriers.

3. Develop curricula and training courses.

New interdisciplinary curricula are needed in forestry schools and management training programs to provide students, managers, scientists, and extension agents with knowledge regarding: a) the ecological and cultural importance of NTFPs; and b) the role of NTFPs in ecosystem management. This capacity building effort contributes to the goals of ecosystem management and biodiversity conservation by training current and future foresters, resource managers and policy makers. In addition, specific courses designed to impart the requisite skills for creating and implementing participatory NTFP inventory and monitoring programs are needed to support the implementation of our first two recommendations.

Nontimber Forest Products Management on National Forests in the United States

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Department of Agriculture Forest Service Pacific Northwest Research Station General Technical Report PNW-GTR-655 October 2005

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This work was performed under Contract No. 43-046W-4-0210, Special Forest Products Program.

Abstract
McLain, Rebecca J.; Jones, Eric T. 2005. Nontimber forest products management on national forests in the United States. Gen. Tech. Rep. PNW-GTR-655. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 85 p. This study provides an overview of nontimber forest products (NTFP) programs on national forests in the United States. We conducted an email survey in 2003 to obtain data on NTFP management

activities on national forests across the country. Program characteristics examined in the study included important NTFPs managed on national forests, presence of NTFP coordinators and law enforcement programs on ranger districts, incorporation of NTFPs into forest planning documents, presence of NTFP inventory and monitoring programs, managers' views on barriers to and opportunities for including NTFP harvesters in NTFP inventory and monitoring efforts, and managers' perceptions of barriers to expanding commercial NTFP harvesting. The data indicate that the agency is constructing a foundation for scientific NTFP management. The study identifies lack of funding and internal administrative capacity as key barriers to adequate incorporation of NTFPs in Forest Service planning, inventory, and monitoring.
Keywords: Nontimber forest products, forest planning, inventory and monitoring, biodiversity conservation, special forest products.

Preface

We have opted to use the term "nontimber forest products" in this report so as to conform to prevailing international convention and the predominant trend in the United States.

PAGE 1 Harvesting of NTFPs remains widespread throughout the United States (Emery and McLain 2001, Jones et al. 2004, McLain 2000).

Estimating the contribution of NTFPs to the national or regional economies is difficult owing to the lack of broad-based systems for tracking the combined value of the hundreds of products that make up the various NTFP industries. In 1998, Brevoort estimated the retail value of medicinal plant products sold in the United States, many of which were wild-crafted, at $4 billion. Chamberlain et al. (2002) placed the wholesale value of just one medicinal species–forest-harvested ginseng (*Panax quinquefolius* L.)–gathered from a four-state area at $18.5 million dollars in 2001. Schlosser and Blatner (1995) estimated that the wild mushroom industry in 1992 contributed $41.2 million and the floral greens industry in 1994 contributed $106.8 million to just the Pacific Northwest economy. Maple syrup (*Acer* spp.) production, which occurs primarily in 10 states in the Northeast and Great Lakes regions, had a wholesale value of $30 million dollars in 1997 (Chamberlain 2000). The aggregate economic value of NTFPs harvested in the United States is thus likely in the billions of dollars each year.

PAGE 2-3 Aside from their economic value, many NTFPs have significant cultural values (Danielsen and Gilbert 2002, Emery 1998, Fisher 2002, Richards and Creasy 1996, Schroeder 2002). For example, the huckleberry (*Vaccinium* spp.) is a sacred food among many Native Americans in the Pacific Northwest, and huckleberry gathering has long served as a focal point for renewing kinship and cross-tribal social ties (Fisher 2002, Knudson 1980). Emery (1998) documented the cultural importance of NTFPs for Native Americans and descendants of European settlers in Michigan's Upper Peninsula, noting that nonmonetary exchanges of NTFPs serve to enhance social ties. Similarly, Lee

(2002) described the importance of nonmonetary exchange networks centered on fish, game, and wild plants in maintaining links between rural and urban Native Alaskans. Thus, NTFP gathering and processing contribute toward the development and maintenance of the social ties needed for long-term cultural sustainability. Through harvesting NTFPs, indigenous and nonindigenous cultural groups develop ecological knowledge of the areas in which they live and work. Anthropologists refer to such knowledge as traditional ecological knowledge (TEK). Berkes (1999) defined TEK as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the living beings (including humans) with one another and their environment (cited in Danielson and Gilbert 2002: 289)."

Historically, the Forest Service has viewed nontimber forest products harvesting as a locally important, albeit limited vehicle for rural economic development (Shaw 1949; Thomas and Schumann 1993; USDA FS 1965, 1970). The National Forest System's 192 million acres (78 million hectares) of land are particularly important sources of raw materials for NTFP harvesters in the Western United States where national forests constitute a large percentage of the forested land base (Nelson 1995). Although most forested land is held privately or by state agencies in the states east of the Rocky Mountains, national forests also serve as important repositories of NTFPs in the southern Appalachians, the upper Great Lakes, and parts of New England and the Southeast (Chamberlain 2000, Emery 1998, Emery et al. 2002). The NTFPs in many areas, including some national forests, are extracted under commodity management strategies similar to those used for timber. Emery (1998) has identified the commodity management paradigm as it has been applied to timber management as problematic for some NTFP users. For example, her study of NTFP livelihood strategies on Michigan's Upper Peninsula notes that nonmarket uses for NTFPs, such as subsistence consumption and gifting to strengthen kinship and other social ties, are undermined under commodity management approaches.

PAGE 3 This report describes USDA Forest Service NTFP programs on 84 national forests located in the continental United States and Alaska (fig. 1). The description is based on data gathered through email surveys distributed to ranger districts nationwide in 2003 (app. 1).*1*

PAGE 4 **Legislative and Administrative Context of NTFP Management**

The Forest Service authority to develop and administer rules governing NTFP harvesting and related activities, such as buying and camping, on national forest lands stems directly from the "use and occupancy" and "protection" provisions of the 1897 Organic Act (table 1 provides a list of laws, regulations, and policies affecting NTFP management on national forests).*2 3* Congress initially granted this authority to the Secretary of the Interior (Steen 1991), the official responsible for managing the national forest reserves established under the 1891 Creative

Act. In 1905, Congress shifted this authority to the Secretary of Agriculture when jurisdiction over the national forests was transferred from the General Land Office to the Department of Agriculture (Steen 1991).

Additionally, the Final Rule for the National Forest Land Management Planning (36 Code of Federal Regulations [CFR] Part 219) published on January 5, 2005, establishes "requirements for sustainability of social, economic, and ecological systems" in the forest planning process (Federal Register 2005: 1023). Taken as a whole, these laws and related regulations require the Forest Service to manage resources under its jurisdiction in ways that provide adequate protection for threatened and endangered species, and that ensure longterm sustainable harvest of its renewable resources (Antypas et al. 2002).

PAGE 4-5 The Alaska National Interest Lands and Conservation Act of 1980 (ANILCA), which establishes priority for subsistence use of fish, wildlife, and other renewable resources, also affects NTFP management on the two national forests in Alaska (Mater 2000, Schroeder 2002). According to Schroeder (2002: 303), ANILCA has made federal agencies "loath to encourage commercial exploitation of nontimber forest products where conflict with existing subsistence uses might result." In addition, under the American Indian Religious Freedom Act of 1978, national forests throughout the United States are required to protect the religious cultural rights of American Indians, including rights to harvest culturally sacred plants (Mater 2000). Indian-reserved rights to NTFPs also apply on many national forests (Danielson and Gilbert 2002, Fisher 2002, Goodman 2002).

PAGE 5 The Forest Service's explicit regulation of NTFPs dates back to at least 1928 (Emery 1998). Regulation S-21 in the 1928 *National Forest Manual* authorized regional foresters to issue instructions regarding sales of NTFPs and to establish minimum prices for NTFPs that differed from those set for timber (USDA FS 1928).

PAGE 7 The principal regulations within the CFR that authorize how the Forest Service can dispose of NTFPs on national forest reserves include 36 CFR 223.1, which sets forth the procedures for disposing of forest products, 36 CFR 223.5, which covers the circumstances under which free use of forest products is permitted, and 36 CFR 223.6, which sets forth appraisal and fair market value requirements for forest products harvested on national forest lands (GPO 2004). The Forest Service Manual (FSM) and Forest Service Handbook (FSH) elaborate specific policies and directives applicable nationwide, as well as to specific regions and national forests (USDA FS 2005b).*4* The directives in the Forest Service Manual contain guidance needed by line officers and primary staff on more than one administrative unit, whereas the Forest Service Handbook directives provide guidance primarily for specialists and technicians. Although the regions and the national forests provide management direction on NTFPs to the ranger districts, the districts exercise some discretion in how they implement those directives (Emery 1998).

PAGE 7-8 The FSH 2409.18 Chapter 80 (USDA FS 2005b) constitutes an important source of national-level management direction for NTFPs on national forests. An amendment dated December 12, 2002, removed obsolete direction under this handbook chapter regarding … It also added important new direction for sustainable management of NTFPs, reserved treaty rights, NTFP valuation, collection of deposits for NTFP harvesting, control of harvesting activities, and reporting of NTFP harvest volumes and revenues. The FSH 2409.18_80 defines NTFPs as:

a. Non-timber vegetative products, such as mosses, fungus, and bryophytes, echinatia [sic], roots, bulbs, berries, seeds, wildflowers, beargrass, salal, ferns, and transplants;

b. Non-convertible timber products, such as Christmas trees, tree sap, boughs, bark, cones, burls, yew bark, and transplants of trees; and

c. The following convertible timber products: posts, poles, rails, shingle and shake bolts, firewood, fence stays, vegas [sic], mine props, and bow staves (FSH 2409.18_87.05).

PAGE 8 Among other items, the amendment directs the agency to manage natural resources (including NTFPs) “in such a manner that there is not impairment of the productivity of the land” (FSH 2409.18_87.11), to use inventories “to determine the effects of proposed management actions” (FSH 2409.18_87.12), to incorporate NTFPs into forest plans (FSH 2409.18_87.13), and to conduct NEPA-mandated environmental analysis for NTFP harvesting (FSH 2409.18_87.14). The amendment also encourages agency managers to use “locally based partnerships and collaborative projects” (FSH 2409.18_87.17) in NTFP management. Additionally, FSH 2409.18_87.3 requires NTFP managers to apply minimum rates established under FSM 2431.31b to convertible NTFPs (e.g., firewood, posts, poles, etc.) and allows the regional foresters to set minimum rates for nonconvertible NTFPs (e.g,. moss, bark, needles, etc.). The FSH 2409.18_87.3 also directs forest supervisors to set standard rates for NTFPs sold on their forests, and to update the rates annually. Under FSH 2409.18_87.51a, national forests may choose to grant individuals free use to special forest products for personal use.

PAGE 9-10 The 2004 Final Planning Rule, effective January 5, 2005 (Federal Register 2005), emphasizes the importance of monitoring, not just inventorying, as a central part of the forest planning process. Under the Final Planning Rule, the Forest Service adopts the use of the environmental management system based on International Organization for Standardization (ISO) 14001, an international standard for environmental management. The Final Planning Rule requires (Federal Register 2005: 1033): ... each administrative unit to implement an EMS [environmental management system] that includes defined procedures for identifying environmental conditions, keeps that information current, and includes monitoring and measurement procedures for continually evaluating conditions in the unit.

PAGE 10 Although the 2004 Final Planning Rule does not explicitly call for monitoring NTFPs, it does so implicitly through the statement that the goal of the ecological element is to “provide a framework to contribute to sustaining native ecological systems by providing ecological conditions to support diversity of native plant and animal species in the plan area” (Federal Register 2005:1059).

The Forest Service uses a variety of mechanisms to allocate access to NTFPs on national forest lands, including nonexclusive harvest permits, exclusive leases, stewardship contracts, and stewardship leases.

PAGE 11 For example, many national forests in Oregon, Washington, and Montana require mushroom harvesters to camp in designated industrial camp sites, and a few require mushroom buyers to purchase permits to buy wild mushrooms on national forest lands (McLain 2000, McLain et al. 2005, Parks and Schmitt 1997)

PAGE 12-13 In 1999, the UNITED STATES Congress clarified the legal mandate of the USDA Forest Service regarding NTFP management through the addition of a rider, known as Section 339, on P.L. 106-113, the Consolidated FY 2000 Appropriations Act. The rider was entitled “Pilot Program of Charges and Fees for Harvest of Forest Botanical Products” (Antypas et al. 2002). Section 339 included provisions requiring the Forest Service to charge fair market value fees for NTFPs and conduct analyses to ascertain whether NTFP harvesting levels are sustainable. Additionally, Section 339 prohibits the Forest Service from allowing unsustainable harvests and permits administrative units to retain a portion of the revenues obtained through permit and contract fees.

As Chamberlain et al. (2002) noted, however, few national forests have the staffing levels and requisite knowledge of NTFPs among their current employee base to implement the provisions of Section 339. Similarly, as Emery (1998: 144) observes, the Forest Service’s lack of knowledge about NTFPs hampers its ability to adequately fulfill its legal mandates originating in the NEPA and the NFMA to provide for the protection of plant and animal community diversity on national forests (Emery 1998: 144): Central to this act [the RPA as amended by the NFMA] and its implications for NTFP management are its requirements that the Secretary of Agriculture conduct and maintain a current inventory of all renewable resources on National Forest lands and provide for public participation in planning for their management. In so doing, the Act broadens the primary duties of the Agency from managing resources as a relatively autonomous body of experts to managing information on those resources and conducting their decision making in an open manner. This places a nearly impossible demand on Agency personnel vis a vis NTFP. There is a general dearth of comprehensive information about the herbaceous layer of forests, from which a majority of NTFP are derived.

PAGE 14 Questions
included in the survey questionnaire were developed on the basis of the authors' interactions with Forest Service NTFP managers over the course of a decade. Our fieldwork between 1993 and 2003 associated with several NTFP-related projects (Jones 2002, Jones et al. 2004, Love et al. 1998, Lynch and McLain 2003, McLain 2000) included discussions with NTFP managers on national forests and districts in Regions 1, 2, 3, 4, 5, 6, and 8 (i.e., most of the Western and Southeastern United States).

PAGE 15 Study Objectives and Survey Topics
We viewed this survey as an exploratory data-gathering process aimed at constructing a rudimentary picture of the Forest Service NTFP programs across the country. We asked respondents to provide information on the following aspects of NTFP management (app. 1):
• Major types of products harvested.
• Types of mechanisms used for allocating access to different categories of NTFPs.
• Presence of NTFP concerns in key planning and decision documents.
• Presence of NTFP program managers and law enforcement.
• Presence of NTFP inventory and monitoring.
• Barriers to implementing NTFP inventory and monitoring.
• Presence of systems for tracking the effects of NTFP management on biodiversity.
• Managers' familiarity with the USDA Forest Service national NTFP strategy.
• Managers' familiarity with three information resources developed through collaborative partnerships between the USDA Forest Service and the Institute for Culture and Ecology (i.e., two books and one Internet database).
• Barriers to and opportunities for including harvesters in NTFP inventory and monitoring.
• Barriers to expanding commercial NTFP harvesting on national forest lands.

PAGE 17 Response Rates
We received responses for 218 of 531 ranger districts, a district response rate of 41 percent (app. 2). These districts were distributed across 81 national forests.

Limited financial resources did not permit us to conduct a sample survey of nonresponding districts to determine how their programs differed from responding districts. Our conclusions thus apply only to those districts and forests that responded to the survey and cannot be generalized to all districts or forests in the National Forest System.

PAGE 19 **NTFP Products or Species**
During the past two decades, scientists have published a number of studies about NTFP harvesting and management in the United States. However, most studies encompass relatively small geographic areas, such as portions of states (Danielsen and Gilbert 2002, Emery 1998, Fisher 2002, Hansis 1998, London

2002, Love et al. 1998, McLain 2000, Weigand 1997) or a geographical region or two (Chamberlain et al. 2002, Hosford et al. 1997, Schlosser and Blatner 1995, Schroeder 2002).*14* Consequently, we were interested in clarifying the extent to which NTFP harvesting takes place on public forests throughout the United States.*15* We thus asked survey respondents to list the five most important NTFPs harvested on their district or forest.

PAGE 20 The survey data demonstrate that NTFP harvesting takes place in all regions of the United States.

PAGE 22 Transplants, boughs, and wild mushrooms appeared as important products on between one-third to one-half of the reporting national forests. Mushrooms figured commonly as important NTFPs on reporting national forests in just three regions, all in the West.

PAGE 23 **NTFP Program Administration and Enforcement**
A major theme in the NTFP literature is the lack of capacity within the Forest Service to administer NTFP programs and enforce regulations governing NTFP harvesting and buying activities (Anderson et al. 2000, Chamberlain et al. 2002, Jones et al. 2004, Lynch and McLain 2003, McLain 2000, Parks and Schmitt 1997, Richards and Creasy 1996, Robbins 1999).

PAGE 24 NTFP Coordination and Law Enforcement
Respondents for 66 percent of the reporting districts stated that their district had a designated NTFP coordinator (fig. 3).*21 22*

Sixty-one percent of the responding districts reported the presence of districtlevel law enforcement for NTFPs (fig. 4).

PAGE 26 We included several questions on the survey about the inclusion of NTFPs in commonly used planning documents. We also incorporated a question about the existence of NTFP documents.

PAGE 26-28 Incorporation of NTFPs in Forest Planning Processes
Forest plans constitute the key documents guiding management decisions on national forests. Respondents on 87 percent of the reporting national forests indicated that their forest plan included discussion of NTFPs (fig. 6). Respondents on 67 percent of the reporting national forests stated that their forest included NTFPs in environmental assessments (EA).*24* Respondents from only 39 percent of the reporting national forests, however, indicated that their forest included NTFPs in environmental impact statements. Reporting national forests in Regions 1, 3, and 4 had the highest rates of inclusion of NTFPs in the three major planning processes, whereas reporting national forests in Regions 5 and 9 had the lowest rates (fig. 7).

Respondents also indicated that their forests addressed NTFP considerations in a broad spectrum of other planning documents (table 6). These ranged from documents needed to fulfill ESA and NEPA mandates to regional-level planning requirements (e.g., watershed analyses, landscape analyses, and social impact assessments) to fuel treatment and product management plans.

PAGE 29 NTFP Planning Documents
Respondents on 42 percent of reporting national forests indicated that their forest or district had prepared planning documents focused specifically on NTFPs. Survey respondents listed a wide spectrum of NTFP planning documents, ranging from site-specific biological and environmental assessments to forestwide NTFP policies and monitoring plans (table 7).

PAGE 31-32 Managers' Familiarity With Selected Resources on NTFP Management and Policy
During the late 1990s and early 2000s, the Forest Service and the Institute for Culture and Ecology collaborated in the development of two texts and a Web site on NTFP management.*25*

We asked respondents if they had read the two texts, *Nontimber Forest Products in the United States* (Jones et al. 2002) and *Non-Timber Forest Products: Medicinal Herbs, Fungi, Edible Fruit and Nuts, and Other Natural Products from the Forest* (Emery and McLain 2001). Both texts emerged from a multiorganizational, multiyear national assessment funded in part by the Forest Service. Fewer than 20 percent of the reporting national forests had even one respondent who had read either book.

We included a question on another product of the national assessment effort noted above, the Web site, "Nontimber forest products: United States" ((www.ifcae. org/ntfp/). Created in 1999, the Web site contains a national NTFP species database and an NTFP bibliographic database including all records from the Forest Service publication, *Conservation and Development of Nontimber Forest Products in the Pacific Northwest: An Annotated Bibliography* (von Hagen et al. 1996). At least one respondent from 25 percent of the reporting national forests stated that they had visited the Web site.

During the 1990s, the Forest Service developed and circulated a draft strategy for NTFPs, a document that the agency eventually published in 2001 under the title, *National Strategy for Special Forest Products* (USDA FS 2001b). The developers of the strategy envisioned the document as a guiding framework for the agency's NTFP management program (USDA FS 2001b: v). The authors also viewed the strategy as a potential resource for state, tribal, and private forest managers (USDA FS 2001b: v). Forty-three percent of the reporting national forests had at least one respondent who had read the strategy.

PAGE 33 [FIGURE 9 SHOWS THAT 6% OF RESPONDENTS MONITORED FOR MUSHROOMS WHILE NONE INDICATED INVENTORIES HAVE

OCCURRED]

PAGE 43 Respondents on 56 percent of the 84 reporting national forests stated that harvesters contributed knowledge that helps NTFP management in their area; and respondents on 38 percent of the reporting forests indicated that Forest Service employees are currently collaborating with harvesters.

PAGE 44 **Expanding Commercial NTFP Harvesting on National Forests**
In the early 1990s, the Forest Service funded several studies that examined the economic development possibilities associated with expanding NTFP harvesting and processing (Mater Engineering 1992, Schlosser et al. 1991, Thomas and Schulmann 1993). Several years later, researchers funded through the Forest Service research branch explored the economic opportunities for managing forests jointly for timber and a variety of NTFPs (Pilz et al. 1999, Schlosser and Blatner 1997, Weigand 1997). The Forest Service research branch has also funded research aimed at developing methods for inventorying commercially important NTFPs (Kerns et al. 2002a, Vance et al. 2001) and predicting productivity of edible mushrooms (Pilz et al. 2002). Since the early 1990s, the Forest Service has also supported efforts to develop methods for assessing the ecological impacts of harvesting high-value commercial NTFPs on national forests (Ballard 2004, Chamberlain 2000, Hart et al. 2004, Hosford et al. 1997, USDA FS 2001a, Spero and Fleming 2002). The agency also funded Emery's (1998) work on NTFP livelihood strategies in the Upper Peninsula of Michigan and Chamberlain's (2000) study of NTFP management on Eastern national forests.

PAGE 45 Barriers to Expanding Commercial Harvesting
Respondents listed 32 types of barriers to expanding commercial harvesting (app. 9). Respondents from 52 percent of the reporting forests mentioned funding as a barrier, with lack of planning capacity and lack of staff being mentioned next most frequently. We condensed the 32 barriers into the following five major categories: insufficient funding, lack of agency capacity, business obstacles, regulatory restrictions, and political obstacles. As indicated in figure 20, respondents from 67 percent of the reporting forests mentioned business-related obstacles, such as lack of market demand and transportation difficulties, as important barriers to expanding commercial NTFP harvesting. Respondents from more than 50 percent of the reporting forests also cited lack of agency personnel and funding to administer expanded commercial harvesting programs as key obstacles.

PAGE 45-47 Effects of NTFP Management on Biodiversity
Respondents from most of the reporting national forests that conducted ecological monitoring on NTFP activities noted that they either didn't know the results of the monitoring data or that the data was inconclusive. Respondents on fourteen percent of the reporting forests stated that NTFP management had a positive effect on biodiversity; none reported a negative effect.

PAGE 47 Manager Perceptions of Barriers to NTFP Inventory and Monitoring Survey respondents mentioned a variety of barriers to implementing NTFP inventory and monitoring, ranging from lack of funding to limited commercial demand for NTFPs to the low prioritization of such efforts within the agencies (app. 10). These barriers fell into four broad categories: lack of funding, lack of internal capacity, lack of political will within the agency, and limited or no perceived need because of either an abundant supply of NTFPs or a small number of harvesters relative to supply. The most commonly cited barrier to NTFP inventory and monitoring was lack of funding, which respondents from 85 percent of the reporting forests listed (fig. 22). The second biggest barrier for the Forest Service was lack of staff, which respondents from 74 percent of the reporting forests mentioned. Both of these fall into the category of internal capacity.

PAGE 49 The findings for inclusion of NTFPs in forest plans for Regions 8 and 9 differ from the study by Chamberlain et al. (2002) of NTFPs in forest plans for those same regions; they found that only 22 percent of the 32 national forests addressed NTFPs to some extent. The difference is likely due to differences in methods between the two studies. Chamberlain et al. employed a content analysis technique in which they examined each plan to determine the percentage of the text addressing NTFPs. They concluded that “the attention afforded to NTFPs is minimal” (Chamberlain et al. 2002: 11) and that “no plan provided comprehensive coverage similar to that of other natural resources” (Chamberlain et al. 2002: 12). Our study did not include ground-truthing of the plans, and a strong possibility exists that respondents may have interpreted even minor or oblique references to NTFPs as evidence that their forest plan included NTFPs.

PAGE 50 Forests with NTFP documents sometimes have highly visible NTFP activity. For example, the Tongass National Forest developed a comprehensive forestwide NTFP policy in order to ensure adequate supplies of NTFPs for subsistence harvesters in the area. Similarly, several national forests in western and central Oregon developed EAs for NTFPs during the 1990s when demand for NTFPs, such as matsutake (*Tricholoma magnivelare* (Peck) Redhead) mushrooms, increased dramatically.

PAGE 51-52 The survey also reveals that many of the reporting national forests draw on harvesters’ knowledge for managing their NTFP programs. In addition, nearly 40 percent of the reporting national forests collaborate in some form with NTFP harvesters to manage NTFPs. However, it is unclear from the survey data what such agency-harvester knowledge exchanges and collaborations consist of. Text answers from the respondents indicate that collaborations range from conversations between agency employees and harvesters about resource conditions to NTFP inventory and monitoring partnerships.

Respondents from the majority of reporting national forests indicated that they believed harvesters could contribute to NTFP inventory and monitoring, with knowledge of NTFPs and labor being considered the most important inputs harvesters could provide. However, support for involving harvesters is tempered by concerns about whether the agency has the capacity to manage collaborative inventory and monitoring efforts, doubts about the ability of harvesters to do the work in a scientific manner, and skepticism as to whether harvesters would be willing to be involved in such efforts.

Respondents from half the reporting national forests noted that they conduct ecological monitoring to determine the effects of NTFP management activities, such as regulatory restrictions and controlled burns. However, responses to further questions indicate that the data from such studies are insufficient to determine how NTFP harvesting affects biodiversity. Districts on only 20 percent of the reporting national forests are currently engaged in activities to enhance NTFP habitat or productivity. These data raise the possibility that national forests may lack the capacity to determine whether commercial harvesting levels are sustainable or to take action to enhance sustainability. Respondents from the majority of reporting national forests indicated that expanding commercial NTFP harvesting on national forests would require addressing several key internal constraints, including the agency's lack of funding, staff, and planning capacity, as well as external barriers, such as limited markets and transportation costs.

In summary, the study indicates that NTFP harvesting is widespread within the National Forest System. It also suggests that many managers are struggling with how to incorporate NTFPs into forest management and planning in an era of declining budgets and decreases in staffing levels. Survey respondents identified lack of funding and personnel as the two major internal barriers to NTFP inventory and monitoring. Many respondents indicated that agency-harvester collaborations could be used to develop and expand NTFP inventory and monitoring programs.

However, they identified lack of internal capacity as a major impediment to involving harvesters in collaborative inventory and monitoring efforts in addition to noting concerns about potential bias and lack of incentives for harvester participation. For agency-harvester collaborations to work, the designers would need to develop inventory and monitoring systems that simultaneously addressed the needs of harvesters (e.g., safeguards to protect information about site locations and the provision of access guarantees) and the needs of forest management agencies (e.g., data quality control). Effective collaborative NTFP inventory and monitoring systems would also require the development of suitable training materials for both harvesters and forest managers, as well as a long-term commitment on the part of upper level agency administrators to invest in such systems.

PAGE 53 Section 339 of P.L. 106-113 authorizes forests to retain receipts from the sale of NTFPs greater than 1998 levels of sales. This design allows for districts or forests to create a process whereby they can expand their NTFP programs, retain receipts, and possibly create sustainable programs that are outside the normal parameters of appropriated competition. Forest Resource Enterprises, a forest enterprise team based in central Oregon, has designed a fair market valuation program that provides resource managers the ability to fulfill their legal NTFP management obligations and also receive current and accurate prices for NTFP sales. The team has completed analysis for Regions 2, 6, and 10 and has started a similar analysis for Region 5. Implementation of the fair market valuation program, together with the retention of receipts once the agency implements regulations for Section 339, has the potential to address some of the concerns expressed about lack of funding for NTFP programs.

PAGE 54 In developing tools for NTFP management, it would also be useful to explore the extent to which the Forest Service's standard economic tools and models used during forest plan revisions (i.e., Impact Analysis for Planning [IMPLAN]) allow them to look indepth at the contributions of NTFPs, as well as the extent to which the large-scale recreation data sets address links between NTFP gathering and recreation. The Southern Region has recently taken a step in this direction through the development of a strategy for research and technology transfer on NTFPs (Sallee et al. 2004). Technical guides on the social, economic, and ecological sustainability aspects of NTFPs will likely need development to facilitate adaptive management as the agency implements the 2004 Final Planning Rule.

Agency-Harvester Collaboration

Agency-harvester inventory and monitoring partnerships are emerging in parts of the National Forest System to overcome the difficulties of inadequate funding and staffing for monitoring and inventorying NTFP species. A companion piece to this report, *Nontimber Forest Product Inventorying and Monitoring in the United States: Rationale and Recommendations for a Participatory Approach* (Lynch et al. 2004), discusses in more detail examples of ongoing efforts to develop agency-harvester inventory and monitoring partnerships. Greater understanding of the barriers and opportunities for developing such collaborative efforts can assist forest managers and researchers in identifying appropriate modes of collaboration at the forest and district levels. Development and dissemination of materials to forest managers regarding the utility of traditional ecological knowledge, as well as training in how to communicate in mutually understandable ways with NTFP harvesters, constitute critical components of viable agency-harvester partnerships.

[NOTE: APPENDIXES BEGINNING ON PAGE 69 HAVE USEFUL INFORMATION AS WELL]

Workshop Guide and Proceedings: Harvester Participation in Inventory and Monitoring of Nontimber Forest Products

Facilitated by the Institute for Culture and Ecology
Funded by the National Commission on Science for Sustainable Forestry

Compiled by Kathryn A. Lynch, Ph.D. Institute for Culture and Ecology
www.ifcae.org March 2004

Abstract
This document is both a guide for planning a multi-stakeholder workshop and the proceedings for a series of workshops and a retreat held by the Institute for Culture and Ecology, in 2002-03. The workshops brought together land managers, policy makers, scientists, harvesters, buyers and other nontimber forest product (NTFP) stakeholders to explore how harvesters might be included in biological inventory and monitoring efforts. The workshops took place in Denver, Atlanta, Pittsburgh, Portland, Oregon and Silver Falls, Oregon. These workshops were a component of a larger national research project funded by the National Commission on Science for Sustainable Forestry that explored the linkages between forest management, nontimber forest products and biodiversity conservation. Part One of this document provides an overview of the planning process used to develop the workshops. We share our specific experiences with these particular workshops, as well as illustrate key questions to address when developing participatory workshops or meetings. We hope that by sharing our experiences with the ofteninvisible process of planning that this first section will be a useful guide for those interested in workshop planning and facilitation skills. Part Two then presents detailed summaries of each regional workshop, including the workshop announcements, agendas, participant lists, focus group flipchart transcripts, plenary discussions, and workshop evaluations. Where we have information from case study presentations, we include that as well.

PAGE 5 Introduction
In June 2002, the National Commission on Science for Sustainable Forestry (NCSSF) awarded the Institute for Culture and Ecology (IFCAE) an 18-month, $200,000 grant to assess the relationships between forest management practices, nontimber forest products (NTFPs), and biodiversity in the U.S. The objectives of the project were to: 1) synthesize data regarding the impact of nontimber forest products management on forest ecosystem sustainability and biodiversity; and 2) directly support the ability of U.S. forest managers to assess nontimber forest product sustainability.

To accomplish these objectives, we developed a research design that involved five interrelated components. The first component involved the expansion of our public web-based NTFP species database that is used for identifying commercially harvested NTFPs in the United States. Similarly, the second component focused on expanding our public web-based NTFP bibliographic database that catalogs references specific to NTFP conservation, policy, management, culture and ecology. The third component focused on expanding a

NTFP management survey, administered to both state forestry offices and federal National Forest Ranger Districts, in order to document managers' view on how management activities are affecting biodiversity. The fourth component involved a year of anthropological fieldwork focused on documenting NTFP harvester knowledge about forest management and biodiversity issues. The fifth component and focus of this document consisted of four regional workshops and one national team retreat that explored the possibilities for and barriers to developing collaborative approaches to inventory and monitoring.1

PAGE 9 In total, our advertising efforts included contacting:
• 150+ University professors at regional forestry schools
• 100+ Extension and RC&D agents
• 80+ NGOs (e.g., National Network of Forest Practitioners, United Plant Savers, Heritage)
• 80+ Government scientists (e.g., FIA program)
• 300+ Federal and State government land managers
• 100+ Private consultants
• 40+ Regional Native American Tribes
• 200+ NTFP harvesters and/or buyers
• Email mailing lists: Forest List <forest@listserv.funet.fi>
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PAGE 22 Harvester Involvement in Inventorying and Monitoring of NonTimber Forest Products
Thursday, October 17, 2002
Geographical Focus: AZ, NM, CO, UT,WY, MT
Purpose of the Workshop: To bring together those people interested in the sustainable management of nontimber forest products—including Federal, tribal, state, and private land managers, policy makers, scientists, buyers, and harvesters—to explore how harvesters might participate in a comprehensive biological monitoring program.

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PAGE 29 **RESULTS: Morning Small Group Work: Identifying Issues and Needs**

Group 2: Vera Evenson, Gretchen Fitzgerald, Andy Kratz, Shelby Limberis, Rebecca McLain

1. What species are being harvested in your area, both commercially and/or for personal use.

A. Wild mushrooms
Boletus edulis
Leccinum spp
Suillus spp
Matsutake
Truffles
Chanterelle
Morels
Pleurotus
Cortinarius (dermocybe) – dyes
Coprinus comatus
Puffballs

2. How is the species harvested and used as a nontimber forest product?

A. Matsutake (and in general ectomycorhizzal fungi)
People dig and rake the beds using hand tools, also some use of leaf-blowers to clear the leaves and litter; trying to get the buttons which have high value, but which are below the surface.
Problem associated with harvesting is the extent to which the digging activities are damaging to the matsutake and/or other parts of the ecosystem.

PAGE 30 E. Truffles
These are robbed from squirrel middens, and thus also have concerns for lynx via squirrel connection since the squirrels use the truffles to mark their cache sites.

3. Briefly describe current management practices for these species and also how general forest management is impacting these species.

A. Mushrooms
__ Have a permit system for commercial and personal collection but no specific management standards and guidelines. Vera noted that many of the mycological society folks are reluctant to go in and get permits and are “closet collectors” – don’t want to be identified as collectors (and some sell their mushrooms).
__ Activities that have impacts on matsutake, boletes and other mycorrhizzal fungi include timber harvesting, road construction, tree spading, and other

significant soil disturbances.
4. Discuss ecological, political, economic, cultural concerns.
Note: We didn't have time to do this for each of the species identified above, so we came up with general concerns:
__ Ecology: In some cases, harvesting may not be ecologically sustainable (but we don't know much about which cases those are)
__ Political: Have demands for products that the agencies may need to address; have NEPA requirements, National Fire Plan may have an effect (positive for some species and negative for others)
__ Cultural: Have traditional/indigenous and recreational uses
__ Economic: Small businesses and subsistence users form a large portion of those involved.
5. Identify specific information needed to manage these species as NTFPs
Note: We didn't have much time to spend on this question so the answers are vague
__ Who harvests it, what is harvested (species and parts), when is it harvested, how much is harvested, and where?
__ What's the value
__ Ecological characteristics

PAGE 41 **Final Discussion**

I & M Design Issues:
__ Important questions to ask: How to you identify study plots? And what are the consequences for the users/harvesters?
__ Analyze existing permit system, and figure out how to get the bigger NTFP industry more involved and accountable.

Education Needs:
__ We need to fund education efforts to educate community, land managers, colleagues in our own offices about the importance of NTFPs.
__ Need to include NTFPs in Forestry School curriculums.
__ Involve harvesters in developing education programs for other harvesters (example of creating videos)

Policy and Funding Issues:
__ Fair market value issues and Section 339- Code of Federal Regulations should be coming out soon and we can offer comments. Frank Duran, Region 6, is person to contact for more information.
__ We need to develop a NTFP Strategy/mandate from D.C. office. Then we can develop species specific guidelines- since some forests are ignoring NTFPs.
__ Explore how to obtain KV Funds (Forest Service) for managing NTFPs. This might be mechanism to help manage NTFP program, since KV funds allow a district to keep some of the money they receive from permits in their district to manage their program.

Networking Opportunities:
__ Network/More Information:
__ Alliance of Forest Workers and Harvesters. Eugene, OR. Contact: Jennifer Webster, Assistant Coordinator. office@alliancefwh.org or 541-342-6146.
__ PNW Special Forest Product Council. Forest Service, Region 6 and BLM collaboration. Contact: Jerry Smith at (541) 536-2983, grsmith@fs.fed.us or John Hegg at 541-683-6644 jhegg@or.blm.gov Website: www.edo.or.blm.gov/nsfpc

Potential Models/Opportunities:
__ Stewardship Contracts as possibility?
__ Need permission of congress? Goods for services issues.
__ Pre-commercial thinning-pilots
__ 3.5 contracts (product contracts). Karl Mendonca discussed these from experiences in Region 6. Offered to provide a copy to all.

PAGE 42 **2. What needs improvement?**
__ Need more harvester viewpoint
__ Better communication among the races—for example between whites and Indians.
__ Maybe develop a handout on how to get involved politically ie. addresses, phone numbers, dates.
__ More involvement of harvesters in workshop and information on buyers would be useful
__ More harvesters involved and more specifics with "strategies"
__ Presentation of case studies
__ Involve more harvesters and leave more time for work in breakout groups with maybe more specific guidance?

PAGE 43 In General:
__ Development and coordination of a regional NTFP program, and a better understanding of regional demand, supply and sustainability of NTFPs. Development of working/cooperative relationships with harvesters, professional plant societies and universities.
__ After a National Strategy is developed, then we need to be specific as to seed picking, healing plants, other products, etc. Some programs will be relatively simple to develop, others will be much more complicated. It is imperative that NTFPs be addressed in the revisions of ALL Forest Plans and BLM Land Management Plans. This policy should come forward immediately from the Washington office. I know that some forest do not intend to address this issues, based on meeting that I have recently attended.

PAGE 45 Harvester Involvement in Inventorying and Monitoring of NonTimber Forest Products
Thursday, February 27, 2003

Geographical Focus: TX, AR, LA, MS, AL, GA, FL, SC, NC, VA, KY, TN, MD, DE

Purpose of the Workshop: To bring together those people interested in the sustainable management of nontimber forest products—including federal, tribal, state, and private land managers, policy makers, scientists, buyers, and harvesters—to explore how harvesters might participate in a comprehensive biological monitoring program.

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PAGE 67 Harvester Involvement in Inventorying and Monitoring of NonTimber Forest Products
Thursday, April 3rd, 2003
Geographical Focus: ME, NH, VT, NY, MA, RI, CT, PA, NJ, WV, OH, MI, WI, MN

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PAGE 99 Harvester Involvement in Inventorying and Monitoring of NonTimber Forest Products
Thursday, September 4, 2003
Geographical Focus: WA, OR, CA

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PAGE 106 NTFP Data Gaps
- Density and distribution of resources
- NTFP population structure and productivity
- Ecological impact of harvesting
- Economic, political, and cultural factors affecting harvesting
- Impacts of forest management on NTFPS.

This last one is important and often forgotten. We often focus on the impact of harvesting without contextualizing it within the bigger landscape land-use issues. So not only do we need to research what is the impact of different harvesting techniques to be sure we are using/promoting best practices, but we also need to understand how other land management practices are influencing NTFPs. How does logging, grazing, road building, development impact populations of NTFPs and what does that mean for biodiversity conservation.

PAGE 109-110 **Some Preliminary Project Findings.** Eric Jones.

Defining terms: So what do we mean by “Harvester”
This typology is meant to illustrate the diversity of harvesters, and not to pigeon-hole anyone. Many harvesters fall into various categories at different times and many folks don’t use the term “harvester”-we met folks who call themselves root diggers; salal, mushroom and berry pickers; wild foods foragers, etc. But this general typology below is useful to illustrate a few of the motivations for why people harvest NTFPs.
__ Subsistence harvesters- collect for personal or household consumption.
__ Commercial harvesters- collect for trade or cash, across scales from small mom and pop shops to large international operations.
__ Recreational harvesters- collect for pleasure, recreation, exercise, hobby.
__ Healers- gather plants they use for treating illnesses.
__ Spiritual harvesters- collect for spiritual endeavors, or treat NTFPs as sacred objects.
__ Scientific harvesters- formal or amateur scientists, that harvest or reserve areas for observation or study.
__ Educational harvesters- collect for educational purposes.

PAGE 111 “Over the last seventeen years I have had about fifty patches I regularly visited. I figure I’ve walked over a 1,000 miles scouting alone. I’ve got a name for each one...I only have about twenty [patches] left because most have been logged or locked up. The first few years I felt it was their right, logging was the most important thing...but as I got better at picking I realized how much could be made with just mushrooms alone. I had this patch that spread over two hills, bigger than a football field, and in the fall it would be a carpet of orange [chanterelles]. When I saw it marked for logging I went to the ranger to protest. I told him there was no patch like it, but they logged it anyway. I’ve never gotten over that one; they desecrated something sacred.”

PAGE 112 **Case Study Presentations**
Heidi Ballard: “Harvester Knowledge and Science A Case of Involving Mobile Forest Workers in Ecological Research in Olympic Peninsula, Washington.” Department of Environmental Science, Policy and Management, University of California, Berkeley. hballard@nature.berkeley.edu

The non-timber forest product (NTFP) industry in the Pacific Northwest of the United States has been gaining momentum over the last 15-20 years. Harvesters of these NTFPs have a strong interest in maintaining the sustainability of the resource. The Northwest Research and Harvester Association (NRHA) in Mason County, Washington was created by harvesters to address the variety of ecological, social and management problems currently affecting harvesters and resource managers of NTFPs in this region. Part of the NRHA’s mission is to help conduct research and monitoring on harvest impacts on the land they manage. Ballard, a researcher from the University of California, Berkeley, collaborated with the NRHA to examine the relationships between tenure institutions, harvest practices and sustainability of the resource by conducting participatory research with harvesters on the impacts and sustainable levels of harvest of a shrub called salal (*Gaultheria shallon*), used as a floral greenery. From 2001 to 2003, harvesters and land managers (both public and private) have participated in all aspects of designing and conducting the study, including but not limited to:

• Choosing the appropriate plot locations of represent real harvest conditions.
• Developing the precise research question within the larger question of harvest intensity impacts.
• Developing hypotheses about particular ways the plants will respond to harvest.
• Designing methods to measure impact on regrowth on the plant.
• Defining the harvest treatments to be tested based on actual harvest practices.
• Collecting data for the 2 1/2 years of the study.
• Interpreting the results after the researcher completes the statistical analysis.
• Develop management recommendations based on experimental results and local knowledge and experience.
• Dissemination of the results of the research to harvesters, public and private land managers and research scientists in the region.

Andy Moore: Masutake Mushroom Monitoring in southern Oregon
Please see www.matsiman.com for a complete overview of Andy's presentation and a variety of other useful information regarding matsutake mushrooms.

PAGE 116 **RESULTS: Confederated Tribes of Warm Springs Perspective**
John Arena, Talya Holladay, Raymond Moody, Tom Love

What follows is very specific to the Confederated Tribes of Warm Springs situation, which is characterized by informal ties among members of a relatively small community; NTFP harvesting by nontribal members is rare, though there are occasional trespass issues (e.g., a Cambodian group harvesting beargrass a few years ago). Tribal authorities do not have to deal very much with non-tribal harvesting. An important distinction: members retain substantial autonomy in use of traditional resources for personal use (medicinals, basketry materials, etc.), and the tribe does not begin to attempt to regulate – it is self-regulating. The Tribal government is trying to get a handle on commercial NTFP harvesting (especially boughs and poles/posts). Harvest of these products requires a free permit, so has just launched a six-year project, focusing on sustainable harvest of boughs (incense cedar mostly, but also juniper, white pine, and noble fir (they've planted some noble fir; total only 120 acres).

1) How do we engage harvesters in I & M?
__ Inventory is done by staff.
__ Monitoring is done by tribal harvesters using weight tickets. The 670,000 acre reservation is divided into nine units; each of the nine commercial bough harvesters has one unit, and they allocated units fairly by themselves. Not one has yet reached even the initial limit of 50,000 lbs. for their unit.
__ Commercial theft does not appear to be an issue of concern.

2) Barriers to involving harvesters?
__ Very few barriers. Public meetings about the permit/sustainability project were well advertised (radio, letters to known individuals, newspaper, word of mouth) and attended.
__ Although Warm Springs is a small community, it's still not clear who all is out there harvesting these NTFP resources, esp. non-members.
__ Biggest barrier, perhaps, is tribal politics. By that participants meant the individual sense of entitlement to resources and areas tribal members feel, particularly for personal use – the tribal government has no authority (and should not have) in those matters. Sustainability of those resources not a problem, it would seem, but it appears there is no inventorying of those personal use (non commercial) NTFP resources.

3) Ideal participatory I & M program?
__ The Confederated Tribes of Warm Springs program seems near ideal. Harvesters were involved from the beginning. Harvesters regulated themselves. Relatively good trust level with tribal staff, which does the inventorying.
__ Time will tell; in six years (2009) the program will be evaluated.

PAGES 145-150 APPENDIX 2 HAS A SAMPLING OF PARTICIPANT'S INTERESTS AND BACKGROUNDS AND EXPERIENCES WITH NTFP

Species richness, abundance, and composition of hypogeous and epigeous ectomycorrhizal fungal sporocarps in young, rotation-age, and old-growth stands of Douglas-fir (*Pseudotsuga menziesii*) in the Cascade Range of Oregon, U.S.A.

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Can. J. Bot. **80**: 186–204 (2002)

Received 17 May 2001. Published on the NRC Research Press Web site at http://canjbot.nrc.ca on 28 February 2002.

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Abstract: Knowledge of the community structure of ectomycorrhizal fungi among successional forest age-classes is critical for conserving fungal species diversity. Hypogeous and epigeous sporocarps were collected from three replicate stands in each of three forest age-classes (young, rotation-age, and old-growth) of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) dominated stands with mesic plant association groups. Over four fall and three spring seasons, 48 hypogeous and 215 epigeous species or species groups were collected from sample areas of 6300 and 43 700 m2, respectively. Cumulative richness of hypogeous and epigeous species was similar among age-classes but differed between seasons. Thirty-six percent of the species were unique to an age-class: 50 species to old-growth, 19 to rotation-age, and 25 to young stands. Seventeen species (eight hypogeous and nine epigeous) accounted for 79% of the total sporocarp biomass; two hypogeous species, *Gautieria monticola* Harkn., and *Hysterangium crassirhachis* Zeller and Dodge, accounted for 41%. Average sporocarp biomass in young and rotation- age stands compared with old-growth stands was about three times greater for hypogeous sporocarps and six times greater for epigeous sporocarps. Average hypogeous sporocarp biomass was about 2.4 times greater in spring compared with fall and for epigeous sporocarps about 146 times greater in fall compared with spring. Results demonstrated differences in ectomycorrhizal fungal sporocarp abundance and species composition among successional forest age-classes.

Key words: ectomycorrhizal fungi, sporocarp production, forest succession, *Pseudotsuga menziesii*, *Tsuga heterophylla* zone, biodiversity.

PAGE 187 **Introduction**

Knowledge about community structure and dynamics of ectomycorrhizal (EM) fungi in natural environments is limited. Many factors influence EM fungal community structure, including host plant species composition and stand age, habitat conditions, and edaphic factors (Molina and Trappe 1982; Deacon et al. 1983; Molina et al. 1992; Vogt et al. 1992; Visser 1995; States and Gaud 1997; Gehring et al. 1998; Claridge et al. 2000; Smith et al. 2000). Down wood in various stages of decay influences fungal species occurrence and abundance (Harmon et al. 1994; Smith et al. 2000). Changes in plant species composition from forest succession or large-scale disturbances significantly affect EM species composition and total sporocarp production (Cooke 1955; Dighton and Mason 1985; Arnolds 1988, 1991; Termorshuizen 1991; Vogt et al. 1992; Amaranthus et al. 1994; Visser 1995; North et al. 1997; Waters et al. 1997; Baar et al. 1999; Colgan et al. 1999).

Most studies comparing EM fungal sporocarp communities among successional forest age-classes have lacked replication of forest age-classes (Vogt et al. 1981; Luoma et al. 1991) or sampling years (O'Dell et al. 1992; Amaranthus et al. 1994; Clarkson and Mills 1994). Only a few published studies include both hypogeous and epigeous EM species richness and abundance in successional age-classes of forests (O’Dell et al. 1992; North et al. 1997).

Most field data on EM fungal species ecology are based on occurrence of sporocarps. Sporocarp studies are the primary bases for understanding ecosystem food web functions involving mammals and insects (Maser et al. 1978; Ingham and Molina 1991) and for documenting fungal diversity. Sporocarp studies of EM fungal communities typically underrepresent belowground EM fungal diversity (Gardes and Bruns 1996; Dahlberg et al. 1997; Kårén et al. 1997; Gehring et al. 1998; Jonsson et al. 1999; Horton and Bruns 2001) but are essential for discerning rare species that form obvious sporocarps. Current conservation efforts regarding EM fungi (Arnolds 1989; Castellano et al. 1999; Molina et al. 2001) rely on comparison of current with historic sporocarp data to identify trends in fungal communities and develop conservation strategies.

Fungal community dynamics are less well understood in forest succession where vegetation dynamics shape community recovery. For example, the rapid reestablishment of pioneering EM host plants can maintain late-seral EM fungi (Perry et al. 1989; Molina et al. 1992). Many fungi are present throughout forest stand development, although their abundance and dominance may change with time or disturbance (Visser 1995; Molina et al. 1999). Comprehensive studies of fungal succession are needed in many forest types to improve understanding of fungal community dynamics.

Federal land management agencies in the Pacific Northwestern region of the United States are concerned about the effects of forest management practices on conservation of fungal species, particularly species associated with diminishing old-growth forests. Plant species richness tends to remain constant or increase slowly with forest age-class in some physiographic provinces in the region (Spies 1991). In contrast, the response of fungal communities to forest succession is largely unknown. The accurate comparison of mycological data in harvested and unharvested forests is essential for determining diversity patterns of fungi, making science-based decisions regarding conservation of fungi (O’Dell et al. 1996; Molina et al. 2001), and developing models for predicting fungal species occurrence (Dreisbach et al. 2002).

PAGE 190 **Results**

Species richness

Overall patterns

During the course of the study, 263 species or species groups (48 hypogeous and 215 epigeous) within 51 genera (26 hypogeous and 25 epigeous) were recorded from 4590 collections (1069 hypogeous and 3521 epigeous) (Tables 2, 3, and 4). Forty-one of the genera belonged to the Basidiomycotina, nine to the Ascomycotina, and one to the Zygomycotina. One hypogeous genus and one species each of *Russula* and *Rhizopogon* were new to science.

The greatest number of collections belonged to the genera *Cortinarius*, *Inocybe*, and *Russula* (508, 1022, and 739, respectively) and accounted for 49% of the total collections and about 52% of the total species. Eight subgenera of *Cortinarius* were separated into 21 macroscopic subgroups and 81 species, eight broad species groups of *Inocybe* were separated into 12 subgroups and 31 species, and the genus *Russula* was separated into 25 species or species groups (Table 3).

Cumulative species richness increased more rapidly during the course of the study for epigeous compared with hypogeous species or species groups (Fig. 1). In Fig. 1, epigeous species groups were counted once for each sampling period in which they were found, resulting in a conservative estimate that is slightly less than the total number of species or species groups identified in the study. Curves for epigeous species or species group richness appeared to approach an asymptote in spring 1994 and then increased in fall 1994. The curve for hypogeous species richness began to level out in fall 1993 at 3600 m2 with 39 species total.

diversity between stands

Stand age had a greater effect than aspect or environmental conditions on species similarity. Stand richness ranged from 12 to 22 for hypogeous species and from 54 to 72 for epigeous species or species groups. b diversity between pairs of stands within age-classes (0.56–0.68) and between pairs of young and rotation-age stands (0.58–0.68) was higher than comparisons between pairs of young and old-growth stands (0.41–0.48) and pairs of rotation-age and old-growth stands (0.43–0.54) (Fig. 2). The rotation-age stand most similar to the old-growth stands in environmental conditions (Table 1) did not differ from the other rotation-age stands (0.68) (Fig. 2).

Age-class and seasonal comparisons

Hypogeous species richness totaled 28 each in the old-growth and rotation-age-classes; 27 species were found in the young age-class. In old-growth stands, 105 epigeous species or species groups were found compared with 83 in rotation-age and 86 in young stands.

PAGE 194 Average seasonal cumulative richness of hypogeous species in stands was found to differ among age-classes ($F[2,6] = 14.27$, $p = 0.005$). Seasonal richness of hypogeous species was similar in old-growth and rotation-age stands (Table 2). Seasonal richness of hypogeous species in young stands was lower in fall and higher in spring than richness in the other two age-classes (Table 2). In young stands, there were, on average, five species more in spring compared with fall (Table 2).

PAGE 195 Overall, hypogeous sporocarps were found in 37% of the 1575 circular plots. Hypogeous sporocarps were found in 27% of the plots in old-growth stands compared with 44% in rotation-age and 42% in young stands. Hypogeous sporocarps were found in 52% of the plots in spring compared with

26% in fall.

Seasonal comparison of total sporocarp production

The majority of species in our study showed strong seasonal variation in relative sporocarp biomass. Similar sporocarp biomass was produced in fall (53%) and spring (47%) for combined hypogeous and epigeous sporocarps. Sporocarp biomass in fall was about twice as great for epigeous compared with hypogeous sporocarps and in spring about 84 times greater for hypogeous compared with epigeous sporocarps.

Dominant genera and species

Four major genera (*Gautieria*, *Hysterangium*, *Rhizopogon*, and *Russula*) comprised 68% of the total biomass; *Hysterangium*, *Rhizopogon*, and *Russula* were dominant in all age-classes (Table 4). Most of the dominant genera differed in relative percentage of biomass among the stand age-classes (Table 4). *Cortinarius*, *Elaphomyces*, *Ramaria*, *Rhizopogon*, and *Russula* all had a higher percentage of the biomass in the old-growth stands than in the young and rotation-age stands. In contrast, *Gautieria* and *Inocybe* had a higher percentage of the biomass in the rotation- age and, to a lesser extent, the young stands compared with the old-growth stands. *Hysterangium* had a higher percentage of the biomass in both the young and rotation-age stands compared with the old-growth stands. *Lactarius* and *Suillus* both had a higher percentage of the biomass in the young and, to a lesser extent, rotation-age stands compared with old-growth stands.

PAGE 197 **Species or species groups unique to an age-class**

Fifteen of 51 genera (Table 4) and 94 of 263 species or species groups (Table 3) were unique to a particular age-class. Four genera (one hypogeous and three epigeous) were collected only from old-growth stands, three (hypogeous) only from rotation-age stands, and eight (seven hypogeous and one epigeous) only from young stands (Table 4). None of the genera unique to an age-class comprised 31% of the biomass within the age-class (Table 4). Fifty species or species groups (10 hypogeous and 40 epigeous) were collected only from old-growth stands, 19 (six hypogeous and 13 epigeous) only from rotation-age stands, and 25 (nine hypogeous and 16 epigeous) only from young stands (Table 3). Three species or species groups, *Cantharellus subalbidus* Smith and Morse, *Ramaria* gp. 3A, and *Ramaria* gp. 4, were unique to old-growth stands and each comprised 31% of the biomass in old-growth stands (Table 3).

PAGE 197-198 **Discussion**

Species richness of EM fungi in mesic Douglas-fir associations in the *Tsuga heterophylla* zone in the Cascade Range of Oregon is relatively stable from canopy closure through late succession. Working in Douglas-fir stands similar to ours in age, plant association, and location, Spies (1991) found that richness of plant species also did not differ in relation to age-class. Furthermore, differences in species abundance and occurrence were detected among forest age-classes for EM sporocarps in our study as well as for plants in the study by Spies (1991). Most understory species in these plant associations are not EM symbionts but belong to plant families that characteristically form arbuscular and ericoid mycorrhizas (Trappe 1987; Molina et al. 1992). The degree to which edaphic factors and understory plant species abundance and occurrence influence sporocarp production of EM fungi among stands with similar plant associations is poorly known.

In our old-growth, rotation-age, and young stands, we found average cumulative richness values of 27, 28, and 28 hypogeous species, respectively. In Douglas-fir stands, North et al. (1997) sampled an area nearly four times the size of that sampled in our study yet found hypogeous species richness values similar to ours, i.e., 34, 29, and 27 in natural old-growth stands, mature stands, and managed young stands, respectively. Our finding of 48 total hypogeous species is similar to total species richness values found in other hypogeous sporocarp censuses in Douglas-fir-dominated stands (Luoma et al. 1991; North et al. 1997; Colgan et al. 1999). Luoma et al. (1991) sampled from a total area similar in size to that sampled in our study, and Colgan et al. (1999) sampled from a total area about twice the size of that sampled in our study. Only about 50% of the hypogeous species found by Luoma (1989) and Colgan et al. (1999) were common to our study, suggesting that differences among the studies in microhabitat conditions influence the composition of hypogeous species.

Our epigeous richness value of 215 species or species groups is higher than those from similar sporocarp censuses in spruce (*Picea* spp.) and hardwood forests with sample areas about two times (Bills et al. 1986) and seven times (Villeneuve et al. 1989) larger than was sampled in our study. Species richness values in our managed forest age-classes were higher than those reported in forest types between 55 and 70 years old in the studies by Bills et al. (1986) and Villeneuve et al. (1989), suggesting that Douglas-fir and western hemlock forests are particularly species rich. In old-growth stands, we found a number of epigeous species, after estimating species numbers within subgroups of *Cortinarius*, similar to the number reported by O'Dell et al. (1999) in a 2-year study; total area sampled in the two studies was similar.

Our finding of a greater percentage of the more common unique species in old-growth stands is in keeping with observations for succession of EM fungi with accumulations of recalcitrant plant litter (Last et al. 1984, 1987). The large number of species or species groups found uniquely, but only rarely, in old-growth stands in our study is consistent with that of O'Dell et al. (1999). Results of our study and the study by O'Dell et. al (1999) suggest that old-growth stands contain many species of fungi that infrequently produce sporocarps.

Some genera in our study contained species with notable annual variability. For example, the number of *Russula* species varied from three to 23 per fall season, and 11 were found only in a single fall season. Seven of these were found in the final fall collecting season, strongly contributing to the continued increase in the diversity curve (Fig. 1).

PAGE 199 Sporocarp production responds to changes in habitat associated with forest succession. In our study, sporocarp production was significantly greater in young and rotation- age stands compared with old-growth stands. In contrast, mean epigeous sporocarp biomass did not differ significantly among stand types in the study by North et al. (1997). Because our study did not examine mature (80–195 years) or very early (1–20 years) stages of forest succession, the entire pattern of changes in EM sporocarp abundance, as well as species richness, in Douglas-fir forests in the Oregon Cascade Range cannot be examined with these data. However, in a study in the H.J. Andrews Experimental Forest, Luoma et al. (1991) reported greater hypogeous sporocarp biomass in mesic stands of mature forest (80–199 years) compared with old-growth (3200 years) and young (70–80 years). North et al. (1997) reported the highest production of hypogeous sporocarps in natural mature and old-growth and the lowest in managed young (55–60 years) stands in the Olympic and North Cascade ranges of Washington. In a comparison of paired old-growth and mature true fir stands, species richness and biomass of hypogeous sporocarps did not differ, but species composition did (Waters et al. 1997). Other studies showed that after stand replacing disturbance, stand biomass and species richness of hypogeous EM fungi is significantly less in very young stands (4–27 years) compared with adjacent late seral stands of Douglas-fir (Amaranthus et al. 1994; Clarkson and Mills 1994) and of Pacific silver fir (*Abies amabilis*) (Vogt et al. 1981).

The incongruity between hypogeous sporocarp production patterns across age-class gradients in our study, most notably our low sporocarp biomass value for old-growth stands, and studies by Luoma et al. (1991) and North et al. (1997) may be due to the composition of the hypogeous community sampled, the sporadic detection of large clusters of sporocarps, and the small sample size. In our study, the hypogeous sporocarp biomass value in old-growth stands was about three times less than in young stands. In contrast, the sporocarp biomass value was about 1.3 and 5 times greater in old-growth stands compared with young stands in the studies by Luoma et al. (1991) and North et al. (1997), respectively. In our study, five major hypogeous biomass dominants made up a majority of the biomass in old-growth stands compared with only two and one in the studies by Luoma et al. (1991) and North et al. (1997), respectively.

One species, *Elaphomyces granulatus*, accounted for 25% of the biomass in old-growth stands in our study compared with 63 and 95% in old-growth stands in the studies by Luoma et al. (1991) and North et al. (1997), respectively. *Elaphomyces granulatus* sometimes produces large clusters of sporocarps (Vogt et al. 1981; Luoma et al. 1991; North et al. 1997), making interpretation of study results problematic. North et al. (1997) found a greater number of large clusters of *Elaphomyces granulatus* in old-growth compared with younger stands. Luoma et al. (1991), however, found only one large cluster and substituted a lesser value for the data analysis.

PAGE 200 It is unclear why we found less sporocarp biomass in old-growth stands compared with younger managed stands. Possible explanations include (*i*) a decrease in net primary production or differences in belowground carbon allocation with stand age (Waring and Schlesinger 1985; Waring and Running 1998), (*ii*) differences among forest age-classes that influence microhabitat conditions contributing to the development of sporocarps, (*iii*) a larger number of EM species not producing conspicuous sporocarps in old-growth stands compared with younger stands, (*iv*) an artifact of the single- interval sampling method, and (*v*) a high level of small mammal mycophagy in our old-growth stands. Small mammal population densities and small mammal mycophagy are highly variable across stands and landscapes (Cazares et al. 1999). However, mycophagy likely did not have a significant effect on biomass because we sampled at times of sporocarp abundance (North et al. 1997).

The most dominant genera appeared in all age-classes. However, about 25% of the genera in our study appeared exclusively in either young or old-growth stands (Table 4), suggesting genus-level patterns of EM sporocarp succession as forests age. Fox (1986) noted a EM genus-level distinction between young and aging birch (*Betula* spp.) forests. However, many of the genera characterized as early stage or late stage in the study by Fox (1986) were multistage in our study. Differences seen in age-class association of genera in our study compared with those in the study by Fox (1986) suggest that it is difficult to (*i*) to generalize patterns of EM succession between different forest types and (*ii*) define ecological traits common to all species within a genus. Nevertheless, sporocarp production occurring exclusively and repeatedly in a single age-class by some genera suggests similar habitat requirements for species within those genera. Defining distribution patterns associated with taxa at levels higher than species would be helpful for landscape-scale models of fungi occurrence (Dreisbach et al. 2002).

Each forest age-class, as well as our study overall, was characterized by a few biomass dominant species of both hypogeous and epigeous sporocarps and a larger number of less abundant species. This pattern of biomass dominance by a few species is common to many groups of organisms and has been documented in EM sporocarp communities, especially among hypogeous fungi (Luoma et al. 1991; North et al. 1997; Waters et al. 1997; Colgan et al. 1999). Many species appeared in greater abundance in a particular age-class (Table 6). Repeatedly detected species provide a framework for exploring microhabitat variables contributing to their occurrence and abundance. Such knowledge may provide insight into the habitat requirements of more rare species and is essential to species conservation efforts.

Other studies in Douglas-fir in our region also have reported higher biomass of hypogeous sporocarps in spring compared with fall (Fogel 1976; Luoma et al.

1991; North et al. 1997; Cazares et al. 1999). Epigeous sporocarps show relative rarity in seasons other than fall in our region (Fogel and Hunt 1979; North et al. 1997; O'Dell et al. 1999). The more even production of hypogeous sporocarps in spring and fall makes them a more reliable food supply for mycophagists (North et al. 1997; Cazares et al. 1999). Colgan et al. (1999) reported that some species of hypogeous fungi produce sporocarps throughout the winter when many food resources are scarce.

Species richness and patterns of EM community structure reported in this study are based on the sporadic production of ephemeral fungal sporocarps and our ability to detect them. Describing EM communities by sampling sporocarps provides data essential for predicting impacts of disturbance and management on sporocarp diversity and production but not total EM diversity. Species richness, composition, and relative abundance likely would have differed if we had sampled EM roots (Gardes and Bruns 1996). To further increase knowledge of the community dynamics of EM fungi, both sporocarp and root tip approaches should be considered for determining EM species diversity and dominance in future studies.

Knowledge of EM fungal communities improves our ability to maintain biological diversity in old-growth, managed rotation-age, and young stands. In summary, we found (*i*) high EM species richness in forests in the *Tsuga heterophylla* zone in the Cascade Range in Oregon, (*ii*) a similar number of EM fungal species among forest age-classes with similar plant association groups, (*iii*) a change in abundance of some dominant species or species groups as forest stands age, and (*iv*) a greater likelihood for species or species groups unique to an age-class to occur in old-growth stands. Our results suggest that all age-classes of forests are important for maintaining the biological diversity of EM fungi and the organisms they support.

The Relationship between Nontimber Forest Product Management and Biodiversity in the United States

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March 2004 (Revised August 2005)

Abstract
Nontimber forest products (NTFP) in the United States are harvested for commercial and noncommercial purposes and include thousands of wild or semi-wild species or parts of species used for medicines, foods, decorations, fragrances, containers, dyes, fuel, shelter, art, ceremonial purposes, and more. Despite the known and substantial economic value of a few individual NTFPs, and the unknown, but likely high economic value of NTFPs in aggregate,

historically managers have not included them as important factors in forest management. Not only do NTFPs comprise a significant part of the biological diversity of forest ecosystems, but given the lack of formal NTFP research, the many people who harvest NTFPs part or fulltime have the most knowledge about them. Consequently, efforts to conserve biodiversity are unlikely to succeed unless knowledge about NTFPs, and the effects on them of various forest management activities such as timber removal, grazing, prescribed burning, and NTFP harvesting practices, becomes an integral part of forest management. This research project attempts to address these issues through achieving two objectives: 1) to advance understanding of the role and impact of NTFP management in forest ecosystem sustainability and biodiversity; and 2) to support the ability of U.S. forest managers to assess NTFP sustainability. We developed five interrelated components to meet these objectives. The first component is an online species database expanded from 857 to 1,343 entries. The database serves as an initial tool for identifying NTFP species that currently or formerly existed in their region and that can potentially be incorporated into planning for biodiversity conservation, forest restoration, cultural use patterns, and sustainable economic development. The second component is an online bibliographic database expanded from 1,468 to over 2,600 entries. The database aids in identifying NTFP references of books, journals, and gray literature. A large portion of the entries are annotated. The academic publications included in the database are drawn more heavily from the international NTFP arena, which is where the majority of NTFP research has been done thus far. The third component is a national survey of Forest Service Ranger District employees and state forest managers for the purpose of examining NTFP management in relation to biodiversity. The surveys include several questions specifically addressing inventory and monitoring activities. The fourth component is ethnographic fieldwork throughout the lower 48 United States that entailed driving over 37,000 miles to meet harvesters and other stakeholders in their communities. The fieldwork included formal and informal interviews and participant observation with hundreds of NTFP harvesters and other stakeholders including land managers, scientists, Native Americans, commercial businesses, and environmental groups. The fifth component is a series of four all-day multi-stakeholder workshops and a three-day retreat of the seven member project team held to discuss the possibilities for inventory and monitoring programs involving NTFP harvesters. The results of these meetings including rationale, harvester incentives, barriers, case studies, recommendations, and steps for creating participatory inventory and monitoring programs are incorporated into a companion document to this report.

Companion Documents: *Nontimber Forest Product Inventorying and Monitoring in the United States: Rationale and Recommendations for a Participatory Approach* and *Workshop Guide and Proceedings: Harvester Involvement in Inventory and Monitoring of Nontimber Forest Products*. Available online at: www.ifcae.org/projects/ncssf1

PAGE 5 In June 2002, the National Commission on Science for Sustainable Forestry (NCSSF) awarded the Institute for Culture and Ecology (IFCAE) an 18-month grant to assess the relationship between forest management practices, nontimber forest products (NTFP) and biodiversity in the United States. This report provides a synthesis of findings from the study.

Rationale and Theory
Nontimber forest products have been recognized internationally as an important element in sustainable forestry. In 1992, delegates to the United Nations Conference on Environment and Development, known as the Rio Earth Summit, identified sustainable forest management as a key element in sustainable economic development. Agenda 21, which emerged from this conference, set out nonbinding guidelines for sustainable forest management with specific inclusion of nontimber forest products. In addition, over 150 countries signed the Convention on Biological Diversity (CBD), which addresses not only the conservation of biological diversity and the ecosystems where it occurs, but also how to ensure its sustainable use. The inclusion of this concern for sustainable use increased attention to nontimber forest products.

NTFPs are a subset of biological diversity, actively sought and collected for particular purposes with utility to human society (Wong 2000: 3). Throughout the world people living in forests often have extensive knowledge about and sometimes use nearly every plant in their area, whether it be for food, medicine, building materials or for cultural or spiritual practices. For example, Moerman (1998) documents the vast knowledge of native North American societies (in total 44,691 different uses of 4,029 plants in 291 different societies) in his volume, *Native American Ethnobotany*. Such knowledge is sometimes called Traditional Ecological Knowledge (TEK).

PAGE 8 The U.S. Nontimber Forest Product species database contains 1,343 currently or formerly harvested commercial species for the states and territories3 and is available free of charge to the public online at www.ifcae.org/ntfp/.

PAGE 9 **Results from a Survey of US Forest Service Districts and State Foresters**
Three major questions underlie this component of the study: 1) How widespread is NTFP harvesting on National Forests and state forests in the United States; 2) To what extent have public forest management agencies already taken steps to ensure that NTFP harvest levels are compatible with biodiversity conservation; 3) Since NTFPs themselves constitute a reservoir of biodiversity, to what extent do national forest and state forest managers analyze the effects of other forest management activities, such as timber harvesting, grazing, mining, and recreation, on NTFPs? To answer these questions, we conducted written surveys of USFS employees and state foresters about their NTFP programs. The surveys had three main objectives:
• To identify the extent of NTFP harvesting activities on National Forests and

state forests in the United States;
• To identify gaps within the U.S. Forest Service and state forestry agencies with respect to their capacity to manage NTFPs;
• To gather information about the use of NTFP inventory and monitoring efforts, as well as barriers to and opportunities for effective NTFP inventory and monitoring, by the U.S. Forest Service and state forestry agencies.

We asked survey respondents to provide information on seven aspects of their NTFP programs:
• Important NTFP products harvested from the lands they manage
• Incorporation of NTFPs in resource management planning
• NTFP inventory and monitoring efforts
• Effects of NTFP management on biodiversity
• Barriers to implementing NTFP inventory and monitoring
• Contribution harvesters make to NTFP management
• Barriers to or advantages of using harvesters to do inventory and monitoring

PAGE 10 We received responses for 218 of 531 ranger districts, a district response rate of 41 percent. These districts were distributed across 81 national forests. In addition, staff from three national forest Supervisors Offices (George Washington-Jefferson, Modoc, and Nez Perce) did not provide district breakdowns in their answers. Including the responses from these three forests with the 81 national forests from which we had at least one district response, 84 national forests, or 77 percent of national forests, participated in the survey.

We also emailed a survey (Appendix 4) with questions similar to those for the U.S. Forest Service to the state forester representatives listed on the National Association of State Foresters website for all 50 states. We received responses from 34 states, a response rate of 68%. A detailed analysis of the Forest Service survey, including regional level analyses, is scheduled for publication in fall 2005 as a General Technical Report under the auspices of the USDA-FS Pacific Northwest Research Station.

The survey data demonstrate that NTFP harvesting takes place on national forests across the United States, rather than being limited to national forests located in one or two regions.

PAGE 10-11 Twenty-eight, or 82% of the state foresters, listed at least one important NTFP product harvested off state forestlands.5 Sixteen, or 47% of the state survey respondents, mentioned four or more important NTFP products. Of the state foresters who listed no NTFP products harvested on state lands, one was from West Virginia, which prohibits the harvesting of all NTFPs on state forests. Another respondent was from Arizona, which doesn't issue contracts or permits for NTFPs because commercial harvesters wanting to harvest on state forestlands "do not exist." A third was from Texas, where the respondent noted that there is no interest for harvesting NTFPs on state forests. It is unclear whether no NTFP harvesting occurs on state lands in these states, or whether harvesting occurs, but is not visible to the state forest agencies.

Forest Service survey respondents listed 132 NTFPs, while state foresters mentioned 64 NTFPs.

PAGE 12 Familiarity with Selected Resources on NTFP Management and Policy During the 1990s, the Forest Service developed and circulated a draft strategy for NTFPs, a document that the agency eventually published in 2001 under the title," National strategy for special forest products" (USDA-FS 2001). The developers of the strategy envisioned the document as a guiding framework for the agency's NTFP management program (USDA-FS 2001: v). The authors also viewed the strategy as a potential resource for state, tribal, and private forest managers (USDA-FS 2001:v). Respondents from 43 percent of the reporting national forests had read the strategy (Table 3). The strategy has also received only limited use by state foresters, as only 21% of the state survey respondents had read the document.

PAGE 13 As indicated above, respondents from many of the reporting national forests and state forestry departments had not read either of the only two texts presently available that provide national overviews of a broad range of non-timber forest products management and policy concerns in the United States. Likewise, respondents from very few of the reporting national forests and state forestry departments had visited the NTFP website.

Respondents on 36% of the National Forests reported that NTFP inventories take place on their forests (Table 4). NTFP monitoring, however, occurred on 60% of the National Forests. Only 9% of the state foresters conducted NTFP inventories, while 29% monitored NTFP harvesting activities (Table 4).

Ethnographic studies of contemporary NTFP harvesters indicate that many are very knowledgeable about the ecological characteristics of the resources they harvest, and the ecological conditions of their harvesting sites (Emery 1998; Jones 2002; McLain 2002; Richards 1997). These studies also reveal that forest managers either don't include, or discount the importance of including harvesters, in forest management and planning.

PAGE 14 Respondents on 56% of the National Forests stated that harvesters contributed to NTFP management in their area (Table 5). The percentage was lower among state foresters, only 24% of whom noted that harvesters contributed to NTFP management on the lands they administer (Table 5).

NTFPs in Resource Management Planning
The literature on NTFP management in the United States indicates that NTFPs are often not included, or are addressed only superficially, in natural resource management planning (Chamberlain et al. 2002; Emery 1998; Antypas et al.

2002). Yet, the U.S. Forest Service is implicitly mandated under a variety of statutes, including the National Environmental Policy Act and the National Forest Management Act, to include discussions of commercial and non-commercial NTFPs in forest planning documents. These documents include, among others, Forest Plans (also referred to as Land and Resource Management Plans), Environmental Impact Statements, Environmental Assessments, and a host of other large and small-scale planning documents, such as Watershed Analyses, Social Impact Assessments, Landscape Analyses, and Biological Assessments.

Forest plans constitute the key documents guiding management decisions on national forests. Respondents on 87 percent of the reporting national forests indicated that their forest plan included discussion of NTFPs (Figure 3). Respondents on 67 percent of the reporting national forests stated that their forest included NTFPs in environmental assessments (EA).7 Respondents from only 39 percent of the reporting national forests, however, indicated that their forest included NTFPs in environmental impact statements. Environmental Impact Statements are typically very extensive documents involving months, and sometimes years, of analysis.

PAGE 15 Chamberlain et al. (2002) analyzed the amount of text devoted to nontimber forest products (i.e. SFPs) in Forest Plans in Regions 8 and 9. They concluded that “the attention afforded to NTFPs is minimal” (p.11) and that “no plan provided comprehensive coverage similar to that of other natural resources” (p.12). It is likely that Chamberlain’s findings hold true for most National Forests.

Respondents on forty-two percent of reporting national forests indicated that their forest or district had prepared planning documents focused specifically on NTFPs. Survey respondents listed a wide spectrum of NTFP planning documents, ranging from site-specific biological and environmental assessments to forestwide NTFP policies and monitoring plans (Table 6).

PAGE 15-16 We also asked state foresters to provide information about whether they include NTFPs in planning documents. Since each state has its own legal mandates for planning documents, it is difficult to develop a list of documents that are applicable to all states. State foresters listed three kinds of forest planning documents that included NTFPs: forest-level management plans, statewide forest management plans, and forest inventories. For all categories of documents, fewer than 20% of the state foresters reported including NTFPs.

PAGE 17 Respondents from slightly more than half (53%) of the reporting National Forests indicated that ecological monitoring of NTFPs takes place on their forest. Forty-eight percent of the respondents from National Forests doing ecological monitoring provided no details about the kinds of things they monitored. For the 23 National Forests for which respondents provided ecological monitoring details, 65% focused their ecological monitoring on unspecified types of ecological impacts of NTFP management. The remaining

44% focused their ecological monitoring on the impacts of NTFP management on NTFPs themselves. Only four states (12%) reported doing ecological impact monitoring for their NTFP management activities.

PAGE 18 **Manager Perceptions of Barriers to NTFP Inventory and Monitoring**

Survey respondents mentioned a variety of barriers to implementing NTFP inventory and monitoring, ranging from lack of funding to limited commercial demand for NTFPs to the low prioritization of such efforts within the agencies (Appendix 10). These barriers fell into four broad categories: lack of funding, lack of internal capacity; lack of political will within the agency; and limited or no perceived need due to either an abundant supply of NTFPs or a small number of harvesters relative to supply. The most commonly cited barrier to NTFP inventory and monitoring was lack of funding, which respondents from 85 percent of the reporting national forests listed (Figure 6). The second biggest barrier for the Forest Service was lack of staff, which respondents from 74 percent of the reporting forests mentioned. Both of these fall into the category of internal capacity. Twenty-five percent of the state forester survey respondents mentioned institutional capacity types of barriers, such as lack of agency knowledge and logistical difficulties, 14% listed lack of agency support, and 14% perceived no need for inventory and monitoring.

As indicated in Table 8, respondents from the majority of reporting National Forests stated that it would be desirable to involve harvesters in inventorying (58%) and monitoring (54%).

PAGE 19-20 Figure 7. Forest Managers' Reservations about Harvester Involvement

Concerns about Harvesters' Abilities

Concerns about Harvester Bias

Lack of Trust and Incentives for Harvesters

Lack of Capacity within the Forest Service

PAGE 21 **Summary**

The surveys demonstrate that NTFP harvesting is a nation-wide phenomenon that takes place on many National Forests and state forests. Not only is NTFP harvesting widespread but, even using a conservative estimate, the range of NTFP products and species harvested encompasses hundreds of different kinds of biological organisms, as well as a few non-biological products, such as rocks and minerals. Therefore, to ignore NTFPs in forest management is to ignore important components of biodiversity. Furthermore, efforts to conserve biodiversity are unlikely to succeed unless knowledge about these species, products, and the effects on them of various forest management activities, including but not limited to NTFP harvesting practices, becomes an integral part of forest management.

Unfortunately, the survey results also show that many of the reporting National Forests and state forestry departments pay limited attention to the impacts of other forest management activities on NTFPs, as well as the impacts of NTFP management on forest biodiversity. Many of the responding forest managers are unfamiliar with key NTFP policy documents and web resources. NTFPs are not included or are inadequately addressed in many forest planning processes. Few of the reporting National Forests or state forests make use of scientific inventory and monitoring procedures for gathering data about NTFPs. Moreover, managers on many of the reporting National Forests and state forests do not incorporate harvester knowledge into NTFP management and planning. Thus, NTFP management on many state and national forests is taking place in the absence of significant input from the very stakeholders most likely to have detailed knowledge about NTFPs. In short, many forest managers are either unaware of or are not using resources and tools that are available for learning more about NTFPs and the effects of NTFP management on biodiversity.

National Forest managers and state foresters are struggling with how to incorporate NTFPs into their forest planning processes in an era of declining budgets and decreases in staffing levels. Indeed, survey respondents identified lack of funding and personnel as the two major internal barriers to NTFP inventory and monitoring. However, many respondents indicated that agency-harvester collaborations could be used to develop and expand NTFP inventory and monitoring programs. For such programs to work, the designers would need to develop inventory and monitoring systems that simultaneously addressed the needs of harvesters (e.g. location information safeguards and access guarantees) and the needs of forest management agencies (e.g. data quality control). Effective collaborative NTFP inventory and monitoring systems would also require the development of suitable training materials for both harvesters and forest managers, as well as a long-term commitment on the part of upper level agency administrators to invest in such systems. In the course of our ethnographic fieldwork and a supplemental literature review, we identified a range of collaborative inventory and monitoring projects that can serve as models for developing a nation-wide network of NTFP inventory and monitoring projects aimed at supporting the biodiversity conservation objectives of the Montreal Process' sustainable forest management agenda.

PAGE 21-22 **COMPONENT 4 FINDINGS:**
Ethnographic Fieldwork with Harvesters

We included an ethnographic component in this research because ethnography has a good track record as a method for studying populations, such as many NTFP harvesters, who are marginalized or invisible in natural resource management and policy making (Emery 1998; McLain 2002). This section presents findings from the ethnographic research component. It includes a discussion of the different types of harvesters we identified, how their local knowledge could be beneficial to forest managers and policy makers, and their perspectives on the impacts of both harvesting and other forest management practices on NTFP species and biodiversity in general.

PAGE 24 Motivations underlying harvesting are often diverse (Table 10). Previous research has identified seven distinct, but often overlapping, categories of harvesters (Jones and Lynch 2002). These include people harvesting for subsistence, market exchange, recreation, spiritual purposes, healing, the development of formal scientific knowledge and the development of informal scientific knowledge. We added a new category to the typology – education – to refer to educators and students who harvest NTFPs in the course of teaching and learning.

PAGE 25 One division that runs through the typology that has clear ramifications for sustainable management is commercial and noncommercial harvesting. For example, individual commercial harvesters may take larger quantities than individual noncommercial harvesters, but collectively noncommercial harvesters might remove larger quantities if their population outnumbers commercial harvesters. All categories in the typology except commercial harvesters are noncommercial harvesters, though they may also gather commercially at times. Our definition for commercial harvester included anyone acquiring any income from selling or trading NTFPs they have harvested. Thus, an educator who charges for a workshop would be considered to be commercially motivated. Within our formal interview sample, 29 harvesters fit exclusively into the commercial category, 25 could be described as noncommercial, and 89 did both commercial and noncommercial harvesting. We interviewed 31 people who provided formal instruction on harvesting NTFPs through courses, workshops, and other forms of training.

NTFP research shows that harvesters in the United States are diverse in terms of gender, age, ethnicity, class and cultural identity (Emery 1998; Richards and Creasey 1996; Hanson 1996; Jones and Lynch 2002). Although research on the social aspects of NTFPs is still in an exploratory stage, studies thus far indicate that harvester demographics vary considerably across specific NTFP sectors. For example, the floral greens sector in western Washington has a large Latino harvester population (Lynch and McLain 2003), while wild mushroom harvesting in southwestern Oregon and northern California has a large population of pickers of southeast Asia origins (Richards and Creasey 1996).

PAGE 26 In some areas, forest managers take into account harvester diversity when developing NTFP policy and regulations. For example, many Forest Service districts distinguish between commercial and noncommercial use, regulating each differently. However, our research and previous studies of NTFP policy and management (Alexander et al. 2002; Carroll 2003 et al.; McLain 2000), suggest that this simple dichotomy does not adequately capture the diversity of harvesters' motivations and thus produces hardships for many harvesters. For example, it is common for some harvesters gathering mushrooms for their own use to collect more than the small amount per day allowed under the Forest Service's personal use permits in order to dry and store the mushrooms for the winter or for several seasons. Staying within the limits of the personal use permit requires such pickers to increase the number of their gathering trips. This increases both the time and the costs for them to harvest the quantities they need. Some of the types of hardships that can occur when policies are unable to differentiate between different types of forest use are revealed in the following quotes from interviewees:

Harvester: As an independent educator, working with the Forest Service is needlessly impractical, so I've abandoned it. For instance, if I wanted to offer a one time event on their land they would require me to pay a base fee, a per person fee, limit me to 12 persons—11 students plus the instructor—no matter the habitat, require me to purchase special outfitters insurance, and join—pay annual fees to—an outfitters association. All that just to take students on a three hour educational hike in the woods. I would have had to double my fees to something no one could afford. They don't differentiate between a single ethnobotanical hike along an established trail, and an outfitter who makes his sole living catering high risk rock climbing expeditions on their land.

Harvester: I teach classes all over the state [Colorado] and Wyoming so I would have to get a permit from that national forest and this national forest and one up in Wyoming. It is expensive so I will take that class out one time and take the risk that I am not going to be caught. I have never been caught because I hardly ever do it. A guy like me just doing a part-time business has to feel like I am doing something illegal because I don't want to spend hundreds of dollars on permits.

PAGE 26-27 Despite the apparent ubiquity of harvesting, many harvesters in our study observed that they are overlooked or ignored by forest managers. The frustration and anger that some harvesters have toward forest managers is revealed in the quotes below.

Harvester: Amongst the pickers, here is how it goes: Scientists don't know a damn thing, right? Managers don't give a shit and rip you off. Sociologists ain't worth a shit. They are useless so you are in the useless category here. I have heard it all and the managers have heard all of this so you have got this mess that nobody trusts anybody and nobody has any confidence in anybody.

Harvester: I don't really think it [harvesting] is on the radar screen. So far they have all been trained to promote the timber and I don't think they really know how to even be concerned.

Harvester: I feel like I sometimes have to kiss ass with them. Instead of a mutual agreement it feels like I go way out of my way to work with these people and they do nothing to approach me.

Harvester: Well, you might as well work with a stick. [laughs]. They told me that us old people don't know nothing, but we know more about that then "the book". They just go by the book. Whoever wrote that book must have been crazy.

Most harvesters were passionate about their livelihoods and said that they would welcome the opportunity to work with managers. For example, when asked if he knew of any harvesters working with forest scientists or managers, one harvester responded:

Harvester: I don't. They've never asked me here. They've never asked anybody. I would gladly point them in the right direction. We'd be glad to work with any of them if they'd give us a chance.

PAGE 30-31
However, it appears that both private and public land managers and law enforcement are increasingly discouraging harvesters from coming on their lands. For private property, access limitations are increasingly being enforced by absentee landowners on lands that local people formerly had informal agreements with previous property owners to hunt and harvest on. Several harvesters commented that they feel unwelcome on public land as well:

Harvester: I don't believe you're supposed to get anything out there, unless you get a permit for it, and you can't get a permit for anything because they don't want to mess with it. They used to give out firewood permits...They used to sell ginseng permits. They don't do that anymore. Just mainly because they say that there's no study out there to tell them if it's good or not. That's their excuse but their excuse is they just don't have the people to do it and they don't want to.
One harvester we talked with described numerous negative encounters with Forest Service law enforcement such as intimidation, invasion of privacy, and roadblocks. In the following quote he identified lack of respect as the root of the problem:

Harvester: There is absolutely no respect for them here or anywhere anymore and all it would take is for them to quit feeling like they deserve respect and earn it. You don't just come waltzing into my camp...you say, "do you mind if I come in and talk with you for a minute?" This is my home and I have certain rights...

PAGE 33 **Forest Management Impacts to NTFPs**
The attention of land managers, conservationists, the media, and other stakeholders is often focused on the potential negative consequences of NTFP harvesting on biodiversity, while they ignore the bigger picture and effects of forest management on NTFPs. Few scientific studies document the impacts that NTFP extraction has on forest ecosystems, or the sociocultural and ecological impacts of other forest industries and activities on NTFPs. The harvesters we interviewed expressed considerable concern about the impact of forest management practices on the nontimber forest product species they gathered.

While some harvesters mentioned positive effects, the vast majority of interviewees described negative impacts to NTFPs from activities such as mining, grazing, logging and associated activities such as herbicide spraying (Table 12).

PAGE 34-35 Many public and private forestlands are sprayed with herbicides to control invasive weeds and to prevent herbaceous vegetation from interfering with young tree growth. These sprays often have a negative effect on both nonnative and native species. We looked for national statistics on how much spraying takes place overall on American forests, but such data appear to be unavailable. However, some Forest Service documents provide spraying statistics for lands administered by the Forest Service. For example, a draft environmental impact statement for the Helena National Forest's noxious weed control project indicates that their preferred option is to spray 5,800 acres with herbicides over a 12-year period (Helena EIS 2003). Such a program costs hundreds of thousands of dollars. The document does not directly discuss the potential effects of spraying on nontimber forest products, harvester livelihoods, or forest users' health. This is a pattern reported by harvesters in other regions, many of whom indicated that local forest managers were unaware of the negative impacts of spraying on their livelihoods. A few examples of comments we received from harvesters about the effects of spraying on forest biodiversity are provided below:

Harvester: Spraying is probably the number one thing [concern]. As far as when the fire happened, they sprayed all kinds of stuff there so people who wanted to harvest up their medicine couldn't…. if you need your medicine you're going to go harvest your medicine, and if somebody has sprayed it and you can't use it, now its totally going to affect your life….Right now they are going to start spraying on the Klamath again…herbicide spraying. It's just a giant, huge issue, not just for all harvesters, but forest workers and just people in the community.

Harvester: A few years ago when they sprayed the County Road… it wiped out a lot of gooseberry bushes down there on that road. And the magnesium they're using on county roads now days too, raise heck with berries along the roads. They're just spraying for weeds, but the weeds flourish and everything else dies.

Harvester: …they are doing a lot of logging and then after they log they come in and plant a type of pine and then they will spray the whole forest with an herbicide to kill off any other hardwoods that are coming up so there won't be any competition for the pines. Again you are killing, even though they are replanting the forest, these herbicides that they are spraying will prevent those native plants that were growing there from coming up.

Harvester: Now they are using a lot of herbicides to spray power lines and areas like that, see and it just makes it bad. I am definitely against that...To them it is no good, to me that [area] is a gold mine....I was watching and they got my willows.

They went in and sprayed and cut ‘em down and I would have got every one of them in a matter of a day or two. I would have had them cleaned out.

PAGE 35-36 Timber Removal
Timber extraction has long dominated U.S. forest management but an extensive array of archaeological and ethnographic monographs and related research demonstrates that NTFPs have also been an important part of forest history in America (e.g., Emery 2002; Moerman 1998; Sturtevant 1978). Research examining the relationship between timber management and nontimber forest products, however, is limited at best. Some contemporary NTFP harvesters are very concerned about this relationship, as illustrated by the following quote:

Harvester: I just think at some point it’s got to be recognized, the value [of medicinal herbs] ....I’m not opposed to logging, I’m a wood worker. So I’m not anti [logging], but I don’t want someone to come in and say you’re going to yank out ten thousand bucks worth of trees out of this area when you’ve got sixty thousand bucks worth of herbs...that grow underneath there....You know, this is where I come to gather my herbs. I don’t want to come up here and [find] they’re gone. This is how I stay alive. I’ve had such really bad health problems at different times that I know that the tincture is what really did the saving. So for me it’s really pertinent for my health. Many harvesters reporting that timber removal operations have substantially affected the NTFPs they harvest. The following quotes from harvester interviews provide a few of the many examples:

Harvester: I’ve lost a lot of ground because they clearcut it and it just wipes it out....A lot of my good seng [ginseng] ground has been taken away when they go in and clearcut it....There is just a big spot in the middle of the woods now and they had the biggest hollow of ginseng...It will take fifty years before anybody can find seng back in there again. They are doing it everywhere though. Where I used to dig goldenseal and ginseng, they wiped the whole side of that hill out too. Seems like the big timber only grows where the ginseng is because that is where they wipe it out. I see that every year. I go back to places I was at three or four years before that and there ain’t nothing there. There aren’t many people in the woods now because there ain’t nothing there. It is gone.

Harvester: Well logging does [affect me]. Once they log it off it tears the moss all up and it’s useless. They can go into places and if they log it off, you know them skidders and logs, they just tear the moss all to pieces. And plus, it opens the canopy to the sun and the sun kills the moss all out.

Harvester: Terrible. Terrible. These clearcuts. There ain’t nothing that grows back, but sprouts…You can’t walk through ‘em. I mean the deer can get in there and hide, but they can’t eat none. Ain’t no acorns in there. I can show you a clearcut that used to be beaucoup [Fr. much; slang – great in quantity] of goldenseal. It is not there. I can show you where they logged, right down here. There is no goldenseal, it is just scattered, one here, one there. They logged it, don't have enough shade to...you know its gotta have some shade.

PAGE 39 The ethnographic results show that a wide range of NTFPs representing hundreds of organisms are being removed from forests. These findings suggest a critical need for forest managers to better understand the relationship between nontimber forest products and biodiversity if they are going to develop effective measures for protecting biological diversity and promoting sustainable forestry.

Harvesters have insights and knowledge about NTFPs that guide their decision-making and which could also inform forest management. They have understandings about harvest techniques, quantities harvested, and other harvesters' activities, but they also have ecological knowledge about optimal habitats for certain species and observations about changes they see occurring in the ecosystems in which they harvest. Many harvesters have intimate connections with their harvesting sites and strong beliefs about stewardship. Some conduct experiments to see whether it is possible to affect productivity of the species they harvest. However, the extent to which harvesters have opportunities to develop ecological knowledge varies depending on the frequency with which they visit an area. Thus, how landowners regulate access can affect the degree to which harvesters have the opportunity to develop ecological knowledge.

When managers and other stakeholders talk about NTFPs the discussion often centers around fears about unsustainable harvests. Much less commonly discussed are the effects of forest management practices on NTFPs and, consequently, biodiversity. Harvesters, however, described a multitude of forest management practices with negative impacts on NTFPs they gathered. These practices included logging, grazing, the spraying of herbicides and pesticides, the encouragement of high wildlife populations that over-browse understory vegetation, and loss of habitat from development. Even when NTFPs could be salvaged before being destroyed by these other activities, programs that allow harvesters to do so are nonexistent. The lack of such programs and general disregard of NTFPs by forest managers helps explain why some harvesters feel overlooked or ignored, even when they do make efforts to interact with managers.

COMPONENT 5 FINDINGS:
Regional Workshops Examining Harvester Involvement in Inventory and Monitoring

PAGE 40 Through the discussions at the workshops and retreat, we found that harvester involvement in inventory and monitoring is a viable and prudent idea and that most stakeholders supported the idea. A key benefit of an inventory and monitoring approach that involves harvesters is that it can provide forest managers and policymakers with the data needed to develop and maintain sustainable NTFP management programs in an era of declining forest management budgets and staffing levels. Survey results indicated that many managers support the idea and some indicated that they have collaborated with harvesters in various activities. As the results from our ethnographic component demonstrate, harvesters spend regular time in forests and already have ecological knowledge, insights about what factors affect the species they harvest, and a desire to understand sustainable harvesting. They identified various incentives for their participation and many expressed an interest in volunteering or being paid to collect data. Furthermore, as case studies and other literature presented in the report attest to, participatory inventory and monitoring is being successfully implemented in domestic and international programs. The Component 5 workshops provided feedback from a diverse set of stakeholders on barriers and strategies for implementation. The report provides a synthesis of the findings and a set of recommendations for moving forward with participatory inventory and monitoring programs involving NTFP harvesters.

PAGE 40-41 DISCUSSION:
Implications for Biodiversity Conservation
The history of forest management is largely the story of how governments and private companies have acquired and maintained control over forested areas for the purposes of expanding and assuring continual supplies of timber and other wood products. Forest history accounts, which could perhaps more properly be labeled timber history accounts, emphasize the military value of timber resources to political rulers and economic value to governments and private companies over the centuries. What is less clear, however, is why forest managers have placed so little importance on exerting control and assuring supplies over the wide array of NTFPs that forest users have gathered for millennia. Lack of economic value of NTFPs is an insufficient explanation: turpentine production in the southeast in the early 20th century generated substantial revenue alongside timber (Gerrell 1999). Today, the multi-million dollar pine straw industry in southern states allows pine tree plantation managers to obtain annual profits from their land while waiting for the timber to mature (UGA 2002; Zwolinski 1998).10 Yet, despite the known and substantial economic value of a few individual NTFPs, and the unknown, but likely high economic value of NTFPs in aggregate, historically managers have not included them in forest management. Also unknown is what economic and ecological values forest managers have lost by focusing primarily on timber management, often at the cultural expense of an array of NTFPs. Though there is management interest in developing alternative silvicultural systems and new forest practices that embrace multiple values including biodiversity (Kerns et al. 2003), economists Alexander and Fight point out that although promising, few examples exist of joint management that produces an optimal mix of timber and nontimber products (2003).

A number of factors have converged in recent years to bring NTFPs into forest policy debates thus placing them at a critical juncture in forest management. First, the Forest Service and other federal land management agencies have adopted an ecosystem management approach that promotes the need for understanding the ecological and social relationships in forest ecosystems. Second, even though the U.S. government has refrained from signing the Convention on Biological Diversity, many forest stakeholders in the U.S., including the U.S. Forest Service, are actively working on implementing criterion and indicators emerging from the Montreal Process that followed on the heels of the drafting of the Convention on Biological Diversity. Third, in 2000, the U.S. Congress passed a law, commonly referred to as Section 339 (HR3194 1999), requiring the U.S. Forest Service to pay explicit attention to the harvest of botanical products within the national forest system.11

11 The Forest Service has not yet released the Code of Federal Regulations explaining how they will implement the law.

Given the results of our study it is uncertain how Congress expects the Forest Service to implement its ecosystem management mandate, fulfill its responsibilities with respect to the Montreal Process criterion and indicators, or implement Section 339. As the survey results presented earlier in this report indicate, many National Forest and state forest managers pay limited attention to NTFPs. Specifically, the surveys identified the following weaknesses in the capacity of the U.S. Forest Service and state forestry departments to manage forests for biodiversity conservation, of which NTFPs are an important element:
• NTFPs are not included or are inadequately addressed in many forest planning processes;
• Few of the responding forest managers conduct NTFP inventories and the methods used to conduct monitoring are often inadequate;
• Few of the reporting forest managers incorporate harvester knowledge into NTFP management and planning;
• Many of the responding forest managers are unfamiliar with elected documents and resources on NTFPs;

Ignoring NTFPs is no longer a sensible option, nor is it necessary, for several reasons. First, our data indicate that the number of species harvested, commercially or non-commercially, on national and state forests is very likely in the hundreds, if not thousands. Together, the harvesters and managers in this study listed a combined total of 657 NTFPs, a number that likely represents hundreds of species. 12 The updated NTFP species database lists over 1,300 species as currently or previously commercially harvested in U.S. ecosystems. These findings suggest that NTFP species may comprise a significant part of the botanical diversity of forest ecosystems. Consequently, efforts to conserve biodiversity are unlikely to succeed unless knowledge about these species, products, and the effects on them of various forest management activities, including but not limited to NTFP harvesting practices, becomes an integral part of forest management.

PAGE 42 Third, although many of the traditional practices and knowledge systems around NTFPs have become fragmented or lost, harvesters with extensive knowledge about the plants and their habitat are still out working in the nation's forests. Our findings demonstrate that harvesters often return to the same areas to harvest year after year, facilitating the development of detailed understandings of, and human relationships with, specific forest ecosystems. Harvesters develop such relationships in forest ecosystems located on lands held under a variety of private and public land ownerships. Traditional ecological knowledge and related theory suggests that cultural groups with long-term intimate connections with specific places can develop understandings of their local ecology equal to scientific ecological understandings (Anderson 1996; Becker and Ghimire 2003; Johnson 1992). Given the potential of local ecological knowledge to inform sustainable forest management, it would be wise to promote policies and management environments in which such knowledge can flourish. The importance of harvesters as a source of ecological knowledge is made all the more important by the lack of scientific research evaluating the impacts of both forest management practices and harvesters on NTFPs.

This study shows that nearly all experienced harvesters make detailed observations about the ecological as well as sociocultural environments of NTFPs. These observations guide their harvesting decisions and could be useful to sustainable forestry management. Empirical data from harvesters could be integrated with science to develop ecological theories and hypotheses for testing. Such data could also provide forest managers with a better understanding of the social and ecological needs for managing forests in ways that conserve biodiversity. The following list based on the data presented in the survey and ethnographic component descriptions in this report provides specific examples of areas in which harvesters could contribute and, in some cases, already do contribute, toward biodiversity conservation:
__ Identification of optimal habitat and inventories
__ Observations on unusual ecological change, species diversity and competition effects
__ Monitoring patches or plots for effects of different harvest techniques and other data
__ Keeping log books on quantities harvested, sold, and purchaser prices
__ Sharing scientific findings and management decisions with other harvesters
__ Reporting trespassing, vandalism, and theft

PAGE 42-43
The future of nontimber forest products is uncertain. Without broad stakeholder cooperation, forest managers may continue to emphasize management focused on a few species rather than on conserving biodiversity. NTFPs may simply be too much of a burden for the current forest management system. For example, active management done properly on public lands would require NEPA scoping processes and other costly measures. Consequently, managers may thus choose to discourage harvesting rather than actively manage for NTFPs.

Unfortunately, forest mangers currently are more likely to obtain their information about NTFPs and NTFP harvesters from the media's inaccurate and stereotyped portrayals of NTFP industries than they are from reliable scientific publications. For example, numerous managers and other people we met along the trail have the image that mushroom harvesters in the west are prone to violence and that frequent murders occur over access to mushroom patches. While some aspects of the wild mushroom harvesting arena can resemble the anything-goes spirit of the 19th century western United States, mushroom harvesting is hardly the lawless bastion of violence commonly portrayed in the media. We also frequently heard from noncommercial harvesters, tribes, managers and others that commercial harvesters are ruining the resource, despite typically lacking scientific evidence to support such accusations. We do not doubt that some species are being overharvested or are at risk, but unsustainable extraction runs contrary to the attitudes expressed by the commercial harvesters in this study, as well as most other harvesters we have studied during 10 years of ethnographic research. Ironically, whatever damage harvesters may be doing pales in comparison to the loss of NTFPs and impacts to harvester livelihoods caused by logging, grazing, spraying herbicides and pesticides, mountain top removal for coal, power line maintenance, and a multitude of development projects including subdivisions, gold courses, ski runs and parking lots.

PAGE 43-44 **RECOMMENDATIONS**

1. Acquire Basic Understanding of NTFPs

• Agencies need to create permanent NTFP management and research staff positions along with providing training and materials;

• Research is needed to develop basic ecological, economic, and sociocultural understandings of NTFPs including but not limited to a) the impacts of forest management practices on NTFP biodiversity, b) the role of NTFPs in commercial and noncommercial cultural traditions, and formal and informal economies, and c) economic evaluation of NTFPs and biological diversity relative to other management activities and forest uses;

• Broaden NEPA scoping processes so that they are capable of identifying NTFP stakeholders and their needs, including such practices as meeting personally with harvesters, buyers, and tribes in their communities.

2. Build mutually beneficial working relationships between NTFP Stakeholders

• Actively seek the participation of harvesters in collecting social and ecological data about NTFPs;

• Support pilot programs to examine the viability of NTFP harvester and product certification;

• Increase collaborations with non-agency organizations in areas of research, education, and management programs.

3. Actively Manage for NTFPs

• Initiate pro-active NTFP management as a tool to help meet forest conservation

goals, such as restoring native forest biodiversity, reducing catastrophic wildfire risks, and having resource extraction dependent on the maintenance of biodiversity;
• Public land managers should publicize NTFP availability and harvesting opportunities for sustainably harvestable NTFPs;
• Require and advertise NTFP salvage opportunities before habitat destruction.

APPENDIXES HAVE SOME INTERESTING INFO AS WELL

Sustainable Use of Non-Traditional Forest Products: Alternative Forest-based Income Opportunities

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IN Proceedings and Invited Papers
Natural Resources Income Opportunities on Private Lands Conference
April 5-7, 1998 • Hagerstown, Maryland

Abstract: For generations, residents of Central Appalachia have supplemented their income by processing and marketing non-traditional forest products (NTFPs) gathered from forest lands. The NTFP business is growing rapidly—perhaps faster than that of timber. Some estimate that NTFP markets had grown nearly 20 percent in the last few years. The size of Virginia's NTFP industry has been estimated at $35 million. In 1991, Virginia exported nearly 6.5 tons of ginseng collected from its forests, worth more than $1.8 million.

However, little is known about the extent of harvesting or the long-term effects of extraction. Much less is known about the multitude of products found in our forests but not widely marketed. Information is needed that draws attention to critical issues related to non-traditional forest products. Recent increased demand for NTFPs may have serious long-term effects on the forest ecosystem and will slow efforts to ensure sustainable management of the region's forests.

Virginia Tech has embarked on an effort to learn more about these products and how they would support increased incomes for landowners in the region. Through interviews with stakeholders, and structured and unstructured focus meetings with local communities, we have begun to gather the data needed to better understand this burgeoning forest use. Before developing policies to sustain forest resources, local management practices, the value and volume of products traded, and the scope of NTFP markets need to be documented. Those who gather, market, and manage NTFP resources are involved at all stages of the research. Early indications show that NTFPs offer good opportunities for increased income in rural areas, especially in those hard hit by recent declines of

traditional timber industry and the region's coal mining, and should lead to the sustainable management of forest resources.

Keywords: non-timber forest products, special forest products, forest-based economic development

PAGE 141 **INTRODUCTION**
Several opportunities for improved rural development are linked to non-traditional forest products (NTFPs). In many areas, rural populations have traditionally depended on local forest resources to provide additional income through collection and marketing of NTFPs. Where employment opportunities from traditional industries are declining, workers looking for alternative income sources often turn to collection of these products from nearby forests. This is particularly noticeable in the Pacific Northwest where employment in the logging industry is declining rapidly. It is just as critical in Southwestern Virginia where the declining coal industry has increased the average unemployment rate to 3-4 times higher than the state average.

Unemployment will continue to increase until sustainable alternative employment opportunities are developed. Local pressure on forest resources to provide NTFPs will increase without sustainable forest management programs.

PAGE 142-143 Sustainable environment and economic development depend directly on the diversity of investments and diversity of the ecosystem. The Appalachian region has some of the most biodiverse ecosystems in the world.

"The most ecologically diverse region in Virginia is home to more than 400 rare plants and animals" (The Nature Conservancy 1996). In the Eastern United States, The Nature Conservancy is supporting "ecologically compatible development" through the formation of the Center for Compatible Economic Development (CCED). One of three pilot programs is focused on Virginia's Clinch River valley and creating jobs in environmentally friendly small businesses, including wood products, but not NTFPs. In the Pacific Northwest, non-traditional forest products are considered to be the most viable option for strengthening those rural communities suffering from the decline in timber harvests from government lands. There is an urgent need to examine the markets for these products and to integrate these findings into land-use planning and Extension programs.

In the 1990's, there has been a dramatic increase in demand for natural products, including those made from non-traditional forest products. This can be traced to a number of factors, including a growing interest in alternative medicines and homeopathy. Environmentally conscious and responsible consumers actively seek ecologically friendly and socially correct products. The potential for non-traditional forest products as alternative income sources to a timber-based economy is expanding tremendously. These products will continue to play an important role in economic development of communities-especially those depressed by the decline of traditional industries such as timber in the Pacific Northwest and coal in Central Appalachia.

RESOURCE BASE

Non-traditional forest products are found on all timberlands, The increasing market demands for these products often exceed the capabilities of many public and private agencies to provide sustainable supplies of these products. As more than 75 percent of the land in Virginia is held by non-industrial private landowners, it is easy to postulate that much of the NTFP resources are found on private lands.

The eastern deciduous forest, much of which is located in the Central Appalachian region, provides the habitat for most of the American medicinal plants used in commerce today. One of the more popular eastern species, Podophyllum peltatum (mayapple), is found in forests from southern Quebec, south through the Appalachian region to Florida. "No other region in North America hosts so much living diversity, than Appalachia," notes Constantz (1994). Some estimate that the temperate hardwood forests of Southern Appalachia may be one of the most diverse forest ecosystems in the world (Johnson 1996). More information is needed on this great diversity and its potential to produce NTFPs on a sustainable basis.

VALUE AND GROWTH OF THE NTFP SECTOR

Markets for non-traditional forest products and the capacity for NTFP enterprises to add value at the local level are not well known, but are thought to have significant impact on rural economies. A few of the edible forest products are prominent enough to generate national economic data. In 1993, the United States exported about 77 tons of wild harvested American ginseng, worth more than $21 million (Foster 1995). Two years earlier, Virginia exported about 6.5 tons of ginseng collected from its forests, worth more than $1.8 million (O'Rourke 1993).

PAGE 144 Less is known about how to manage forests for non-traditional forest products than for more common timber products. Overall, management and marketing NTFPs remain an enigma; very little information exists on the management systems or market channels for these products. But, the collection and processing of NTFPs may provide valuable employment opportunities. To learn more about these opportunities, extensive field visits to meet stakeholders in the study area are necessary.

PAGE 145 **Project Activities**

The study is based on the fundamental assumption that market opportunities exist for non-traditional forest products that can sustain economic development of the region and still conserve valuable forest resources.

However, before this can occur, much more knowledge is needed on all factors that influence NTFP resources. To date, information has not been collected on the distribution and management of the region’s NTFP resources, and the nature of and extent to which these products are harvested, processed, and used. The conspicuous lack of information on the scope and value of these markets is a major obstacle to the sustainable development of NTFP resources.

Understanding the needs of the stakeholders, those involved in managing and marketing these products, is most critical. Forest landowners, NTFP harvesters and processors, and policy makers all greatly influence how the NTFP resources are used ‘and whether suggested policies will be successful. Their collaboration is essential to improve our understanding on how the NTFP resources are managed, and hold the key to successful implementation of any suggested changes. We seek to document local knowledge on all aspects of these products, to identify local needs for policy changes, and to collect suggestions of inputs required for improved management and marketing.

We are also documenting the distribution networks for non-traditional forest products. Representative products from each of the four general product groups will be selected and traced through the market. These examples will illustrate the breadth and depth of the markets for NTFPs. We are illustrating the extent to which these products are marketed, showing that the markets are significant at local, regional, national, and international levels. This will verify the tremendous market potential for many of these products.

PAGE 145-146 **Anticipated Results and Applications**
The project is beginning to examine, define, and develop information on the NTFP resources, products, and markets. This information had not been documented or organized. It is crucial to establishing guidelines for the sustainable management of forests for non-traditional forest products. The results will have applications far beyond the geographic scope of the project.

We are producing a market profile for each of several example NTFPs to illustrate how widely these products are distributed. From these opportunities for improved management, potential new markets, and technologies appropriate for the sustained economic development of Southwestern Virginia will be identified. All recommendations should be ecologically sound and based on criteria that conserves the ecological integrity of the region. We seek a balance for management of these resources that provides the maximum benefits to the local people while conserving the forest ecology.

There is significant potential to improve the economic conditions of the people involved in the non-traditional forest products. The value of these products to Virginia's economy was estimated to be about $35 million, in 1995, and growing at an annual rate of 25-30 percent. By the year 2000, with growth continuing at this rate, the value of the NTFPs to the state of Virginia, would be in excess of

$1.05 billion.

PAGE 146 **DISCUSSION**
For generations, many families of Central Appalachia have supplemented their income by gathering and marketing non-traditional forest products. Increased demand for NTFPs may have serious long-term effects on the forest ecosystem. The integrity of the environment and economic development in many rural areas depends on the sustained management of the forests.

Less is known about managing forests for NTFPs than for timber products, even though NTFPs contribute significantly to rural and regional economies. Clearly, these resources are valuable and their sustainable use must be maintained. Yet, little is known about the extent of or the long-term effects that extraction of these products has on our forests. There is a severe lack of information on all aspects of non-traditional forest products, particularly on their markets.

Wild Edible Mushrooms in the Blue Mountains: Resource and Issues

Abstract Parks, Catherine G.; Schmitt, Craig L. 1997. Wild edible mushrooms in the Blue Mountains: resource and issues. Gen. Tech. Rep. PNW -GTR-393. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 22 p.

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This paper reviews the wild mushroom resource of the Blue Mountains of northeastern Oregon and southeastern Washington and summarizes issues and concerns for regulation, monitoring, and management. Existing biological information on the major available commercial mushrooms in the area, with emphasis on morels, is presented. Brief descriptions of the most commonly collected mushrooms are given, as well as the site conditions and plant communities influencing their occurrence or proliferation.

Keywords: Morels, special forest products, commercial mushroom harvest, Blue Mountains.

PAGE 1 In the last several years, forest managers in the Blue Mountains have observed a marked increase in the recreational and commercial pursuit of wild mushrooms. What had once been a casual recreational pastime and resource used by a few of the local population has developed into a major commercial industry for at least 2 months of the year. The commercial market has become increasingly organized and has spawned an influx of pickers and buyers into the area during the mushroom season. Aware ness of the availability of this resource also has increased the recreational pursuit of wild mushrooms. Given the high demand and limited resource, there are concerns about the increasing conflicts among commercial pickers and recreational users, and that mushroom harvesting may reduce future mushroom harvests or adversely affect other forest resources. Public land management agencies are striving to regulate mushroom harvest in a way that conforms to sustaining healthy ecosystems.

PAGE 2 At least 23 mushroom species found in the Blue Mountains have some commercial value.2 By far, most of the mushroom harvest are the morels that fruit in late spring and early summer and to a much lesser extent, the boletes. The valuable American matsutake mushroom (*Tricholoma magnivelare*), well known along the coast, on the slopes of the Cascade Range, and in Idaho, does not fruit in commercial quantities in the Blue Mountains.

PAGE 3 Recreational collecting of mushrooms is pursued predominately by local individuals. In a 5.8-percent sample of personal-use permits issued by the La Grande Ranger District, Wallowa-Whitman National Forest, in 1994, all (100 percent) had Anglo-American surnames and 90 percent designated local addresses.3

In the last several years, there has been a large influx of commercial pickers into portions of the Blue Mountains during May and June to pick morels. Many commercial pickers are of Southeast Asian and Latin American descent, ethnic groups not well represented in the resident population. At the La Grande Ranger District, in 1994, commercial permits were purchased by individuals with Asian (51.3 percent), Anglo-American (44.2 percent), and Hispanic (4.5 percent) surnames. Nonlocal commercial permit holders were more common than locals; 73 percent and 27 percent, respectively (see footnote 3).

A Northwest-wide survey conducted in 1992 identified mushroom harvesters as Caucasian (AngloAmerican) (49 percent), Asian (37 percent), Native American (9 percent), and Hispanic (4 percent) (Schlosser and Blatner 1995).

PAGE 4 **Commercial Harvest** In 1992, wholesale mushroom companies processed $11.8 million dollars worth of mushrooms in the eastern portions of Washington and Oregon, and Idaho. Processors paid about $9.9 million to harvesters for all mushrooms purchased in 1992. This in cluded 1.9 million pounds (861834 kilograms) of wild mushrooms (Schlosser and Blatner 1995).

Morels are the biggest money maker among the Blue Mountain mushrooms. Nearly 1 million pounds were gathered in Oregon in 1992, most of them from the Blue Mountain region (fig. 3). Pickers earned an average of $6 per hour in 1992 (Schlosser and Blatner 1995). Forty percent of morels harvested are sold to Asian and European markets, and 42 percent are sold in the Western United States. In 1995, fresh morels sold for $5 to $6 per pound wholesale and $48 to

$60 per pound retail. Until 1996, most morels were dried for packing by large-scale processing plants (fig. 4). Beginning in 1996, much of the morel harvest was sold fresh and shipped within 24 hours of harvest to the European markets (see footnote 2).

PAGE 5 In La Grande, OR, there is one established year-round mushroom buyer and processor. Mushrooms are mostly sold by pickers, fresh, at the end of the day. Some pickers will dry their own mushrooms and later sell them, adding value to the product. Large-scale processors partially dry and freeze their product for shipping out of the area and overseas. A small amount of the commercial harvest is marketed fresh locally in area restaurants and shipped to markets in the Northwest. Most of the market for processed mushrooms is in Europe (see footnote 2).

A law passed in 1994 currently requires a validated specialized forest products permit (Washington Legislature 1994). The law is administered by the Washington State Department of Natural Resources and requires annual licensing of people who buy and process wild mushrooms for market. Monthly reporting is required of licensed buyers. Reports include information on species harvested, weights, location of harvest sites, dates purchased, prices paid, and name of dealer to whom the mushrooms were later sold. Dealers also are required to report to the U.S. Department of Agriculture, the quantity of mushrooms, by species, sold in-State, in the United States, and to individual foreign countries.

The 1993 Oregon Legislature passed House Bill 2130: Special Forest Products (Oregon Legislature 1993). This statute is designed to reduce illegal gathering and theft of various nontimber forest products, including mushrooms. This law requires wholesale buyers to keep a record of purchases which includes the social security number of the person from whom they bought the product, typically the gatherer. In Oregon, there are no State-wide regulations prohibiting mushroom collection; there may be individual city, county, State, or Federal parks and other lands where picking of mushrooms is prohibited or otherwise regulated.

The USDA Forest Service has used several methods to regulate harvesters and buyers in the Pacific Northwest Region. In the Blue Mountains, until 1994, there was a free-use permit available to people who collect for their own use (up to 10 days of picking per year). Until 1995, these permits were available from each Ranger District and were good throughout the Wallowa-Whitman, Umatilla, and Malheur National Forests. In 1995, regulations were changed slightly for the three Blue Mountains National Forests, and the Forests have discontinued issuing personal-use permits. Currently, recreational pickers are able to collect and possess up to 1 gallon (4.4 liters) (3 gallons [13.2 liters] in Washington) of mushrooms per day. These may not be sold.

Commercial picking permits have been required since the late 1980s for those individuals who pick on National Forest lands for sale to buyers. Recent regulations have reduced the cost of commercial permits as managers have found that most pickers will avoid buying commercial permits if the cost is high. At the Wallows -Whitman National Forest, in 1992, the cost of commercial permits was lowered to $1.00 per day. In 1996, commercial permits became available for $2.00 per day per person with a $10 minimum. A $50 annual permit also is available.

PAGE 7 Most private landowners have ignored mushroom harvesting on their lands, but many have come to realize the income potential associated with the mushroom industry. Some believe the value of mushrooms that could be produced under proper management and regulated harvest is likely to equal or exceed that of other land uses. Other land management practices may be compatible with mushroom management. Use of fire, timber harvest, and grazing may even enhance production of some mushrooms if done properly. Recently, some private landowners, including Boise Cascade, have either posted their properties to prohibit picking, or have a policy of prohibiting commercial harvests on their lands. Some private landowners likely will sell picking rights on their lands in the future. Currently, there are landowners in the area who are at tempting to develop the mushroom resource on their lands by active management and culturing (see footnote 2). Presently, most of the mushroom harvest is removed with out compensation to or permission from the landowner.

PAGE 9 Plants can have many mycorrhizal associates; trees are believed to have more than other plant groups. Douglas - fir (*Psuedotsuga menziesii* (Mirb.) Franco) is known to have nearly 2,000 fungal species (Trappe 1977). Mycorrhizal fungi rely on the presence of their host, and will die with their host. Harvesting or fire can result in a short-term disappearance of these fungi, but they recolonize when trees again become established. Trees that are hosts to mycorrhizal fungi in the Pacific Northwest include those mainly in the families Pinaceae, Fagaceae, Betulaceae, Salicaceae, and a few Ericaceae (Molina and others 1993). _ _

Mushrooms and cup-fungi are reproductive structures of individual fungal organisms that are primarily large networks of filamentous microscopic cells (hyphae) in soil, in wood, or on plants. Masses of hyphae (mycelium) are actually the vast bulk of the fungus. Because mycelium is either hidden or not visible to the naked eye, its importance often is overlooked relative to the apparent mushroom and cup-fungus fruiting structures. In actuality, the mycelium network functions throughout the year, whereas the mushroom or cup-fungus is produced for only a few weeks. Picking the mushroom does not alter the individual in the soil (or other substrate) but is analogous to picking fruit from a tree.

PAGE 11-12 Currently, we do not know the effect of picking on morel populations and long-term fruiting levels. This is a research need. A study of chanterelle mushrooms *(C. formosus*) and the effect of picking on production has shown no short-term trends in production of mushrooms associated with picking (Norvell and others 1995). Because the mushroom is simply the fruiting reproductive structure of the fungus, its removal likely has little affect on the remaining portions of the individual in the substrate (soil, wood, etc.).

There is concern over reduction in spore dispersal owing to removal of mushrooms. Spore production does not occur until after the mushroom cap expands. Commercial buyers grade most mushrooms as higher quality if they are picked before full cap expansion. Only mature morel mushrooms have mature spores.*5* The level of maturity is often beyond that desirable for the commercial market. Although many sporophores are missed by pickers and may produce mature spores, it is unknown whether extensive harvest pressure will affect long-term reproduction.

Trappe (1989) makes a strong case for overharvesting of truffles occurring when they are located by raking the soil. Under natural conditions, primary spread of spores and rejuvenation of the species is by animals eating the truffle fruiting body and dispersing spores in feces. Raking disturbs the site and includes harvest of sporophores that are immature. Observations by Trappe indicated marked reductions in production after several years of heavy harvesting in western Oregon. The European technique of using trained dogs and pigs to hunt truffles is most apt to target the fragrant mature specimens and leave those that are immature.

PAGE 12 In the Malheur National Forest, heavy concentration of pickers living in dispersed campgrounds has been reported as a potential source for some environmental effects (Volk 1991). Although traffic-related damage has been observed as a result of heavy use of dispersed camps during deer and elk hunting seasons, the total impacts associated with both hunting and mushroom picking were considered minimal (Volk 1991).

The spring morel season may closely coincide with elk calving in some cases. Disturbances associated with many people walking through these areas may result in some adverse effects on animals. Forest Service personnel in the Blue Mountains have taken an aggressive approach in creating and maintaining secure areas during elk calving. Large blocks of forested areas are closed to road vehicle travel and all-terrain vehicle offroad use.

PAGE 12-13 Because some prized mushrooms are mycorrhizal, there is concern that timber harvesting will decrease the availability of certain mushrooms. There is also the similar concern that removal of mycorrhizal mushrooms may affect tree growth. The population of fungi on forested sites likely will change substantially as communities go through successive stages of plant succession. Those mushrooms requiring cool, moist conditions associated with mature forests are less likely to be found on sites that have recently had a regeneration harvest. Similarly, those fungi associated with disturbed communities will occur soon after timber harvest but disappear as a regenerated stand develops on the site. Thus, mushrooms are part of the diversity of plants that change with succession. Similar changes occur with natural disturbances such as fire. Because forested communities in the Blue Mountains are closely associated with disturbance, especially fire, these changes in fungal populations should be considered a normal process.

To date, there is no indication that heavy harvesting of mycorrhizal fungi fruiting bodies has a detrimental effect on the remnant vegetative structure or the fungal-root relations in the soil.

PAGE 13 Monitoring of diversity, production, and harvest of edible mushrooms was not included in the forest plans of any of the National Forests in the Blue Mountains. The importance of this resource in both value and the heavy recreational use it generates warrants more than passive management. Monitoring of the resource is needed to assure that land management practices are not affecting this ecosystem component. In some cases, there may be decisions to actively manipulate sites to promote mushroom production. Molina and others (1993) recommend three types of monitoring applicable to wild edible fungi.

PAGE 13-14 There are several morel and other wild mushroom research questions that pertain to the Blue Mountains. Land managers are most interested in monitoring and research that eventually will help direct management decisions (Pilz and Molina 1996). Mushroom production differs not only from year to year because of weather conditions, but also between locations because of various site, disturbance, vegetation, and other conditions. Treatments to enhance mushroom production likely will be incorporated in future land management strategies. Initiation of monitoring and inventory procedures are expected to help managers predict production and regulate this resource. There are several research needs associated with selecting management strategies for short- and long-term mushroom production. The most important research questions include:
1. Can productivity be predicted knowing plant community type and successional stage?
2. What are the temperature and precipitation parameters that begin and end mushroom production?
3. What are the cultural techniques that contribute to optimal mushroom production?
4. What are the negative and positive effects of land management practices, such as timber harvest, burning, and tree planting? Would any changes in management operations mitigate negative effects?
5. What is the effect of repeated heavy collection on a site to future mushroom production?
6. Are there different species or varieties of morels in an area? Are some forms mycorrhizal? Do they respond to management differently?
7. What are the proportions of different species or races of morels after fires of

different intensities, and after tree mortality caused by spruce budworm and bark beetle?
8. What is the population ecology of the mushrooms in an area over time? How is genetic variability in the population related to spore spread?

PAGE 14 Wild edible mushrooms from the forests of the Blue Mountains are being marketed locally, nationally, and around the world. We are just beginning to develop an appreciation for the biological and economic value of this special resource. Effective man agement of the commercial mushroom harvest requires anticipating the demand, the primary locations affected, and potential conflicts (fig. 8). Any regulations for protect ing the mushroom resource must apportion the harvest fairly. Extensive communication and cooperation among the public, industrial land owners, and governmental agencies is essential. Research and monitoring are important factors in developing strategies that will both protect and promote the Blue Mountain mushroom resource.

Harvesting and Marketing Edible Wild Mushrooms

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Reprinted October 1998

Harvesting and marketing

In the past 5 years, commercial mushroom harvesting in the Pacific Northwest has increased, especially of matsutakes, king boletes, morels, and golden chanterelles. Harvesters can earn hundreds of dollars per day when the picking is good.

Frequently asked questions about harvesting

* Does heavy or extensive picking reduce future mushroom yields?
No scientific data support the theory that heavy or extensive picking reduces future yields.

* Does logging affect mushroom yields?
Because mycorrhizal mushrooms depend on trees to live, they are adversely affected by clearcutting. Other mushrooms, such as morels, actually require disturbances such as logging and even fire to stimulate fruiting.

* Will there be conflicts with other pickers?
Some pickers return to the same area each year and regard it as their territory. Be careful and courteous when picking in new areas to avoid conflicts with other pickers.

Managing National Forests Of The Eastern United States For Non-Timber Forest Products

by
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IN SUB-PLENARY SESSIONS
VOLUME 1
XXI IUFRO WORLD CONGRESS
7-12 August 2000
Kuala Lumpur MALAYSIA
International Union of Forestry Research Organization

PAGE 407 **Abstract**
Over the last decade, there has been a growing interest in the economic and ecological potential of non-timber forest products. In the United States, much of this increased interest stems from drastic changes in forest practices and policies in the Pacific Northwest region, a region that produces many non-timber forest products. The forests of the eastern United States, however, also produce many nontimber forest products. This analysis focuses on the status of non-timber forest products in management plans of the national forests in eastern United States. Of the thirty-one national forest plans examined for coverage of non-timber forest products, only seven plans addressed the management of these resources. A review of national legislation that affects national forests reveals that non-timber forest products are not recognized as a management objective. But, they are considered as “special products” in key policy documents. There is legislation under consideration that could significantly change how these products are managed. This paper identifies and discusses key issues that could affect decisions to manage for non-timber forest products.

Keywords : Non-timber forest products, Eastern United States, U.S. forest service, Forest management.

Concern for the management for non-timber forest products has increased, in-part due to the changes in forest policies and practices on the national forests in the early 1990s. With a decrease in logging on national forests, and an increase in demand for many non-timber forest products, there are tremendous possibilities to realize the economic development potential of these resources. At the same time, demand on the forest resources could exceed the capacity to supply non-timber forest products, which could have unfavorable economic and ecological impacts.

The eastern United States has not been the focus of much of the dialogue concerning non-timber forest products, even though the region includes more than 50 percent of the U.S. population and more than half the states. Eastern U.S. hardwood forests are one of the most extensive forests of this type in the world (USDA Forest Service 1984). The biological diversity of some forests of eastern U.S. may surpass that found in tropical and temperate rainforests. The broadleaf forests of the Appalachian and Blue Ridge Mountains ecoregion form one of the most biologically rich temperate forest regions in the world (Ricketts et al. 1999). According to Constantz (1994) “no other region in North America hosts so much living diversity than Appalachia.”

PAGE 412 **Findings**
Non-Timber Forest Products in Forest Management Plans

Approximately 23% of the national forest plans in eastern United States address nontimber forest products to some extent. Seven of the thirty-one national forests in Regions 8 and 9 addressed the management of forest resources for non-timber forest products. Of these, six were located in the eastern region (R9). The only national forest plan in Region 8 (Southern) to address NTFPs at some level was The National Forests of Florida (Florida LRMP 1985).

Table 1 describes the extent of coverage for each of the management objectives addressed in the seven national forest plans that included non-timber forest products. Percent coverage was based on the area devoted to a management objective relative to the total coverage. Overall, the amount of attention afforded to non-timber forest products is insignificant compared with other natural resources. No national forest plan provided NTFPs more than one percent coverage.

The seven national forest management plans that addressed NTFPs varied in extent of coverage. In general the coverage focused on the recreational opportunities and the research needed to better address these products. Berry production and collection were identified in all but one management plan as a management opportunity. While all seven national forest management plans provide general forest-wide guidance for NTFPs, only three have prescriptions for maintaining or enhancing NTFP production.

PAGE 415-416 **1995 Resource Planning Assessment**
The 1995 RPA program identifies ecosystem management as the strategy by which the Forest Service can reach the goal of sustainable forest management by 2000. This new strategy will require the Forest Service to “move beyond traditional approaches to include a broad range of values” (USDA Forest Service 1995, p. ES-1). Four fundamental elements (ecosystem protection, restoration, multiple benefits, and organizational effectiveness) are identified as necessary for the success of the strategy (USDA Forest Service 1995).

All of the fundamental elements have direct implications on how forest resources are managed for non-timber forest products. A greater diversity of ecosystems creates potential for greater diversity of forest products. Conserving species before they are protected under the Endangered Species Act helps to assure productive populations of harvestable NTFPs. The use of native species in restoring ecosystems suggests that the gene pool for NTFPs could be conserved. Accelerating natural processes could help to restore NTFP species that have been extirpated from certain forests. For example, Forest Service research efforts to restore the pine/bluestem ecosystem in the Ouachita National Forest may prove beneficial to *Echinacea spp.* (purple coneflower), a plant harvested and marketed for medicinal purposes (Guldin 1999). A priority management activity of developing a system to charge fees for harvesting and using the natural resources that is based on fair market value could significantly change the permit system for collection of NTFPs. Further, an emphasis on restoring and sustaining strong and diversified rural economies could lead to greater assistance to NTFP harvesters.

In the 1995 RPA special forest products are a main concern under the priority management area “economic action programs” (USDA Forest Service 1995, p. III-31) and are identified as compatible with sustainable forest management. The Forest Service uses the term “special forest products” to describe products derived from biological resources, collected from forests, grasslands, and prairies for personal, commercial, and scientific uses. Special forest products exclude sawtimber, pulpwood, cull logs, small round wood, house logs, utility poles, minerals, animals, animal parts, insects, worms, rocks, water, and soils (National Strategy 1999). The RPA commits the Forest Service to “develop these products to strengthen rural communities” (USDA Forest Service 1995, p. III-31).

“One of the most important ways the Forest Service can contribute to special forest products is to collect information” (USDA, Forest Service 1995). This includes identifying and describing the ecosystems and habitats from which NTFPs are collected. Information is needed on defining what materials are collected, the methods of collection, and how much is collected. More economic and market information on NTFPs is needed. Finally, the RPA recognizes the need for management strategies that include NTFPs to protect the health, diversity and productivity of forest ecosystems.

PAGE 416 **National Strategy for Special Forest Products**

The Forest Service is developing a “National Strategy for Special Forest Products” (National Strategy 1999) that recognizes the need to manage for special forest products. The principles and priority areas set forth in the strategy are intended to provide “a solid conceptual foundation for an action plan” (National Strategy, p. 3). To guide and direct management of the renewable resources that produce special forest products, the strategy establishes five strategic goals: 1) availability within ecosystem limits; 2) integration into forest management; 3) consistent and effective policies and plans; 4) inventory and monitoring of resources; and, 5) collaboration with stakeholders.

Issues and Implications

Based on this review of forest management plans and polices, a number of key issues are identified that could significantly affect how the national forests are manage for non-timber products. Societal pressures on how, and for what purposes, national forests are managed continue to intensify. Economic issues are driven by demand for the products and include questions of macro and micro scale. Environmental concerns range from the impact that harvesting has on the species to the impact on the ecosystem from where the products were collected. There is a wealth of knowledge on how to mange for timber, wildlife, recreation, and water resources, but in general there is a lack of technical information and expertise for managing for non-timber forest products. How to incorporate NTFPs into the ecosystem management paradigm remains an issue. Institutional barriers must be removed to allow NTFPs to be well managed.

Social

For the most part, the collectors of NTFPs are under-represented stakeholders in the planning process. They are not organized nor represented by any group, but are individuals who may be apprehensive of getting involved in government activities. They may not want others to know how much is collected nor the collection location. But none-the-less, the collectors are stakeholders in how the national forests are managed, as management decisions can drastically affect these people’s livelihoods.

PAGE 417

Economic

Unlike timber, the economic value of nontimber forest products, in general, is not well defined. Though the overall value of some sectors (e.g., herbal medicinal) is documented, little information is available on forestharvested products (e.g., forest-harvested medicinal plants). Defining the value of nontimber forest products at the forest and district levels is necessary to determine sustainable management levels. Though demand figures for some products (e.g., ginseng) are available, in general very little is known about the demand for most products. As a whole, very little information is available on the supply of non-timber forest products. Forest inventory data for NTFPs is generally non-existent. Without accurate information on the supply and demand for non-timber forest products, it is difficult to determine sustainable economic harvest levels.

Environmental

The environmental issues, if not addressed, could result in a management strategy based on protection of the NTFP resources and not conservation or utilization. If the population of a NTFP species degrades to a level that initiates the statutes of the Endangered Species Act the Forest Service would be required to pursue a protection strategy. To manage for conservation and utilization the status of NTFP species can not drop to the level that requires management under ESA. The effect that harvesting has on local plant populations, as well as the impact on the associated ecosystem is an issue that truly affects how the Forest Service manages these resources.

Institutional

To address the issue of technical management of the NTFP resource will require creating new information through research, broadening horizons beyond traditional forestry, and expanding the expertise involved in management. The research needed to develop the knowledge on how to manage for NTFPs is boundless. In general, there is a lack of information within forestry on how to manage the NTFP resources. But, expanding the inquiry to include knowledge of herbal medicine and gardening could provide valuable information on reproducing some NTFPs. The technical management of NTFPs will require more information on the status, characteristics, and requirements of the habitats and species. To include NTFPs in forest management will require developing the expertise to understand the ecology (biological and social) and botany of the natural resource.

From an institutional standpoint, the economics of management must be defined to determine the investment needed to ensure sustainability of the resource. Over the last decade revenues from timber sales, as well as appropriations from the U.S. Congress have decreased. The decline in fiscal support has put tremendous pressure on the Forest Service to deal with the most important issues. The issue of “below-cost” management could impede Forest Service efforts to manage the NTFP resources. At this point, the costs of managing NTFPs may exceed the revenues generated from the sale of collection permits. To incorporate NTFPs into forest management will require either additional fiscal support or a shift of funds from other management objectives.

National legislation is being considered that would lead to increased revenues from the sale of collection permits and development of sustainable harvest levels. But, until NTFPs are recognized as a natural resource, “more important” issues will subsume the amount of effort devoted to managing them. Legislation that recognizes NTFPs as a management objective for national forests, along with those identified in current legislation, would institutionalize management of non-timber forest products.

PAGE 418 **Conclusions**

In the 1980s, when the first round of national forest plans were developed, non-timber forest products, in general, were not recognized as a management objective nor as a issue of public concern. A few national forests identified NTFPs as a resource and incorporated them into management plans. Still, the coverage devoted to NTFPs was insignificant compared to other management objectives. Much of the coverage focused on recreational collection and research needed to conserve the resource base.

Over the last decade, interest in, and concern for, NTFPs has increased drastically. Today, NTFPs are receiving a great deal of attention in natural resource policy dialogue. The U.S. Forest Service is leading the way on defining how national forests will be managed for nontimber forest products. A great deal of research, analysis and support are still needed to have NTFPs fully integrated into national forest management plans and practices. Non-timber forest products are economically and ecologically important. The collection and sale of NTFPs from the forests of eastern U.S. have local, regional, national and international economic impact. Collection of these products also, may have significant impact on the health of the forests of the region. To realize the maximum economic benefits and to have the minimum ecological impact, the natural resources that produce NTFPs need to be managed.

The Forest Service strategy of managing national forests as ecosystems can not be fully realized until NTFP resources are sufficiently integrated into management plans. The goal of sustainable forest management will remain elusive if NTFPs are not managed as a natural resource. Certainly, the paradigm of multipleuse management needs to be expanded to include these forest products. Perhaps, the ecosystem management paradigm needs modification as well.

Integrating Non-Timber Forest Products into Forest Planning and Practices in British Columbia

Special Report
FPB/SR/19
May 2004

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PAGE I-II **Executive Summary**
Non-timber forest products (NTFPs) are an important forest resource in British Columbia, with the potential to make a significant economic contribution to small, resource-based communities. Non-timber forest products, also known as non-wood forest products and botanical forest products, include all the human-exploited uses of plant and fungal species of the forest, other than timber, pulpwood, shakes or other wood products. Rough estimates from 1997 placed the value of this resource at $680 million in provincial revenues and the sector

has likely grown since then.

The harvest of NTFPs is currently unregulated in BC and this creates a whole range of issues, from lack of government revenue, to potential over-harvesting of the resource, to infringement of aboriginal rights and First Nations' traditional use of NTFPs.

Sound management of BC's public forest lands should include appropriate measures to conserve and develop NTFPs, recognizing that:
· opportunities exist to further develop the commercial NTFP industry in BC; and
· First Nations have rights to NTFPs arising from traditional uses of these forest resources.

The Forest Practices Board has been involved with NTFP issues mainly through its public complaints program, and has identified potential impacts of timber harvesting on NTFPs, as well as concerns about the sustainability of the harvest of NTFP resources themselves. In the late 1990s, the Board recommended that government enact a botanical forest products regulation under the Forest Practices Code, but that recommendation was never implemented.

This report provides a high-level review of the non-timber forest products sector, impacts of forest practices on NTFPs, opportunities to address NTFPs in forest planning and practices, and examples of innovative approaches to doing so. Through this report, the Board hopes to raise awareness of the importance of NTFPs as a forest resource, and to encourage government and forest managers to actively address the relationship between forest planning and practices and NTFPs.

The report notes that there is room for improvement in several areas:
· There is a need for better knowledge about NTFPs – the economic importance and potential of the resource, as well as the science to manage the resource in a sustainable manner.
· It is possible to integrate management of NTFPs with the management of timber.
Better integration will require: • greater awareness of NTFPs within the forest industry; • land use and sustainable resource management plans that set clear and measurable objectives for NTFP resources to guide timber harvesting; and • operational planning mechanisms that address NTFPs, including forest stewardship plans and public and First Nation consultation activities.
· The lack of regulation and rights, or tenure, to harvest NTFPs makes it difficult to develop the sector in a sustainable manner. The lack of regulation also means there is no mechanism to enforce sustainable management of the resource, and the current free reign to gather these products from public and private lands in turn creates little incentive for regulation or tenure arrangements.

 Commercial Use

The commercial harvest of NTFPs has been occurring for several decades and is believed to be expanding. One study (Wills and Lipsey, 1999) estimated that in 1997 the commercial harvest of wild mushrooms, floral greens and other products employed almost 32,000 people on a seasonal or full-time basis, which generated direct business revenues of $280 million and overall provincial revenues in excess of $680 million. However, there is a lack of recent economic data available for the industry in BC and what does exist is based on rough estimates.

Wild edible mushrooms, such as the pine mushrooms and pacific golden chanterelles, are the main commercial species, followed by the floral greens (salal, sword fern, boxwood, evergreen huckleberry and boughs).

There are not recent data; however, based on the estimated 1997 revenues for mushroom and floral greens sales ($55-60 million, Wills and Lipsey in Tedder et al., p. 10), and the apparent growth of these industries, it is reasonable to expect that NTFPs are at least as economically important to some local areas as other non-timber forest uses that are licensed, such as commercial recreation, guide outfitting or range.

PAGE 5
Table 1: Commercial Profile of NTFPs
Mushrooms
Pine mushrooms are most valuable – others include chanterelles, morels and boletes. In 1997, 16 companies harvested, bought or sold BC wild food mushrooms. Seven companies control over 90% of the exports by weight from Vancouver to Japan (pine mushrooms). Due to variable seasonal fruiting conditions, before–tax revenues range from $25 million to $45 million. European and North American markets consume chanterelles (750,000 kg. in a good year), morels (225,000 kg.), boletes (100,000 kg.), and other species (50,000 kg).

Mushrooms and other Fungi
Matsutake (pine)
The world market for wild nutritional and medicinal mushrooms, extracts and products was US $1.3 billion in 1997. Demand is from Asia, where medical research indicates that polysaccharides, terpenes, and steroids etc. found in many BC mushrooms have antibiotic, antitumour, and antiviral properties, reduce lipids in blood and stimulate the immune system.

PAGE 9 The *Forest Practices Code of British Columbia Act* (the Code) (enacted 1995) contained provisions for the Lieutenant Governor in Council to make regulations respecting botanical forest products. The new *Forest and Range Practices Act* (enacted in late 2003) enables regulations for botanical forest products that can include rules about product harvesting, issuance of licenses, fees, enforcement and appeals. Despite this enabling authority, government has not chosen to regulate the commercial NTFP sector yet, nor does the Ministry of

Forests' service plan anticipate such regulation.

PAGE 10-11 **Timber Harvesting, Road Construction and Access Management**
Timber harvesting impacts can be positive or negative, and vary according to timing, silviculture system and harvesting method used. Impacts to NTFPs relate to changes in sunlight and moisture levels, soil disturbance and the retention of coarse woody debris. Clearcuts can eliminate chanterelles and pine mushrooms from a site for decades, but can also substantially increase opportunities for berries such as huckleberries and herbs. Partial cuts, where some trees are left standing, can improve the abundance, vigour and value of understory species for floral greenery (e.g., boxwood and huckleberry). The transition zone between harvested areas and the adjacent forest with its canopy closure often provides a multitude of understory species.

PAGE 18 The current regulatory framework does not explicitly require the consideration of NTFPs when planning or conducting forest practices, but it does create opportunities to do so. The most significant of these is the ability for government to establish objectives for NTFPs through sustainable resource management plans and to designate them as FRPA objectives under the *Land Act*. Creating such objectives would then trigger the consideration of NTFP values in forest stewardship plans and in forest practices.

PAGE 19 In the development of the Kispiox Land and Resource Management Plan (LRMP), the traditional use and commercial value of the pine mushrooms were recognized through the public process. The challenge for the Ministry of Forests (MOF) was to set resource objectives for pine mushrooms, and then to incorporate the objectives into timber planning and practices. Because pine mushrooms thrive in older aged stands, an additional challenge was to incorporate the pine mushroom resource objectives into the timber supply harvesting scenarios, in order to reflect the LRMP.

In 2001, the forest inventory was improved as far as identifying where and how much pine mushroom habitat might exist throughout the timber supply area (TSA). MOF identified and mapped highly productive pine mushroom habitat in two Small Business Forest Enterprise Program chart areas. This research was extrapolated to the entire TSA, a sensitivity analysis was carried out (Recknell 2001) and then incorporated into the Kispiox Timber Supply Analysis.

Forestry Implications: The chief forester's rationale for the 2003 Kispiox Timber Supply Analysis modelled the following specific management regime for pine mushrooms: one third of projected potential pine mushroom habitat was entirely excluded from timber harvesting, one third was entirely included in the timber harvesting land base, and the remaining third was assumed to be subject to an alternative silvicultural regime with at least 40% basal area retained. This is a start at incorporating LRMP objectives into forest practices and planning.

Better inventory and managemen t information is needed for the pine mushroom. The Ministry of Forests (Skeena-Stikine Forest District) and the Ministry of Sustainable Resource Management are continuing with the habitat mapping work and progress is being made.

PAGE 20 The Cariboo-Chilcotin Land Use Plan (CCLUP) requires the mainten ance and enhancement of wildcraft values, which includes mushrooms, berries, floral and decorative materials and medicinal plants. It requires that key pine mushroom sites be maintained in a condition that promotes mushroom growth, and it requires the maintenance of roaded access for the purpose of harvesting wildcraft. Sub -regional plans, and more recently SRMPs, have been drafted to provide more detailed strategies for implementation of the CCLUP objectives in smaller land units within the CCLUP area. Som e of these plans provide objectives and strategies for pine mushroom habitat and access for harvesting wildcraft. However, the strategies focus mainly on conducting inventories and collecting information on the resource and are not as specific to forest practices as those found in the West Babine SRMP. These plans are not legally binding on forest licensees.

PAGE 21 **Information Needs**
In addition to the need for economic data and inventory information on the location and harvest of NTFPs, there is a lack of information on the sustainable management of NTFPs and on compatible management of timber harvesting with NTFPs.

Establishing multiple stand level objectives has been termed “compatible management” in the US Pacific Northwest (Haynes et. al., Kearns et. al). Compatible management produces both timber and another forest value. In British Columbia, some areas such as riparian zones, ungulate winter range, and old growth areas, have primary management objective(s) for non-timber values, with timber as secondary. In British Columbia there are few examples of forest practices with secondary objectives for NTFPs, and rarely examples where NTFPs are the primary management objective. (See case study #6.)

Compatible management opportunities for timber and NTFPs differ with the seral stage, ecological zone, and the NTFP species. NTFP inventories and research are not readily available, and what does exist rarely has information about desirable commercial characteristics, as literature usually discusses species abundance and distribution for other purposes such as wildlife browse (Kerns et al., 2003).

Further, there is very little awareness of NTFPs and opportunities for compatible management among forestry professionals. The FRPA model is based on professional reliance, but most professional foresters and biologists do not have much awareness of NTFPs, let alone formal training and skills in managing ecosystems for NTFPs.

PAGE 22-23 ***Case Study #6: Nisga'a Lands - Integrating Pine Mushrooms into Forest Planning and Practices***

Issue: The Nisga'a treaty settlement for all "forest resources" includes timber as well as plant and fungi products. he Nisga'a are placing high importance on the management of pine mushrooms in their forest management planning and practices.

Background: Mushrooms, particularly pine mushrooms, are a very important resource for community economic stability in the Nass Valley. Their annual value changes considerably, depending on the quality and quantity of the mushroom crop as well as the daily fluctuating market price. On average, however, the regional commercial sales are around $5 million per year.

The Nisga'a have developed a botanical forest products plan for eleven species of mushrooms, of which the pine mushroom is the main commercial product. To facilitate this plan, the Nisga'a have established resource management zones within their land use plan.

The mushrooms grow in association with mature pine-hemlock timber types. One forest inventory polygon in particular known for its mushroom production has been named "the pine mushroom polygon," but this is by no means the only place of interest for pine mushroom management.

Nisga'a have longstanding knowledge about where to find prime pine mushrooms areas, as do experienced harvesters. To further sustainable pine mushroom management, inventories are needed to assess the pine mushroom resource and refine boundaries of forest management units where the forest ecosystem can be managed to support and enhance pine mushroom production.

The *Nisga'a Forest Act* enables the Nisga'a Lisims Government to issue permits to pine mushroom harvesters and buyers. Management costs are recovered through permit fees and volume surcharges. Nisga'a forest officers are responsible for enforcing the harvest and buying permits, and together with the experienced pickers they educate harvesters on sustainable harvest practices.

Forest Practices Implications: Schedule 1 of Appendix H to the Nisga'a Agreement sets out specific, auditable, measurable objectives for the pine mushroom polygon. During the 5-year period of transition to Nisga'a ownership, all forest development plans must comply with the following constraints:
- Timber harvesting, including that associated with roads, will retain a minimum of 80 percent of the forest cover at an age of at least 120 years, and
- Silvicultural systems, other than for areas to be occupied by roads, will be a selection system and provide for retention of a minimum of 70% of the total basal

area of the cutblock.

Following the transition period, Nisga'a land use policy states that "no incompatible use will be permitted in areas identified through the assessment process as productive pine mushroom habitat."

The *Nisga'a Forest Act*, land use plan and botanical forest products plan provide a framework for pine mushroom management, and there are specific, auditable and measurable objectives established for forest development plans. However, logging has not been proposed within the pine mushroom polygon. It is certain that if the mature overstory were logged, the pine mushrooms would be lost. However, the impact different partial cutting regimes would have on the continued production of the mushrooms is unknown and the subject of debate. With this uncertainty, the Nisga'a do not plan to harvest timber in the pine mushroom habitat in the foreseeable future.

PAGE 24 **Conclusions**
NTFPs are a significant, but largely unmanaged, forest resource. They present a significant potential economic opportunity for British Columbia. The most recent economic estimates from 1997 put NTFPs' contributions to the provincial economy in the $680 million range and the industry has undoubtedly grown since that time. However, there is a lack of current data on the importance of NTFPs to the BC economy. NTFPs are also of significant importance to First Nations for traditional and commercial uses.

Government needs to further explore ways of regulating NTFP harvest to create rights of access and use, to develop the commercial sector, to ensure the sustainable harvest of NTFPs and to recognize the cultural and economic importance to First Nations. While some work has been done in this area, no concrete actions have been implemented to date. Further research into what other jurisdictions are doing and pilot projects to test regulatory approaches may be appropriate.

As demonstrated in this report, there are excellent examples of forest managers and NTFP harvesters working together to maximize the timber and non-timber benefits forests can provide. The Board encourages more of these innovative approaches to stewardship and management of all forest resources for the benefit of British Columbians. Success will require further research into the impacts of forest practices on NTFPs and the opportunities for compatible management of these forest resources.

PAGE 26 **Recommendations**
The Forest Practices Board recognizes that a great deal of research and policy consideration has already been done with respect to NTFPs. NTFP management is not a simple issue. However, it does represent a significant economic potential for BC and the issues cannot be left unaddressed in the long term. The Board's

role is to promote and encourage sound management and stewardship of all of BC's forest resources, timber and non-timber, and therefore it makes the following recommendations:

1. Government should conduct the research necessary to quantify the current economic contribution of the NTFP sector to the province and its contribution to economic diversification of rural communities. Government should also continue to support and undertake research to develop knowledge about compatible management of timber and NTFP resources, and sustainable management of NTFPs.

2. Government should further explore the options for regulating the NTFP industry in light of:
· its importance for income and employment;
· the need for sustainable management of the NTFP resource; and
· its cultural and economic importance to First Nations.

3. Government should establish objectives for NTFPs under the *Land Act*, through sustainable resource management plans, to guide forest planning and practices where NTFPs are an important local resource for economic and/or traditional uses.

4. Government, the forest industry and professional associations should promote awareness amongst foresters and other resource management professionals, as well as the NTFP sector and First Nations, about the opportunities and challenges of integrating the sustainable management of timber with NTFPs.

Non-Timber Forest Products: Medicinal Herbs, Fungi, Edible Fruits and Nuts, and Other Natural Products from the Forest

Journal of Sustainable Forestry
Volume 13, Numbers 3/4 2001

International Non-Timber Forest Product Issues
Rajesh Thadani
Perceived as socially, economically, and ecologically sustainable, non-timber forest products (NTFPs) have held special charm as alternatives to forest management focussed exclusively on timber. This paper examines themes central to development of NTFPs as management and conservation strategies in the developing world. Following brief descriptions of seven product types, the paper reviews research on the promise of sustainable prosperity through NTFPs. Critiques of economic valuation and commercialization suggest that NTFP development strategies are not without social, economic, and ecological problems. The paper concludes with a list of eight major issues relating to the extraction and trade of non-timber forest products.

KEYWORDS. Extractive reserves, economic valuation, commercialization, third world, non-timber forest products

Brief Overview of Historical Non-Timber Forest Product Use in the U.S. Pacific Northwest and UpperMidwest

Marla Emery
Shandra L. O'Halek

Non-timber forest products (NTFPs) have sustained indigenous and immigrant populations alike since their arrival in North America. This brief overview focuses on the historical use of NTFPs in the U.S. Pacific Northwest and Upper Midwest. Drawing on sources as diverse as accounts by early European arrivals, archaeological evidence, and contemporary ethnobotanical studies, we touch on documented uses of forest vegetation from prehistory to the present century. The residents of these regions have used NTFPs for food, medicine, and cultural materials. NTFPs have met their livelihood needs through subsistence uses and both non-market and market exchanges. We conclude that in spite of U.S incorporation into a global market-based economy, there is notable continuity in the harvest and use of NTFPs in the United States from prehistory to current times.

KEYWORDS. Non-timber forest products, environmental history, human-forest interactions, Michigan, Pacific Northwest

Aboriginal Use of Non-Timber Forest Products in Northwestern North America: Applications and Issues

Nancy J. Turner
Wendy Cocksedge

Aboriginal peoples in northwestern North America have traditionally used hundreds of different forest plants for food, materials and medicines. Plant products have also been economically important as trading goods. Today there are excellent prospects for aboriginal people to participate in the harvesting and marketing of non-timber forest products, but there are serious issues of access to and control of resources, respect of intellectual property rights, and concerns for conservation of plants ande cosystems that must be addressed. We provide an overview of past, current and potential use of NTFPs by aboriginal peoples in British Columbia and neighboring areas, and discuss the relevant issues and concerns, with recommendations about how these can be accommodated.

KEYWORDS. Traditional food, traditional medicine, indigenous peoples, basketry, British Columbia

An Overview of Non-Timber Forest Products in the United States Today

Susan J. Alexander
Rebecca J. McLain

As people become more interested in personal health and family activities, demand for wild forest products has increased. This increased demand coupled

with an increased concern for sustainable management practices has focused attention on the variety of issues and products involved in the non-timber forest products industry. Forest management organizations have gradually increased funding for research and management of non-timber forest products over the past two decades. The broad categories of U.S. non-timber forest products include floral greens, Christmas greens, ornamentals and craftmaterials, wild edibles, medicinals, ceremonials/ culturals, and native transplants.The increase in resource pressure has had many policy reactions, including restricted access, harvesting fees, and harvest limits. Opportunities for public input to policy decisions on federal, state and private land are often unclear or nonexistent. Researchers, managers, and policy makers are working to understand the multitude of issues surrounding non-timber forest products, including biology, management, public policy and equity issues.

KEYWORDS.Medicinals, floral greens, wild edibles, non-timber forest products

Non-Timber Forest Products in Local Economies: The Case of Mason County, Washington

James Freed

Non-timber forest products (NTFPs) have been a vital part of the local economies of Mason County, Washington since the first peoples came there over 9,000 years ago. First Americans used NTFPs in every fact of their lives. The new Americans, from early Euroamericans to the newest Asian Americans, have used nontimber forest products to provide subsistence resources and income support. Beginning in the 1970s, increased demand for medicinals, wild mushrooms, and floral products brought Mason County’s NTFP industries back into the limelight. Unfortunately, the rise in demand for NTFPs has increased social conflict in Mason County. Indeed, disputes over harvesting practices and the tension between floral greens and wild mushroom business over across to NTFP leaves have made Mason County the floral point of recent efforts to expand government regulation of the NTFP industry in Washington. However, NTFPs may also provide opportunities for decreasing the political conflict over timber management in the region by creating financial incentives for landowners to maintain longer timber rotations.

KEYWORDS. Native Americans, medicinals, mushrooms, floral greens, wild edibles, forest management

SECTION II: RESEARCH ON NON-TIMBER FOREST PRODUCTS IN THE PACIFIC NORTHWEST

Research in Non-Timber Forest Products: Contributions of the USDA Forest Service, Pacific Northwest Research Station

Nan C. Vance

Non-timber forest products (NTFPs) have emerged as a complex set of issues reflecting changes in society and how natural resources are regarded. These

issues range from the sustainability of forest management practices to the relationship of diverse cultures and communities to public lands and their resources. Research and its relationship to this set of issues is a relatively unknown aspect of NTFPs. This paper reports on early NTFP research by scientists in the USDA Forest Service's Pacific Northwest Research Station. It characterizes efforts over approximately five years and identifies their key elements. It also discusses the role research has and could play in addressing the problems and questions associated with NTFPs and sustainable forestry.

KEYWORDS. Pacific Northwest, non-timber forest products, USDA Forest Service, native forest plants, native forest fungi

Productivity and Sustainable Harvest of Edible Forest Mushrooms: Current Biological Research and New Directions in Federal Monitoring

David Pilz
Randy Molina
Michael P. Amaranthus

The commercial harvest of wild edible forest mushrooms has increased dramatically in the Pacific Northwest United States during the last decade, creating public and managerial concerns about potential over-harvesting. These concerns have prompted Federal land management agencies and research organizations to undertake a variety of research projects addressing the ecological impacts and long-term sustainability of widespread harvesting. This article lists and briefly describes 25 ongoing research projects investigating the three most important forest mushroom genera of commerce; matsutake, morels, and chanterelles. We finish by describing future Federal directions in regional research and monitoring designed to ensure sustainable harvests through long-term cooperative monitoring involving multiple stakeholders, especially interested publics.

KEYWORDS. Mushrooms, sustainable harvest, research, monitoring

Socio-Economic Research on Non-Timber Forest Products in the Pacific Northwest

Susan J. Alexander
Rebecca J. McLain
Keith A. Blatner

The non-timber forest products industry in the Pacific Northwest has been viable for nearly a century. Although it is a small part of the regional economy, the industry involves many people in the region and products are exported worldwide. Harvest of non-timber forest products has become more scrutinized as landowners, forest managers, and harvesters struggle to meet their sometimes conflicting needs and requirements, and deal with growing demand for many wild products. Much of the research on non-timber forest products has focused on biology and ecology, although there has been some research on the social and economic aspects of non-timber forest products over the past several decades. There are several social and economic studies of the industry that are underway or just being completed in the Pacific Northwest. Current research includes studies on product yield, market surveys, price analysis, product management and silviculture, recreational use, and policy analysis. Recommendations for future research are outlined. The non-timber forest product industry is a highly varied and frequently changing industry, with issues ranging from biological sustainability to equity. Social and economic research helps resolve questions surrounding management, harvesting, production and marketing of these highly demanded and often poorly understood products.

KEYWORDS. Non-timber forest products, NTFP industry, NTFP markets, NTFP socio-economics

SECTION III: SOCIO-POLITICAL CONSIDERATIONS FOR NON-TIMBER FOREST PRODUCT MANAGEMENT

Why Is Non-Timber Forest Product Harvesting an ''Issue''? Excluding Local Knowledge and the Paradigm Crisis of Temperate Forestry

Thomas Love
Eric T. Jones

Despite an encouraging trend in North America of growing interest across a range of disciplines in non-timber forest products (e.g., this volume), NTFP harvesters' knowledge and practices continue to be poorly understood and undervalued, if not ignored, both by research scientists and forest land policy-makers and managers. This article explores why NTFP harvesting suddenly emerged in North America as an ''issue'' in the early 1990s. Drawing from a three-year study of chanterelle mushroom harvesters on the Olympic Peninsula Biosphere Reserve (Washington, USA), we discuss a variety of forces which intersected in this period to bring NTFP harvesting to wider attention. Unfortunately, harvesters continue to be excluded as knowledgeable actors in, if not legitimate co-managers of, temperate forest ecosystems, resulting in both passive and active harvester resistance to research and management, a devaluing of local harvesting traditions, and missed opportunities for collaboration. We reluctantly conclude that despite ''New Forestry'' co-management rhetoric, given existing institutional barriers and positivist scientific categories, NTFP workers will likely remain excluded from active roles in temperate forest research and management-contributing in turn to the ongoing legitimacy crisis of public and private forest management entities.

KEYWORDS.Chanterelle mushroom, forest management, legitimacy crisis, local knowledge, non-timber forest products

Who Knows? Local Non-Timber Forest Product Knowledge and Stewardship Practices in Northern Michigan

Marla R. Emery

Non-timber forest product (NTFP) literature frequently laments the absence of an

information base for policy and management decisions. While formal scientific data on the biological and social ecologies of most NTFPs are limited to nonexistent, long-time gatherers often have extensive experiential knowledge bases. Researchers and managers may overlook this expertise because of assumptions about the nature of knowledge and the identity of individuals who possess valuable information. These assumptions are explored and contrasted to the concept of local knowledge. A case study of gatherers in Michigan's Upper Peninsula found that many possess extensive knowledge of the products they harvest and observe stewardship practices to assure their sustained availability. The paper is illustrated by descriptions of four gatherers and concludes with recommendations for incorporating the local knowledges of individuals from a variety of cultures into policy, research, and management.

KEYWORDS. Non-timber forest products, local knowledge, sustainable use, Michigan

Recent Trends: Non-Timber Forest Product Pickers in the Pacific Northwest

Richard Hansis
Eric T. Jones
Rebecca J. McLain

The Pacific Northwest is a region where commercial demand for a variety of NTFPs--floral greens, mushrooms, berries, mosses--has expanded rapidly over the past fifteen years, creating space for new types of harvesters. These are mainly recent Southeast Asian and Latino immigrants who find this work allows them some degree of self-direction and income. Tensions have arisen between Native Americans, Euro-Americans, and recent immigrants over access rights to NTFPs as competition for these previously abundant resources has increased. Increased harvesting has also brought concerns about sustainable harvesting forward.

KEYWORDS. Immigrants, participation, conflict

Expanding Non-Timber Forest Product Harvester/Buyer Participation in Pacific Northwest Forest Policy

Rebecca J. McLain
Eric T. Jones

During the past decade, avariety of new state and federal laws and regulations have been developed to regulate the use and management of NTFPs on federal and state lands. A growing body of literature on the social aspects of NTFPs indicates that few NTFP harvesters and buyers are involved in the development of these rules. This policy overview draws upon the authors' five years of ethnographic research on the politics of NTFPs and wild mushrooms in the PacificNorthwest region of the United States to describe and analyze barriers to NTFP harvester and buyer participation in NTFP policy fora. Three case examples of efforts by participants in NTFP industries to organize themselves politically so that they can have a voice in policy and management decisions are discussed. The overview concludes with a series of recommendations for steps that non-governmental organizations and public land management agencies can take to support harvester/buyer efforts to expand their influence over forest policy and management decisions.

KEYWORDS. Participation, public involvement, wild mushrooms, forest policy, non-timber forest products

Synthesis and Future Directions for Non-Timber Forest Product Research in the United States

Rebecca J. McLain
Susan J. Alexander

During the past decade, NTFPs have begun to appear on mainstream scientific research agendas in a variety of disciplines. Development of a strong NTFP research capacity will require the construction of links between on-going and emerging NTFP research programs focused on U.S. NTFP issues, establishment of strong ties to international NTFP research programs, and the use of interdisciplinary and collaborative research approaches. Understanding forests as bio-physical systems that also include humans will enhance the effectiveness and relevance of U.S.-oriented NTFP research efforts.

KEYWORDS. NTFP research, science