

Considerable attention

has been focused recently on the harvesting, processing, and marketing of wild edible mushrooms as a means of partially offsetting job losses from timber harvesting and processing reductions in the Pacific Northwest. The wild edible mushroom industry has drawn local, regional, and even national media attention, with hundreds of news stories highlighting harvester earnings on peak days and a few violent conflicts over harvest rights.

In this paper, wild edible mushrooms—hereafter referred to as mushrooms—are defined as those edible fungal species native to the temperate forest zone of the Pacific Northwest and harvested for commercial consumption. Although more than 25 species of mushrooms are harvested in the region, only a few are harvested on a large-scale commercial basis. These

include morels (*Morchella* spp.), chanterelles (*Cantharellus cibarius*) (pictured at left), matsutake (*Armillaria ponderosa*), and boletes (*Boletus* spp.). Other harvested species include Oregon black truffle (*Picoa carthusiana*), cauliflower (*Sparassis crispa*), true truffle species (*Tuber* spp.), and spreading hedgehog (*Hydnum repandum*).

Such mushrooms are shipped around the world for home consumption and as complements to meals served in restaurants.

Mushroom businesses are located throughout the Pacific Northwest; however, the vast majority are found in western Washington and western Oregon. Since mushrooms fruit at different times of the year, depending on species and weather, mushroom buyers often extend procurement efforts long distances to acquire desired species and extend their business season. The harvest begins during the late winter/early spring in northern California and continues through the spring and early summer throughout Washington, Oregon, Idaho, Montana, and into western Canada and Alaska. Mushroom harvest is interrupted during the hot summer months and begins again in the fall in ap-

proximately reverse order.

This paper summarizes the results of a recently completed survey of mushroom processors in Washington, Oregon, and Idaho. The survey also attempted to contact all those processors whose base of operations was located outside the three-state region, but who purchased mushrooms in the region during 1992. The survey results provide the first published insights into this industry, including estimates of the volume and value of mushrooms harvested by species, major markets, contribution to the regional economy, and characteristics of harvesters and processors.

Methods

Sample frame. The industry is composed primarily of harvesters, buyers, processors, and brokers. Harvesters complete the actual gathering of mushrooms. Buyers typically work as employees of or agents for one or more processors and purchase mushrooms directly from harvesters at mobile buying stations. Processors concentrate on procuring selected species, cleaning, fresh packing or drying, and marketing. Although processors frequently market at least some portion of the mushrooms directly, many businesses use a broker to market a portion of their products. Brokers specialize in domestic and international marketing of processed mushrooms. Some also own one or more processing facilities.

The industry was surveyed at the processor level to minimize the potential for double counting, to allow for the collection of location-specific information, and to obtain preliminary insights into the harvesters working in the industry. Unfortunately no single listing of processors existed. Hence, a list of all known and potential processors was compiled from telephone directories, state departments of agriculture and commerce lists, personal contacts, and other sources.

Data collection. Dillman's total design method (Dillman 1978) was used to design and administer a mailed questionnaire and telephone followup survey. Four mailings were sent to mushroom processors. The first was mailed in early March 1993; it included a 10-page survey, an individualized cover letter, and a return envelope. A reminder postcard and two followup surveys were mailed to the nonrespondents at prescribed intervals. In May, June, and July 1993, all remaining nonrespondents were phoned to determine if



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The Wild Edible Mushroom Industry of Washington, Oregon and Idaho

A 1992 Survey

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Table 1. Estimated total volume in pounds and value paid to harvesters of wild edible mushrooms harvested from Idaho, Oregon, and Washington during 1992, by species.

Species	Scientific name	Volume (pounds)	Value in 1992 (dollars)
Oregon black truffle	<i>Picoa carthusiana</i>	5,951	\$456,013
Cauliflower	<i>Sparassis crispa</i>	7,779	22,070
Chanterelle	<i>Cantharellus</i> spp.	1,135,175	3,664,261
Coral tooth	<i>Hericium abietis</i>	1,488	5,761
Boletes	<i>Boletes</i> spp.	481,660	2,290,599
Matsutake	<i>Tricholoma magnivelare</i>	824,647	7,955,687
Morels	<i>Morchella</i> spp.	1,325,827	5,222,237
Truffle species	<i>Tuber</i> spp.	7,441	235,533
Puffballs	<i>Lycoperdon</i> and <i>Calvatia</i> spp.	2,209	3,648
Spreading hedgehog	<i>Hydnum repandum</i>	42,993	122,438
Others	N/A	100,084	288,833
Total		3,935,254	\$20,267,080

they were in the mushroom business. Co-operating telephone respondents were asked six questions from the original survey to determine their key characteristics.

Response rate. Surveys were sent to 227 known and potential processors in the first mailing. Forty-seven businesses and individuals responded that they were not in the processing business during 1992. Ten processors refused to participate in the survey, but verified that they processed mushrooms during 1992. Forty-three surveys were returned as undeliverable.

A total of 92 businesses did not confirm their status in the industry, including undeliverables. Sixty of the nonrespondents were then contacted directly by phone. Of those businesses, 16 confirmed that they processed mushrooms during 1992; 44 indicated they were not processors or, in the case of Canadian and Californian processors, did not purchase mushrooms in Washington, Oregon, or Idaho. Thirty-two processors could not be

contacted by mail or telephone. Because of the evolving nature of the industry, it was felt that a portion of these potential processors were either involved in processing during 1992 at a different location or were no longer in business when the survey was conducted.

To assess the size of the industry during 1992, an estimate of processors not contacted was needed. As stated, of the 60 nonrespondents contacted by phone 16, or 26.67%, were identified as processors. Therefore, it was assumed 26.67% of the 32 remaining nonrespondents were also processors, adding 9 additional businesses to the total population estimate.

It was estimated that there were 93 mushroom processors buying mushrooms from Washington, Oregon, and Idaho during 1992, 84 of which responded to the survey (mail and telephone combined). The overall response rate for the mail survey was 62.36%. An additional 10% of the industry was contacted during

the nonrespondents survey. No differences were identified between respondents and nonrespondents as a result of the telephone survey.

Differential expansion factors. Evaluation of the data indicated that differential response rates existed for each subregion of the survey area. Survey results also indicated that species, volumes, and prices paid between subregions were significantly different. Evaluation of survey data with significantly different regional response rates has been addressed in the analysis of other highly fragmented and regionally specialized industries (Forbes et al. 1993). Therefore, differential expansion rates were used for each subregion of the study area following the methodology outlined by Forbes et al. (1993). Resulting volume and value estimates were aggregated by state to protect confidentiality.

Respondent Profile

Respondents reported that they had been in business for an average of 9 years, with a range from 1 to 33 years. The typical business employed 5.6 individuals during 1992 to perform tasks such as cleaning, sorting, drying, packaging, shipping, and marketing. The average processor purchased mushrooms from approximately 112 harvesters.

Purchase volume ranged from 1,000 pounds to more than 500,000 pounds. The average processor purchased approximately 54,000 pounds of mushrooms. The vast majority of processors (95%) handled less than 309,000 pounds of mushrooms. Processors spent an average of \$278,000 on the purchase of mushrooms during 1992, with acquisition ex-

Table 2. Estimated volume of wild edible mushrooms, in pounds, harvested and processed by state and species.

Species	Washington		Oregon		Idaho		Out-of-region
	Harvested	Processed	Harvested	Processed	Harvested	Processed	Processed
Oregon black truffle	632	—	4,178	4,951	1,141	1,000	—
Cauliflower	2,707	3,334	3,917	3,695	1,155	500	250
Chanterelle	553,634	369,951	581,540	695,223	—	—	70,000
Coral tooth	278	311	1,210	1,177	—	—	—
Boletes	63,992	89,377	369,950	380,933	47,717	8,050	3,300
Matsutake	274,657	268,879	450,886	440,163	99,104	16,000	99,605
Morels	78,702	113,225	902,581	1,056,102	344,545	143,500	13,000
True truffles	414	383	6,013	6,483	1,014	575	—
Puffballs	1,297	496	912	1,714	—	—	—
Spreading hedgehog	5,803	3,634	36,190	38,740	1,001	500	120
Other species	3,227	2,545	96,857	97,538	—	—	—
Total	985,343	852,135	2,454,234	2,726,719	495,677	170,125	186,275

NOTE: Out-of-region refers to processors located outside of Washington, Oregon, and Idaho who purchase wild edible mushrooms within the three states.

penditures ranging from \$4,000 to more than \$3 million per business. Approximately 95% of the processors spent under \$1.4 million for product acquisition.

Approximately 69% of the respondents indicated that they also processed other products (e.g., other special forest products) during 1992. Of those businesses conducting operations other than mushroom processing, mushrooms accounted for approximately 45% of product sales.

Dates of operation. Mushroom processors are typically open for only a portion of the year. As expected, processors were the most active during spring and fall rainy periods (fig. 1). Processors were open for an average of 135 days in Washington, 240 days in Oregon, and 90 days in Idaho. During the active season processors were typically open seven days a week. Businesses that were open the entire year reported that they also processed other special forest products, such as floral greens and Christmas ornamentals.

Mushroom Species Harvested

Processors purchasing mushrooms from Washington, Oregon, and Idaho reported that they purchased approximately 3.9 million pounds during 1992. Slightly over 2 million pounds were harvested in western Washington and western Oregon. Almost 1.9 million pounds were harvested in Idaho, eastern Oregon, and eastern Washington.

On a volume basis, morels were the single most important species, with more than 1.3 million pounds harvested (table 1), followed by chanterelles (1.1 million lb), matsutakes (824,647 lb), and various boletus species (481,660 lb). Additional species harvested in lesser amounts were spreading hedgehog (42,993 lb), cauliflower mushroom (7,779 lb), true truffle species (7,441 lb), Oregon black truffle (5,951 lb), puffballs (2,209 lb), coral tooth (1,488 lb), and other species (100,084 lb).

Processors also compared the volume of mushrooms harvested during 1992 with the previous three years. Results suggest that 1992 harvests were roughly equal to those of previous three years overall; however, volumes of individual species harvested probably varied by year.

Harvest and processor locations. Overall, Oregon supplied the largest proportion of mushrooms, accounting for 62% of the total supply. Washington provided approximately 25% of the regional total, while Idaho supplied only 13%. Individual state roles varied by species (table 2).

Approximately 68% of the morel harvest was obtained from Oregon. Idaho was the second most important source of morels, accounting for 26%. Similarly, Oregon accounted for 77% of the boletes and 51% of the chanterelles harvested in 1992.

The location where mushrooms were harvested, however, often differed from the geographic location of the processor's business (table 2). This differential highlights the extent of procurement efforts by processors located in and out of the region.

Unfortunately, it was impossible to determine whether the mushrooms purchased in one state by a company headquartered in another state were processed in the originating state or in the state in which the purchasing company was based.

53% of the matsutakes harvested in the region were processed by Oregon-based companies. Washington processors handled 32% of the total, and companies located outside the region processed 12% of the matsutakes grown in the region. Oregon companies processed approximately 79% of the boletes harvested, while Washington-based companies processed 19% of the total harvest (table 2).

The relative competitiveness of processors by state was determined by comparing harvested volumes and processed volumes. Overall, Oregon companies processed 111% of the volume harvested in Oregon—100% means that the state's mushroom companies processed a volume equal to that harvested in the state, so Oregon

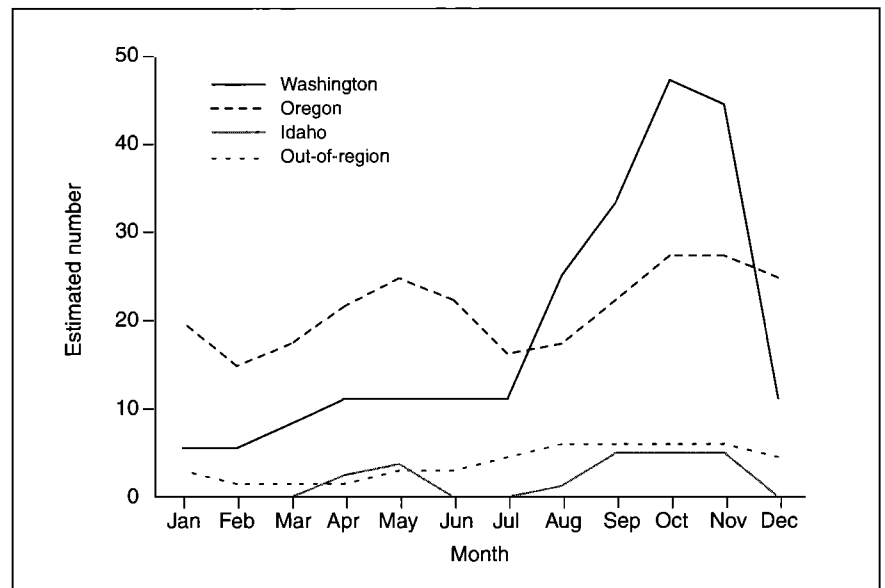


Figure 1. Estimated number of processors open for business by month and business location.

In fresh or dried sales both scenarios are possible. Fresh mushrooms can easily be cleaned and packaged for transport to the nearest airport for shipment. Similarly, some processors operate mobile dryers for the preservation of recently harvested mushrooms, shipping the dried product back to their base of operations for sale. However, purchases by out-of-state mushroom processors appear to represent at least some economic loss to the state in which the mushrooms were harvested.

Nearly 80% of all morels were processed by Oregon-based businesses. Of the 1.1 million pounds of chanterelles harvested, approximately 61% were processed by Oregon-based companies, while Washington-based companies processed most of the remainder. Similarly, approximately

companies processed 11% more mushrooms than were actually harvested there. Washington companies processed 86% of what was grown in that state. Idaho companies processed only 34% of what was grown there. While it could be argued that the harvesting and processing of mushrooms between Washington and Oregon are roughly in balance, given potential variations in the harvest of specific species from year to year, Idaho's economy clearly suffers a loss as a result of out-of-state processing.

Prices. Prices paid for mushrooms varied significantly by species across the region and throughout the season. Mushroom prices are typically higher during the early part of the spring and fall harvest seasons when availability is low. Prices decrease as availability increases. As the end of the har-

Table 3. Average annual prices paid for individual mushroom species by processors whose business was headquartered within the geographic area.

Species	Washington	Oregon	Idaho	Out-of-region ¹	Average
Oregon black truffle	—	\$77.36	\$73.00	—	\$76.16
Cauliflower	\$2.02	3.07	7.00	\$2.00	3.09
Chanterelle	2.61	2.95	—	3.97	2.95
Coral tooth	1.97	4.38	—	—	3.60
Boletes	3.45	4.53	6.25	16.64	4.53
Matsutake	10.82	6.43	18.75	7.93	8.37
Morels	2.87	3.56	6.63	10.00	4.14
True truffles	22.14	32.36	30.00	—	31.62
Puffballs	2.35	1.30	—	—	1.58
Spreading hedgehog	4.00	2.73	4.00	2.00	2.84
Other species ²	—	—	—	—	2.87

¹Out-of-region refers to processors located outside of Washington, Oregon, and Idaho who purchase wild edible mushrooms within the three states.

²Individual values not reported to protect potentially sensitive data.

vest season approaches, prices tend to increase as supply again becomes limited. Mushroom size and quality are also important factors in the price paid to harvesters. Table 3 summarizes the average prices paid to harvesters during 1992, by state.

Of all species surveyed, Oregon black truffles commanded the highest average

price at \$76.16 per pound. Among the high-volume species, matsutakes commanded the highest average price at \$8.37 per pound, followed by boletes at \$4.53, morels at \$4.14, and chanterelles at \$2.95 per pound.

Average Idaho prices were significantly higher for most species than those in Washington and Oregon. The higher prices paid for Idaho mushrooms reflects the late season nature of harvest and reduced availability. Processors also compared the prices paid to harvesters for mushrooms during 1992 against the past three years. Fifty-eight percent of the respondents indicated that 1992 prices were either a bit higher or much higher than the previous three years.

Harvester Characteristics

Given the often close relationship between processors, buyers, and harvesters, researchers felt that the processors could provide at least some preliminary insights into harvester characteristics. Processors reported that approximately 35% of the harvesters collect mushrooms as their primary

source of income during the harvest season. The remaining 65% harvest mushrooms as supplemental income during the active harvest season.

Other sources of income. Processors reported that approximately 17% of the harvesters were also employed in other segments of the special forest products industry, and 13% of harvesters were employed in logging. Approximately 10% of the harvesters were students (college and high school). The remainder were employed as homemakers or otherwise employed in the home (7%), in the commercial fishing industry (6%), and in wildfire suppression and prescribed burning (6%).

Dependence on public assistance and unemployment. Processors reported that approximately 14% of all harvesters received welfare with either full or partial benefits. An additional 13% received unemployment insurance. This suggests that more than a quarter of all harvesters rely on mushroom harvesting to supplement their incomes during periods of financial difficulty.

Ethnicity. Processors reported that nearly half of all mushroom harvesters were Caucasian. The second largest ethnic group was Asian and Pacific Islanders at 37%. Native Americans represented an estimated 9% of the harvesters, while Hispanics accounted for only 4%.

Kinship. It has been speculated that the special forest products industry generally, and the mushroom segment specifically, are characterized by multiple family members participating in the harvest of the raw materials. Processors reported that approximately 2.2 family members per family participated in the 1992 harvest.

Wild Edible Mushroom Markets

Processors marketed mushrooms in a variety of ways during 1992. While some marketed their products directly to retailers and wholesalers worldwide, others chose to use brokers to market their products. Approximately 61% of the producers surveyed indicated that they had developed their own markets for at least some of their mushroom products.

The majority of the processors indicated that they sell to international markets; however, a significant number indicated they marketed all or most of their products in the western United States. Many of these sales were to brokers, who shipped the mushrooms to destinations around the world. Hence, reported volumes may underestimate the amount

Table 4. Key final markets as a percentage of the total volume processed for morels, chanterelles, matsutake, and boletes.

Percentage	Key final markets
Morels	
42%	Western United States
15	Eastern United States
20	Asia, particularly Japan
20	Europe, particularly Germany
3	Other international markets
Chanterelles	
30%	Western United States
14	Germany and France
9	Canada
27	Other Europe
20	Other international markets
Matsutake	
70%	Japan
21	Canada ¹
9	Other
Boletes	
28%	France
12	Other Europe
27	Western United States
15	Eastern United States
12	Japan
6	Other

¹The comparatively large sales of this species to Canada may be a reflection of the large Asian community just across the border in British Columbia, and/or a number of mushroom processors/brokers located in western Canada who specialize in the processing and marketing of matsutakes. Hence, Canadian processors may have purchased matsutakes from US processors to aid in filling international orders for this highly valued species.

shipped to off-shore markets and overestimate the amount of final markets in the western United States. However, the results provide some preliminary insights into domestic and international markets.

Overall, processors indicated that they sold approximately 27% of their mushrooms to buyers in the western United States. Eastern buyers purchased 8%, while Canada purchased approximately 9% of total volume harvested in 1992. Asian markets, primarily Japan, accounted for approximately 28% of total mushroom sales. European markets, particularly Germany and France, accounted for approximately 25% of total sales. However, there was a high degree of variation among markets by species. For example, the United States was the largest market for morels, while 70% of the matsutake harvest was exported to Japan (table 4).

Value Added to the Regional Economy

Cost of employment. Processors purchased \$20.3 million of mushrooms from harvesters during 1992. The industry's total estimated employment during 1992 was 10,400 harvesters and 520 permanent employees. The cost of employment for the 520 individuals included payroll expenses (wages), state worker compensation insurance, state unemployment insurance, FICA, and federal unemployment (table 5).

Payroll expenses (wages) were estimated by multiplying the number of days

each business reported being open during 1992 by the number of employees reported for that business, assuming an eight-hour day with an estimated average wage of \$6.00 per hour. Given these assumptions, it was estimated that mushroom processors paid approximately \$4.9 million in wages to employees (table 5).

State worker compensation payments and state unemployment insurance rates were calculated by state. An average of Idaho, Oregon, and Washington rates was used as a proxy for out-of-region processors who purchased mushrooms in the region. Total estimated contribution by employers for state worker compensation insurance was \$551,000. Total estimated state unemployment insurance paid by processors in the region was \$171,000 in 1992 (table 5).

The FICA rate for all employers during 1992 was 0.0765 times gross taxable income. Federal unemployment insurance was calculated as 0.0008 times gross taxable income, up to a maximum contribution of \$7,000 per person. The total estimated FICA contribution by mushroom processors was \$372,000, and the federal unemployment contribution was approximately \$39,000 for all employers. The estimated total cost of employment including wages, worker compensation, state unemployment insurance, FICA, and federal unemployment was approximately \$1.6 million for Washington, \$4.0 million for Oregon, and \$43,000 for Idaho.

Cost of overhead. Overhead includes

buildings and maintenance, telephone, electricity, equipment, vehicles, and other capital assets required to conduct business. Schlosser et al. (1991) estimated the cost of overhead for special forest products industries during 1989 by using the cost of employment as a proxy for overhead expenses. This method has been used and documented by others (US Department of Commerce 1984) with similar industries. Given their similar asset requirements, the cedar shake industry was viewed as the best proxy for estimating overhead incurred by mushroom processors. The cedar shake industry showed an operating expenses-to-cost-of-employment ratio of approximately 2 to 1. Applying this ratio to the mushroom industry, the estimated cost of overhead was approximately \$12.0 million for the region during 1992.

Total value of the industry. A 7% fair rate of return was used as an estimate of the financial returns to mushroom processors as suggested by Schlosser et al. (1991). Based on this assumption, it was estimated that processors generated \$2.9 million in profits during 1992. Combining this information, it was estimated that the industry contributed approximately \$41.1 million to the regional economy during 1992. The Oregon economy saw the largest gain with \$25.1 million, followed by Washington with approximately \$11.9 million, and Idaho with \$1.6 million (table 5).

Accuracy of the estimates. It is impossible to evaluate the accuracy of the estimates

Table 5. Estimated contribution to the regional economy from wild edible mushrooms.¹

	Washington	Oregon	Idaho	Out-of-region	Total
Payroll expenses (wages)	\$1,272,025	\$3,271,436	\$35,100	\$290,000	\$4,868,561
State workers compensation ²	179,970	336,958	3,787	30,595	551,311
State unemployment insurance ³	57,623	104,686	878	8,265	171,451
Federal: FICA ⁴	97,310	250,265	2,685	22,185	372,445
Federal: unemployment ⁵	10,176	26,171	281	2,320	38,948
Subtotal: cost of employment	\$1,617,104	\$3,989,517	\$42,731	\$353,365	\$6,002,717
Cost of mushrooms	6,251,747	11,365,014	1,397,188	1,253,130	20,267,079
Subtotal: product and processing	\$7,868,851	\$15,354,531	\$1,439,918	\$1,606,495	\$26,269,796
Cost of overhead ⁶	3,234,208	7,979,034	85,461	706,730	12,005,433
Subtotal: all expenses	\$11,103,059	\$23,333,565	\$1,525,380	\$2,313,225	\$38,275,229
Fair rate of return @ 7.5%	832,729	1,750,017	114,403	173,492	2,870,642
Total value of industry	\$11,935,789	\$25,083,582	\$1,639,783	\$2,486,717	\$41,145,871

¹ Totals do not necessarily add due to rounding.

² State workers compensation was calculated as follows: Washington—0.8469 times hours worked; Oregon—0.1030 times taxable gross income; Idaho—0.1079 times gross taxable income plus \$140 filing fee per business; other states—average of Washington, Oregon, and Idaho rates.

³ State unemployment insurance was calculated as follows: Washington—0.0453 times gross taxable income; Oregon—0.0320 times gross taxable income; Idaho—0.0250 times gross taxable income; other states—average of

Washington, Oregon, and Idaho rates.

⁴ FICA was calculated as follows: 0.0765 times gross taxable income for all states.

⁵ Federal unemployment insurance was calculated as follows: 0.0008 times gross taxable income, up to \$7,000 per person.

⁶ Cost of overhead was estimated as follows: twice the total cost of employment.

developed in this study for a number of reasons. Many of the assumptions used are easily debated or challenged. However, the methodology used is well established and generally accepted within the literature. We have also strived to err on the conservative side when possible. Finally, after the project was completed we informally asked a number of key industry leaders whether the data were reasonable. Almost all individuals contacted felt the data are representative of the wild edible mushroom industry.

Implications

Given the attention being focused on this industry as a result of timber harvest policy changes on the region's federal lands, it is tempting to speculate about the potential for mushroom industry expansion. There appears to be little doubt that the industry will continue to be an important contributor to the regional economy. However, resource managers should recognize that the harvest of mushrooms is not a "silver bullet" for the rural communities of Washington, Oregon, and Idaho that

are reeling from timber harvest reductions and an associated loss of jobs.

The estimated \$41.1 million contribution to the region represents less than one-third of the estimated contribution of the floral greens and Christmas ornamental industry during 1989 (\$128.5 million). In addition, the industry pales in comparison to the economic contribution of the solid wood products sector, even after the downsizing resulting from the spotted owl/ancient forest controversy and other environmental conflicts. Further, the vast majority of jobs provided by this segment of the special forest products industry are part-time, or are full-time for only a few months of the year with no benefits.

However, the industry does provide a regular source of supplemental income for those living in rural areas and aids in diversifying the rural economy of the region. In addition, the harvest of mushrooms can be combined with other seasonal occupations to increase the total number of months of employment for individuals who would probably otherwise be unemployed. While it is a comparatively small component of the regional economy, the industry does provide critically important jobs in economically depressed areas and represents a viable economic development option for communities experiencing difficulties as a result of environmental constraints. Hence, we believe practicing professionals should give the industry active consideration as a tool in aiding rural communities. **JOF**

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