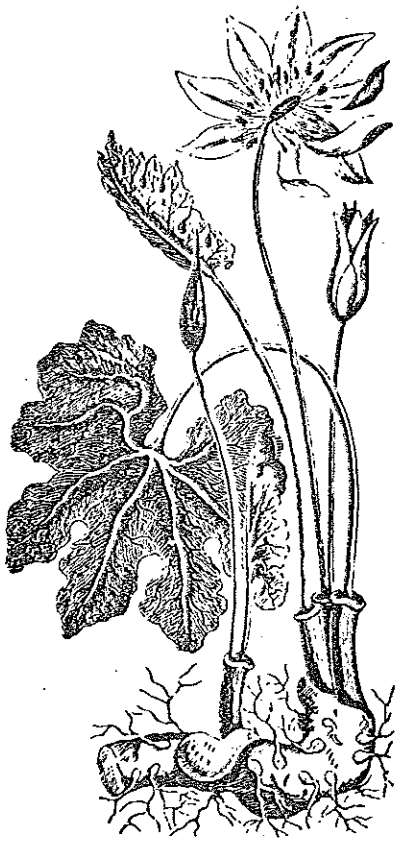
Medicine from the Wild

An Overview of the U.S. Native Medicinal Plant Trade and Its Conservation Implications

Douglas O. Fuller



WWF

Medicine from the Wild

An Overview of the U.S. Native Medicinal Plant Trade and Its Conservation Implications

Douglas O. Fuller

WWF

World Wildlife Fund
Washington, DC

TRAFFIC USA

Medicine from the Wild: An Overview of the U.S. Native Medicinal Plant Trade and Its Conservation Implications

Cover illustration of bloodroot (*Sanguinaria canadensis*) from *The Plant Kingdom Compendium*, edited by Jim Harter (New York: Bonanza Books, 1988).
Printed by Copy Press, Washington, D.C.

Book orders should be directed to WWF Publications, P.O. Box 4866,
Hampden Post Office, Baltimore, Maryland 21211. Telephone: (301) 338-6951.
After November 1, 1991, call (410) 516-6951.

Printed on recycled paper.

Medicine from the Wild

World Wildlife Fund (WWF) is the largest private U.S. organization working worldwide to conserve nature. WWF works to preserve the diversity and abundance of life on Earth and the health of ecological systems by protecting natural areas and wildlife populations, promoting sustainable use of natural resources, and promoting more efficient resource and energy use and the maximum reduction of pollution. WWF is affiliated with the international WWF network, which has national organizations, associates, or representatives in nearly 40 countries. In the United States, WWF has more than one million members. TRAFFIC USA is the wildlife trade monitoring program of WWF-US.

CONTENTS

PREFACE

This report presents the results and conclusions of a study of the state of the U.S. herb trade. The need for this study was recognized several years ago, when scientists at TRAFFIC USA, the wildlife trade monitoring program of World Wildlife Fund, and the Natural Resources Defense Council were alerted to substantial quantities of wild native herbs in trade. At the same time, herbalists around the country were growing increasingly concerned about potential impacts of heightened commercial demand on wild populations of native herbs.

The overall extent of both domestic and international trade in these wild genetic resources is difficult to determine. Herbs enter the market in a multitude of forms and products. Virtually every American home contains some herbs or herbal derivatives. Such common household items as toothpaste, soaps, lotions, and teas may contain substantial quantities of herb parts and derivatives. Because of the popularity and ubiquity of herbal products, it was necessary to confine the scope of this study to *trade in indigenous medicinal herbs,* and thus this report does not cover trade in herbs without immediate health benefits (e.g., culinary, potpourri). For reasons discussed below, the phrase "immediate health benefit" does not adequately define a unique sector of the herb market and so some readers may find this a somewhat artificial distinction.

Those readers knowledgeable about American herbalism may not find a great deal of new material in this report. Nor does the report provide much detail on the pharmacology or ethnobotany of native herbs. Readers interested in these topics should consult Duke (1985, 1986), Lewis and Lewis (1977), and Foster and Duke (1990), in addition to many other books on American herbs and herbalism. Instead, the report is intended to be a synthesis of the current literature, opinions, and personal observations collected over the course of the past year on the U.S. herb trade. The study therefore incorporates the views of many individuals, some with widely divergent perspectives on the subject. Despite the diversity of viewpoints, the reader will find a consensus on the subject of herb conservation.

In preparing this report, it is difficult to acknowledge the many individuals who provided information and guidance. Special thanks are due to Faith Campbell, Ginette Hemley, Nina Marshall, and Lili Sheeline, all of whom helped to launch the project. Joy Bannerman, Steven Foster, and Krista Thie provided invaluable information and insight into the American herbal movement and the species at risk from the herb trade. Many other individuals provided information in the form of letters, data, or personal advice and perspective. Their names are acknowledged throughout the body of the report and in the appendix.

Douglas O. Fuller
Department of Geography
University of Maryland
College Park, Maryland

CHAPTER ONE

INTRODUCTION

The Paradox of Modern Herbalism

Herbalism is an ancient practice that developed long before the rise of human civilization. It entails the use of whole plants, plant parts, and derivatives to better the human condition. Botanically speaking, the term "herb" refers to herbaceous plants lacking a woody stem; however, herbalists refer to all useful plants, vascular or otherwise, as "herbs" or "botanicals."

The exploitation of herbs for their curative powers undoubtedly originated in the context of hunter-gatherer societies where wild plants formed the basis of human diet. In preindustrial civilizations, herbs were the principal source of medicine and were often imbued with magical or supernatural properties. As part of this belief, practitioners of herbal medicine were often among the most powerful and revered individuals in premodern societies (Stuart 1982).

With the advent of the Industrial Revolution and the widespread manufacture of synthetic organic chemicals, herbal traditions began to fade in the United States, although they persisted in other industrialized countries. Despite increased reliance on purified synthetic pharmaceuticals, about half the the world's pharmaceutical compounds are still derived from plants (Oldfield 1984). According to the World Health Organization, more than 4 billion people rely on herbal medicine to some extent (Foster 1990). In industrialized countries represented by the Organization for Economic Cooperation and Development (OECD) the retail market for plant-based medicines in 1985 was valued at US$43 billion. When other economic benefits are taken into account, the value may reach into the trillions of dollars worldwide (McNeely 1988). The potential economic loss due to plant extinctions in the United States alone by the year 2000 is estimated at US$3.2 billion (Farnsworth and Soejarto 1985). In economic terms, diminished species diversity represents a substantial future loss.

While modern medicine still depends on the biosynthetic powers of plants to produce starting material for artificial synthesis, there has been a growing awareness of the risks of using synthetic compounds. With increased wariness of synthetic compounds, many consumers have

sought more holistic, gentler medicinces derived from truly natural sources. This movement, which herbalists refer to as "the herbal renaissance," has grown in tandem with the growing concern about environmental degradation and the loss of physical and spiritual contact with the natural environment (Conrow and Hecksel 1983; Holmes 1989; Israelsen 1990). Among some herbalists, for example, there is a profound distrust of modern reductionist medicine and its scientific underpinnings. A recent article in an herbal magazine articulates this perspective:

> As holistic practitioners our understanding of and approach to health care is radically different from that of our allopathic cousins. An M.D. is not concerned with the health of an individual, but rather with "disease." These practitioners view the body as a machine and a "disease" as a type of mechanical malfunction . . . As holistic practitioners we herbalists simply do not work this way (Vertolli 1989).

Instead, herbalists tend to administer herbal treatments as part of a comprehensive approach to preventive medicine. In the view of most herbalists, there is little difference between regular intake of mild herbal remedies and the daily consumption of healthful food—both prevent sickness by strengthening the immune response.

Herbal remedies differ from the highly purified pharmaceutical compounds in that they contain a complex variety of active and inert ingredients (Scarborough 1991). By using herbs in their raw or semiprocessed form, herbal practitioners help to ensure that ancillary compounds, which are believed to enhance synergistic action, remain intact. Some herbalists even claim that the use of whole plants somehow captures a "vital" force, which is necessary to ensure full efficacy (Clavio 1990).

While a certain amount of purification is tolerated, a major factor that distinguishes herbalists from other health care professionals is their belief that natural is somehow better. The trend toward so-called natural products is nothing new in American marketing strategies, but in their use of herbal remedies, herbal practitioners can rightly claim a direct link with the natural world. But as any student of botany knows, natural does not necessarily mean nontoxic. As Mark Blumenthal, executive director of the American Botanical Council, points out:

> One myth that often accompanies popular herbal literature is that if something is natural, then it is necessarily beneficial. As many of our readers already know, this idea is not only untrue, but potentially dangerous (Blumenthal 1989).

Along with the belief that natural is better, herbalists tend to believe that wild-harvested plants are somehow superior to cultivated or artificially propagated ones (Foster pers. comm.; Conrow and Hecksel 1983). Consumer preference for wild collected herbs extends well beyond the confines of the U.S. market, with perhaps the most dramatic example being the willingness of Asian consumers to pay three times as much for wild American ginseng (*Panax quinquefolius*) than for cultivated varieties (Fuller 1986).

Herbalists are relatively unabashed about their fondness for wild-grown plants, as one prominent herbalist explains:

> I like to use both domestic and wild herbs in [my] products. Certainly the cultivated herbs are very strong and they serve the same purposes as the wild ones, but I think you sometimes develop a greater affinity for the herbs which grow around you. They're growing out of the same soil you walk on and they're breathing the same air. It's a kind of "macrobiotic" idea of herbology (Conrow and Hecksel 1983).

The "wild is better" ethic extends to the

retail markets, where explicit labeling informs consumers as to the geographic origins of wild-collected plant parts and derivatives. The potential consequences of this type of marketing strategy have not been lost on herbalists themselves, especially those who routinely collect wild plants for the herb trade. The practice of collecting plants from the wild, known as "wildcrafting" in the herbal community, is coming under greater scrutiny as plant populations continue to diminish (Thie 1989). For example, the International Herb Growers and Marketers Association (IHGMA), probably the largest membership organization dedicated to the herb business, has adopted a resolution encouraging its members to halt the sale of ladyslipper orchids (*Cypripedium* spp.) (Foster 1990a). Herb companies, too, are cautioning the public about unethical collecting practices. For example, Nature's Way, the largest herb company in the United States, touts its commitment to conservation in its glossy catalog:

> We seek to grow and collect our herbs without any negative impact to water supply, environment or to plant diversity. If an herb is endangered or threatened in its natural state, we will seek to cultivate the herb by certified organic methods. If a threatened herb cannot be cultivated and propagated outside of its natural habitat, we will discontinue its use altogether in order to assure the survival of the plant species.

Although this policy is among the most enlightened of all herb companies, it is certainly not shared by all herb traders. Within the herb trade there is an apparent contradiction between the need to turn a profit from wild plant populations and maintain sufficient commitment to conservation to guarantee future supply. Conservation-minded herbalists are caught in the seemingly contradictory position of promoting the use of wild plants and advocating their simultaneous protection. But when commercial demand, created by herbal advocacy or otherwise, begins to overwhelm meager protective measures, then it is expected that herb populations will dwindle and ecosystems may be permanently altered. It is the purpose of this report to explore these problems and discuss possible solutions.

THE EXPANDING DOMESTIC AND INTERNATIONAL HERB MARKETS

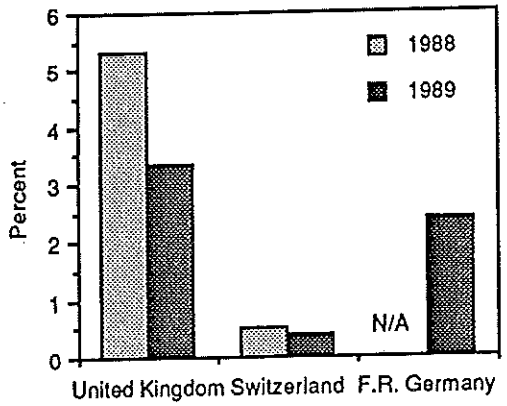
THE INTERNATIONAL MARKET

A logical place to begin an assessment of the world market in U.S. herbs is to examine international trade data for any trends in volume. With the exception of a handful of species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), few international trade statistics differentiate among herb taxa. However, a number of OECD countries have recently established a customs category of "Plants and parts [including seeds & fruit] of trees, etc. for perfumery, pharmacy, insecticidal, or fungicidal purposes." Although this category aggregates herbs of several different types, it should provide a reasonable estimate of the general demand in cultivated and wild-collected U.S. herbs. Figure 1 summarizes the relative demand of U.S. herb exports in three western European nations. The United Kingdom imports the highest relative percentage, followed by F.R. Germany and Switzerland. It is notable that U.S. herbs make up a small percentage of overall imports to these consumer nations, with developing nations such as India and Brazil providing the largest relative quantities. Figure 2 shows the absolute quantity of U.S. herbs imported into the United Kingdom from 1982 to 1990 (no data were available for 1987 or 1989). This seven-year time series shows a variable, though positive demand trend.

The western European herb market is among the most advanced, with herbs making up a significant source of over-the-counter remedies[1] (Der Marderosian 1990; Foster pers. comm.; Mars 1989). As some herbalists point out, western European consumers are much more atuned to the potential benefits of medicinal herbs than are U.S. consumers. The growth of the western European herb market is evidenced by the doubling of medicinal plant consumption there over the past decade. The seriousness with which some European nations view herbal medicine is reflected in the formation of the European Scientific Cooperative for

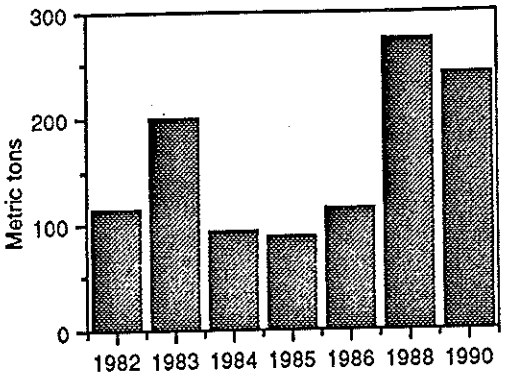
1. This is also true of Oriental markets, which have extensive pharmacopeias. However, the only indigenous U.S. species marketed there in significant quantities is ginseng (Foster pers. comm.).

Figure 1. Percent of Total Herbal Imports Originating from the United States, 1988-89



Source: International trade statistics.

Figure 2. U.K. Imports of Herbs from the United States, 1982–90.



Source: International trade statistics.

Phytotherapy (ESCOP) under the auspices of the European Community (EC). One of ESCOP's main goals is the publication of 200 species' monographs that will detail the pharmacology and preparation of medicinal plants in order to standardize official drug regulation policy throughout the EC. ESCOP also recommends that all herbal medicines should be classified as conventional medicinal products and that users of such medicines should be reimbursed by health care systems for the cost of herbal remedies (Blumenthal 1991; Der Marderosian 1990).

Pharmaceutical companies in Europe have capitalized on the trend toward increased herbal consumption by integrating cultivation, processing, and packaging and many companies have stepped up cultivation of U.S. natives to facilitate local processing and consumption. A taxon such as the common purple coneflower (*Echinacea purpurea*) is cultivated in mass quantities (Foster 1990a). This strategy of combining processing and marketing appears to benefit European pharmaceutical and natural products companies by eliminating the supply problems that occasionally arise in international trade (Landes 1989).

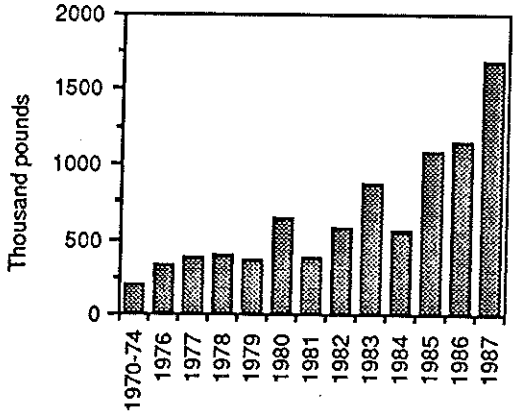
GINSENG: A MODEL OF U.S. HERB PRODUCTION?

The principal source of species-level trade data in medicinal herbs is CITES Annual Reports, produced by most parties to the convention. The only significant, indigenous U.S. species that is both in trade and protected by CITES is American ginseng, which has been designated as Appendix II. An Appendix II listing requires party nations to issue export permits if trade is not determined to be harmful to wild populations. In practice, few exporters are denied permits on these grounds.[2] As mentioned above, there is a strong demand for ginseng in Oriental and European markets, and it could be argued that it is a bellwether of international demand in herbal medicines. Whether or not ginseng is truly representative of international demand in other herbs, it is the sole species of native medicinal plant consistently tracked in U.S. CITES Annual Reports and is the source of considerable attention in this country.

Figure 3 provides a 17-year record of ginseng exports from the United States. It was compiled from U.S. Department of Agriculture data (USDA 1981) collected from 1970 to 1980

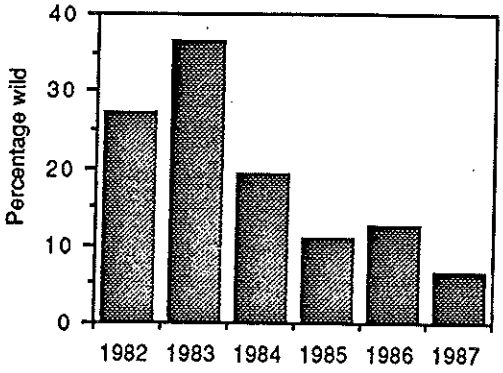
2. For more information on CITES and its regulations, see Wijnstekers (1990).

Figure 3. U.S. Exports of Ginseng, 1970-87



Source: U.S. CITES Annual Reports; U.S. Department of Agriculture, 1981.

Figure 4. Percent of Total Ginseng Exports Reported as Wild in CITES Annual Reports



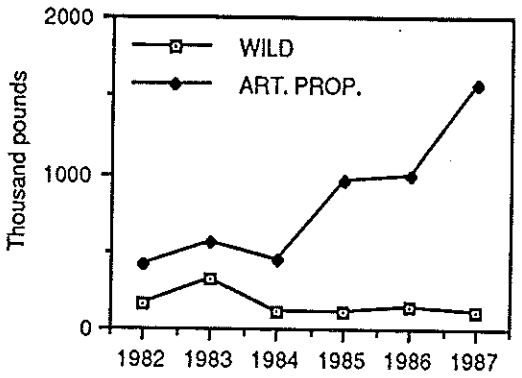
Source: US CITES Annual Reports.

and from U.S. CITES Annual Reports published from 1981 to 1987 (USDI 1981-87). Although it comprises two different data sources, figure 3 illustrates the relatively constant and significant increase in ginseng demand through time. A concommitant increase in supply has been necessary to meet this growing demand, although this increase has not come at the expense of wild populations. Instead, U.S. ginseng farmers have stepped up production of cultivated varieties to provide a more secure supply for the Oriental markets. Figures 4 and 5 show the relative growth in artificially propagated ginseng and the near constant export volume of wild-collected ginseng, respectively.

Much of the increased output in cultivated ginseng has been realized within Marathon County, Wisconsin, where the harvest has grown steadily over the past few years (despite occasional setbacks from fungal infestations). Figure 6 presents Wisconsin harvest data from 1982 to 1987. Despite the small dip in production in 1987, the harvest has continued to grow at a remarkable pace. More than 90 percent of the Wisconsin ginseng is currently shipped directly to the Orient. Its growing success as a commercial crop has begun to attract direct foreign investment from importers in the Far East (Giese pers. comm.).

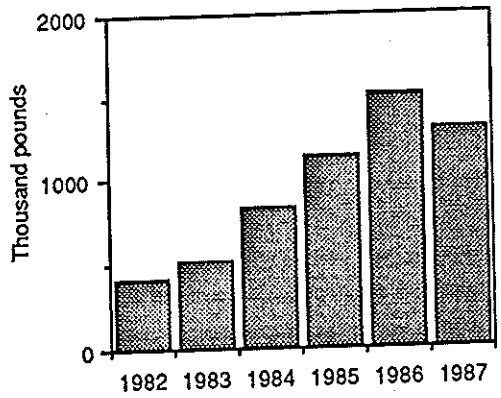
In addition to Wisconsin's production, other areas are being investigated as potential sites of commercial ginseng farming (TGMP 1989). According to a recent article on the subject ("New York Ginseng" 1989), a Hong Kong business group is investing US$500,000 in an experimental 16-acre ginseng farm in New York state. Given the expense of establishing cultivated ginseng (about US$30,000 per acre) and the potential loss from fungal diseases, such a venture is not without substantial risk. Nonetheless, the potential payoff of about US$200 per pound several years after inital establishment makes this an attractive investment ("New York Ginseng" 1989).

Figure 5. Wild vs. Artificially Propagated Ginseng Exports



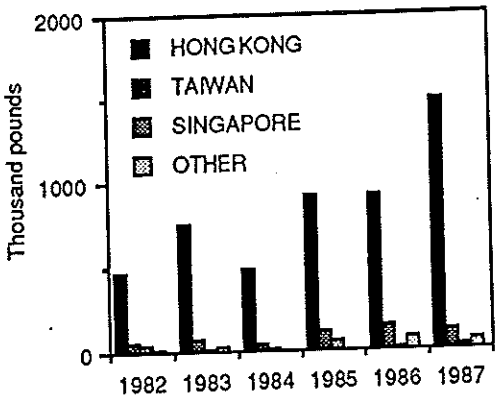
Source: U.S. CITES Annual Reports

Figure 6. Annual Ginseng Harvest in Wisconsin, 1982-87



Source: P. Orton, Pers. Comm.

Figure 7. Quantity of Ginseng Exported by Country of Destination



Source: U.S. CITES Annual Reports

According to CITES Annual Reports, the major import markets of both cultivated and wild-collected U.S. ginseng have remained relatively constant from 1982 to 1987 (figure 7). Of the three top importing countries identified in U.S. CITES data, Hong Kong has maintained a steady lead in ginseng imports. As in other wildlife trade, Hong Kong is generally regarded as an intermediary; that is, where substantial quantities of ginseng roots are processed and distributed to the rest of the Orient (Fitzgerald 1989; Fuller 1986).

SOURCES OF DOMESTIC SUPPLY

As ginseng farmers continue to expand production, it is apparent that their success story has not been duplicated by other herb traders. To a large extent indigenous herbs are still being removed from natural ecosystems to provide the raw material necessary to supply the growing U.S. herb market (Conrow and Hecksel 1983; Israelsen 1990; Thie 1989). According to Steven Foster, a noted expert on American herbs, some 600 medicinal herb species are commonly traded in the U.S. market. The principal retail outlets for these commodities are the 7,000 or so health food stores presently operating in the U.S. (Foster 1990a). In addition to the ubiquitous health food establishments, there are a surprising number of outlets dedicated solely to dispensing medicinal herbs (e.g. Moos 1987). At present the U.S. herb industry is thought to be growing at a rate of ten percent per annum (Foster 1990a).[3]

Within this US$150 million per year domestic market, some 75 percent of herbs originate from foreign sources. The remaining 25 percent originate largely from the eastern deciduous forest biome of the United States, where they are harvested in mass (tonnage) quantities in the wild (Foster 1990a; Israelsen 1990). A simple way to determine the species in trade is to examine herb catalogs, price lists, etc., that advertise herbs by their origin and common name. Foster (1990a) has compiled a list of native species harvested from the wild in mass quantities. Foster's list includes some 56 species that are sold in tonnage; however, after a review of some 50 herb catalogs and price lists, it was decided that an expanded list was warranted for this report (figure 8).[4] Figure 8 includes species traded in significant volumes as well as those that are already rare or sparsely distributed (such as ladyslipper orchids (Luer 1975)).

3. Foster (pers. comm.) considers these figures to be highly conservative estimates.

4. A similar list of 130 botanical species was compiled in a thesis on the economic plants of southern Appalachia (Bailey 1985).

Figure 8. Native North American Medicinal Herbs in Commercial Demand, Primarily Wild-harvested

Scientific Name	Common Name	Part Used
Acorus calamus	calamus	rhizome
Adiantum pedatum	maidenhair fern	leaf
Agastache foeniculum	anise hyssop	leaf
Aletris farinosa	colic root	root
Aralia nudicaulis	sarasparilla	root
A. racemosa	spikenard	root
Arctostaphylos uva-ursi	uva ursi	leaf
Aristolochia serpentaria	Virginia snakeroot	root
Asarum canadense	Canada snakeroot	root
Asclepias tuberosa	pleurisy root	root
Caulophyllum thalictroides	blue cohosh	root
Ceanothus americanus	New Jersey tea	root
Chimaphila umbellata	pipsissewa	leaf
Chionanthus virginica	fringetree	bark
Cimicifuga racemosa	black cohosh	root
Collinsonia canadensis	stoneroot	root, leaf
Crataegus oxyacantha	hawthorn	berries
Cypripedium acaule	pink ladyslipper	root
C. calceolus	yellow ladyslipper	root
Dioscorea villosa	wild yam	fruit, root
Echinacea angustifolia	purple coneflower	root, whole
E. pallida	purple coneflower	root, whole
E. purpurea	purple coneflower	root, whole
Equisetum hyemale	shavegrass	whole
Eupatorium perfoliatum	boneset	flowers
E. purpureum	joe-pye weed	leaf, root
Gaultheria procumbens	wintergreen	leaf
Geranium maculatum	wild cranesbill	root
Hamamelis virginiana	witch hazel	bark
Hedeoma pulegioides	pennyroyal	fruit
Hydrangea arborescens	hydrangea	root, leaf
Hydrastis canadensis	goldenseal	root, whole
Juglans cinerea	butternut	root, bark
Juglans nigra	black walnut	fruit
Juniperus communis	common juniper	fruit
J. virginiana	red cedar	fruit
Larrea tridentata	chapparal	leaf
Lactuca spp.	wild lettuce	fruit
Lobelia inflata	lobelia	flowers
Ligusticum porteri	osha root	root
Mahonia aquafolium	Oregon grape	root
Mitchella repens	partridge berry	leaf
Myrica cerifera	wax myrtle	leaf
M. gale	sweet gale	fruit
M. pensylvanica	bayberry	leaf
Panax quinquefolius	ginseng	root
Parthenium integrifolium	wild quinine	root
Passiflora incarnata	passionflower	fruit, flower

(Figure 8 continued on next page)

Figure 8 (cont.)

Scientific Name	Common Nam	Part Used
Pinus strobus	white pine	bark
Podophyllum peltatum	mayapple	rhizome
Polygonatum biflorum	Solomon's seal	root
Populus balsamifera	quaking aspen	leaf buds
Prunus serotina	black cherry	bark
Quercus alba	white oak	bark
Rhamnus purshiana	cascara sagrada	bark
Rhus glabra	sumac	berries
Salix spp.	willow	bark
Sambucus canadensis	elderberry	flowers
Sanguinaria canadensis	bloodroot	root
Sassafras albidum	sassafras	root, bark
Scutellaria lateriflora	scullcap	leaf
Serenoa repens	saw palmetto	berries
Spigelia marilandica	pink root	root
Taxus brevifolia	Pacific yew	bark
Teucrium canadense	germander	whole
Trilisa odoratissima	deer's tongue	leaf
Trillium spp.	trillium	root
Ulmus rubra	slippery elm	bark
Veronicastrum virginicum	culver's root	root
Zanthoxylum americanum	prickly ash	bark, berries
Z. clava-herculis	prickly ash	bark, berries

Sources: Foster 1990a; Foster and Duke 1990; Stuart 1982; Gleason and Cronquist 1963; USDI 1985; additional species from catalog survey and personal communications. In some species many parts are used, but only the main parts are listed above.

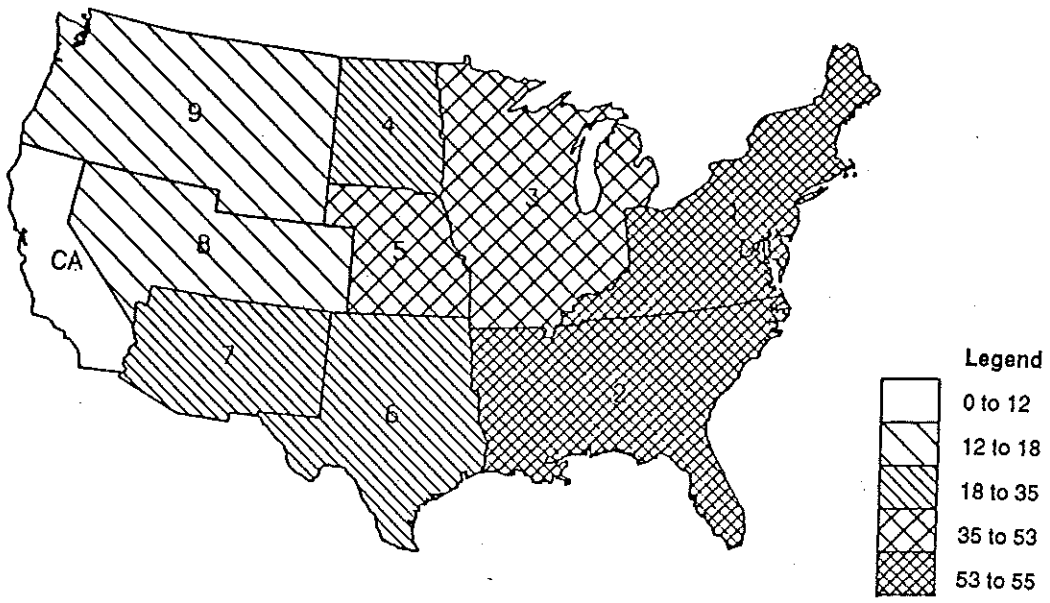
A draft version of figure 8 was circulated to botanists in state natural heritage programs for their input and to herbalists at a number of businesses throughout the country. Several respondents suggested additions to the list, though none suggested any deletions. Of the 70 plus species listed in figure 8, *Panax quinquefolius* and *Cypripedium* spp. are the only ones receiving international protection under CITES as Appendix II species.

THE GEOGRAPHY OF WILDCRAFTING

Readers knowledgeable on the phytogeography of North America will recognize that figure 8 includes a number of extremely widespread taxa. A glance at published range maps of the native woody species (Elias 1980; Little 1971-81) shows the extensive ranges of such species as *Ulmus rubra*, *Juglans nigra*, *Hamamelis virginiana*, all of which span the eastern portion of the country. Their ranges are typical of a number of species in figure 8.

Herb species may therefore originate from many different source regions; however, it is generally assumed that wildcrafting is most prevalent in three main areas of the country: the southern Appalachian Mountains, the Ozark Mountains, and the Pacific Northwest (Campbell pers. comm.; Foster pers. comm.; Lockard 1990). As a way to confirm this supposition, botanists in a number of states were contacted and the taxa in figure 8 were mapped using the same floristic regions developed by Shetler and Skog (1978) in their checklist of North Ameri-

Figure 9. Number of Medicinal Plant Species per Region



can species. Information obtained from written correspondence (see appendix) confirmed that wildcrafting is prevalent in these areas, and specifically that intense collecting occurs in the southern Appalachian region.

Figure 9 shows the number of commercially traded plant species per region—with some modification of the regional boundaries to accommodate the mapping software. While this is not a precise depiction of the ranges of these taxa, figure 8 amply demonstrates the regional variation in phytogeography of commercially valuable herbs. It is also worth noting the prevalence of the eastern United States as a potential source region of wild-collected herbs. It should not be inferred from figure 8, however, that plants of medicinal value occur in lesser density elsewhere. The economic botany of the west, for example, is well documented (Moore 1979; Gunther 1973) and collecting there can be locally heavy (Kruckeberg pers. comm.; Thie 1989). Likewise, California appears to contain a dearth of commercial botanicals, but holds tremendous botanical diversity overall (Davis et al. 1986).

The relationship between presence and intensity of wildcrafting apparently does not hold with respect to New England and much of the northeast (region 1). According to sources contacted in region 1, wild harvesting of indigenous herbs is more for horticultural than medicinal purposes (Brumback pers. comm.; Sorrie pers.comm.). The reasons for the lack of medicinal plant harvesting there appear to be cultural, although there may be biological reasons behind the distribution of wildcrafting in the eastern half of the country.

Geographic variation in concentration of active compounds may play a role in whether wild harvesting is significant. For example, Bennett et al. (1990) examined geographic variation in alkaloid content in bloodroot (*Sanguinaria canadensis*), which contains the active compound sanguinarine. (Traditional uses of bloodroot are as an expectorant, stimulant, and emetic [Lewis and Lewis 1977], although presently it is used as a dentifrice, marketed under the trade name Viadent.) Bennett et al. found that sanguinarine content increases with decreasing latitude, with highest concentrations found in

southern Appalachian populations. The authors theorize that increasing pest, predator, or disease pressure exists along a north-south gradient, which in turn favors selection of plants with higher alkaloid content. If this is the case, then it may be reasonable to assume that other species in figure 8 show similar intraspecific variation in secondary metabolite concentration along the same or other clines. Considerably more research is needed to ascertain whether the results of Bennett et al. can be generalized to taxa other than *S. canadensis*. That other herbs in the southern Appalachians may be more potent and thus more attractive from a commercial standpoint is certainly an intriguing hypothesis.

CHAPTER THREE

CONSERVATION IMPLICATIONS

INDICATORS OF RARITY

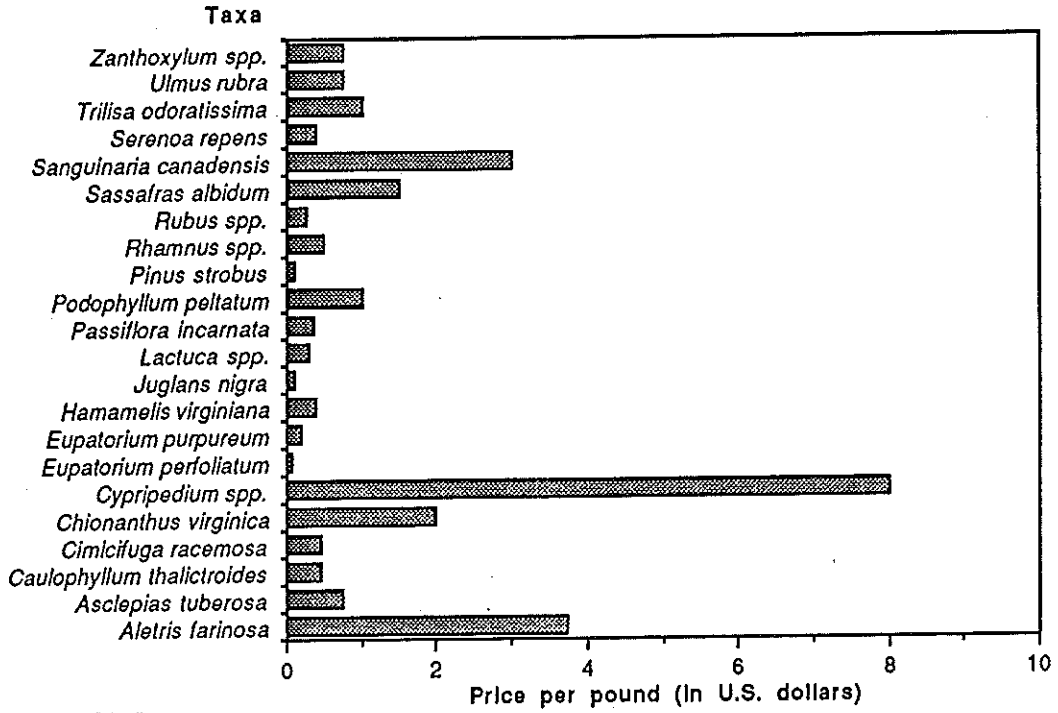
Rarity in plants is difficult to determine. Should a species be considered rare simply because it failed to turn up in a field survey? What if repeated survey efforts failed to sample within appropriate habitats? If a species is found to be rare within a certain area, does this mean that it is rare throughout its entire range? Such questions plague ecologists and conservationists weighing the status of a potentially threatened or endangered taxon.

Each species in a given community is an individualist, with unique responses to an array of conditions in its environment. Each species must therefore be assessed separately to determine how it is faring within a given area under different environmental "stresses." Harvesting for the herbal trade is just one of many potential perturbations, which may or may not adversely affect the long-term status of a particular species. It is therefore difficult to single out wildcrafting as the most important factor in a plant's population dynamics when so many other factors are operating simultaneously. Indeed, natural factors such as predation, competition, climatic change, etc., may be the actual driving forces behind population fluctuations, and harvesting may have no appreciable effect in and of itself.

Of the species presented in figure 8, many are extremely common in the wild. Because of the perceived abundance of these species, no systematic effort has been made to survey their populations over large areas. Thus there is very little published information on how these plants are responding to heightened levels of commercial demand (Foster 1991). One potential source of information on scarcity that is often overlooked in studies of this nature is price. In economic theory, "the invisible hand" of the free market assigns value to commodities as a function of their scarcity. It follows that prices might serve as an indicator of rarity until adequate field studies can be completed. It should also be possible to assess the reliability of price as an indicator of rarity through the use of statistical inference once reliable information becomes available on status in the wild.

To minimize for differences in local

Figure 10. 1989 Wildcraft Prices for Various Herb Taxa in the Southern Appalachians



Source: Price lists

retail markets pre-wholesale prices were analyzed to discern relative price differences among species. In addition to wholesale prices, information was obtained on the prices paid to wildcrafters by wholesale distributors ("wildcraft prices") within the Southern Appalachian and Ozark regions. Figures 10 and 11 present the wildcraft prices for various herb taxa in the southern Appalachians and Ozarks, respectively.

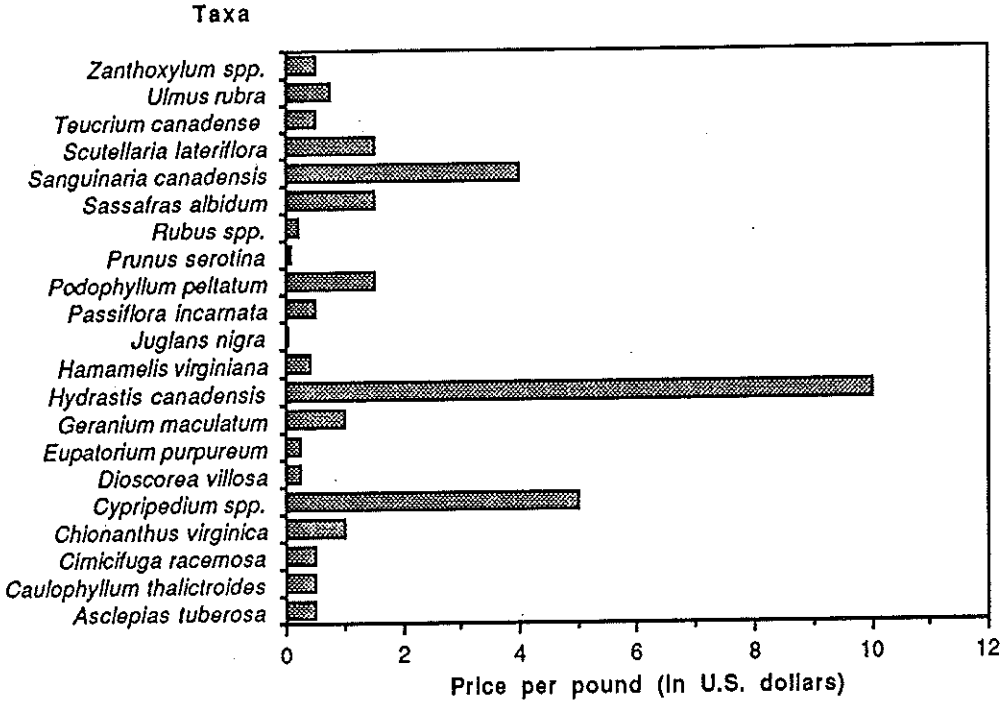
From these figures it becomes apparent that some taxa command much higher prices than others. These are *Aletris farinosa, Cypripedium* spp., *Hydrastis canadensis, Sanguinaria canadensis,* and possibly *Chionanthus virginica* and *Sassafras albidum.* It is interesting to note that in the southern Appalachian region *Cypripedium* spp. command a higher price than *H. canadensis,* whereas the opposite is true in the Ozarks.[5] Both taxa are known to have declined in number due to overcollection for the medicinal trade (Foster and Duke 1990). Conversely, common species such as *Pinus strobus, Hamamelis virginiana, Eupatorium perfoliatum, Asclepias tuberosa, Juglans nigra, Rhamnus* spp., among others, tend to have significantly lower prices. So it appears that wildcraft prices might be a reasonable indicator of scarcity (at least in the herb market, if not the wild).

Until rigorous surveys are completed, wildcraft prices will probably remain the best available indicator of scarcity because these reflect the effort of wildcrafters to obtain a particular herb species. It stands to reason that the less predictable the supply is in the wild, the more effort must be expended to obtain a saleable quantity. Supply problems, of course, could result from a variety of factors, such as climatic fluctuations, poorly developed market links, and overexploitation for the herb trade.

In the view of some wholesale distributors (Lockard 1990), the market for wild-dug

5. When compared to the $150 per pound that wildcrafters receive for ginseng, however, these prices still appear modest (Churchill pers. comm.).

Figure 11. 1989 Wildcraft Prices for Various Herb Taxa in the Ozark Region



Source: Price lists.

herbs is self-correcting and serves to limit overexploitation of certain species. As Lockard asserts:

> Very seldom will a product be in heavy demand for 3 years in a row. Once you produce large quantites for 1 or 2 years it fills up the market chain. The following year it will not be in demand. Most products seem to run a 3 year cycle. It is not necessary nor desirable to harvest heavy [*sic*] every year and this allows regrowth of the plant in the wild.

In the face of constantly increasing demand, however, it is not clear why three-year demand cycles would exist. As with many other commodities, periodic gluts could arise, but at what price to wild populations?

SPECIES CASE STUDIES

As indicated above, the impacts of wildcrafting on the status of the species listed in figure 8 are not fully known. However, several species have received increased attention in the herbal literature and in academic circles due to their perceived or actual value as medicines. The following sections profile four taxa that are especially important to the herbal industry and are believed to have suffered declines in the wild.

Purple Coneflowers (*Echinacea* spp.)

Echinacea is a genus of nine species, two of which are extremely rare in the wild. *Echinacea tennesseensis* is listed as an endangered species under the Endangered Species Act (ESA), and is known from only five natural populations. *Echinacea laevigata* is thought to be even rarer than *E. tennesseensis*, and is being considered for listing under the ESA. A recent sur-

vey of *E. laevigata* populations in Virginia, North Carolina, South Carolina, and Georgia found some 22 populations of E. laevigata containing about 6,000 individual plants. The largest of these populations is located on state-owned land in North Carolina, which is a proposed site of a new toxic waste incinerator (Foster 1990b).

A key issue concerning this genus is that rare taxa may be mistaken for the more common members of *Echinacea*, which are harvested in large quantities. According to botanists in Missouri and Arkansas, wild harvesting of *E. pallida*, *E. paradoxa*, and *E. purpurea* is particularly heavy in these states, especially on highway rights-of-way and some private land (Shephard pers. comm.; Smith pers. comm.; Wallace pers. comm.). The Missouri Department of Conservation has become concerned about unregulated roadside harvesting of *E. pallida* and *E. paradoxa*, and intends to introduce legislation to end commercial harvest from these areas (Smith pers. comm.). Wild harvesting of *E. angustifolia* is also ptevalent in certain parts of its range (Foster pers. comm.). Despite intense collection pressure, these four most commonly collected taxa are not thought to be at risk of extinction. Foster and Duke (1990) caution that *E. pallida* may be "judiciously harvested" in the western portion of its range (eastern Kansas).

The demand for *Echinacea* comes from both the domestic herb market and the international market. Foster and Duke (1990) report that in Germany:

> more than 200 pharmaceutical preparations are made from *Echinacea* plants, including extracts, salves, and tinctures; used for wounds, herpes sores, canker sores, throat infections; preventative for influenza, [and] colds.

German pharmaceutical companies market *E. purpurea* for similar purposes. *E. purpurea* extracts are used to bolster the immune system and to fight chronic infections and inflammations.

With so many different uses, it is not surprising that *Echinacea* is among the most popular of herbal products on both domestic and international markets. Fortunately, *E. pallida*, *E. purpurea*, and *E. angustifolia* are reasonably easy to establish in commercial production (Smith-Jochum and Albrecht 1987). However, *E. angustifolia* has yet to be established in commercial cultivation on any scale (Foster 1990b).

Pacific Yew (*Taxus brevifolia*)

The plight of the Pacific yew has recently gained the attention of scientists, conservationists, and the media because of its potential as a source of novel anticancer drugs (Joyce 1990). The bark of the yew tree contains a diterpenoid compound known as taxol, first isolated in the 1960s as part of the National Cancer Institute's (NCI) drive to discover new drugs from plants (Toxol debut threatened 1990). Conservationists and natural product scientists alike are concerned that large quantities of bark, which are required to obtain a usable quantity of taxol, may lead to scarcity in the wild.

According to researchers at NCI (Blume 1989), it takes approximatly nine metric tons of dried yew bark to obtain one kilogram of taxol, which translates into about 3,000 trees of greater than 10 inches diameter (DBH). NCI currently oversees collection of about 27 metric tons annually; assuming 333 trees/ton bark, the NCI effort requires the felling of approximately 9,000 trees every year. With such high rates of harvest, it is not surprising that botanists in California, Oregon, and Washington have noted significant declines in yew populations (Berg pers. comm.; Kruckeberg pers. comm.; Vrilakas pers. comm.). Complicating its conservation outlook is the fact that loggers in the Pacific northwest routinely destroy stands of *T. brevifolia* in order to gain access to more valuable timber species (Joyce 1990).

Responding to the potential threat to

remaining populations, a number of concerned scientists have petitioned the U.S. Department of the Interior to list *T. brevifolia* as a threatened species under the ESA. In their letter to Interior Secretary Lujan, the petitioners (Manheim et al. pers. comm.) argue that:

> a review of the legislative history of the Endangered Species Act makes clear that Congress clearly contemplated extraction of medicinal compounds from plants...Theauthorized removal of a threatened plant, in a manner that will not further jeopardize the species' existence, to develop a cure for cancer is clearly consistent with this history surrounding the Act.

Depletion of yew populations through collection has not, however, been the primary concern of the conservation community (Norse pers. comm.). Instead, the tree is being viewed as a potential way to generate greater support for the protection of old-growth forests, one of the principal habitats of the species.

Although efforts to synthesize taxol have proven fruitless (Joyce 1990), large-scale propagation of high-yielding yew varieties shows a great deal of promise. A nursery in Maryland has apparently succeeded in mass-producing seedlings of *T. brevifolia* and *T. cuspidata*, containing high concentrations of taxol per pound of root. *T. brevifolia* produced in tissue culture by the U.S. Department of Agriculture has also yielded usable quantities of taxol. Their success has prompted researchers to file a process patent application for taxol production from cell culture (Blume 1989). Despite these positive steps toward large-scale propagation, NCI has only enough taxol on hand at present to treat 200-300 patients ("Taxol Debut Threatened" 1990). The effort to increase supply for further clinical trials has fallen upon Bristol-Myers Squibb, which still relies on raw material from wild populations (Cragg pers. comm.).

Ladyslipper Orchids (*Cypripedium* spp.)

The ladyslipper genus includes about 40 species, 11 of which grow in North America. Many of these are widespread but have very patchy local distributions (Case 1990; Luer 1975). *Cypripedium arietinum*, *C. californicum*, *C. candidum*, *C. fasciculatum*, *C. montanum*, and *C. kentuckiense* are candidates for listing under the ESA. *Cypripedium kentuckiense* is thought to be the rarest of these six species (USDI 1985). As in *Echinacea*, a primary concern is that these relatively rare taxa will be taken by wildcrafters, who are more likely to encounter species like *C. acaule* and *C. calceolus* (and its varieties) in the wild. Ladyslipper orchids, also known as American valerian, have been in demand for their purported ability to relieve headaches, insomnia, hysteria, and other nervous disorders. Herb companies that offer ladyslipper tend not to discriminate among species. According to T. E. Smith of the Missouri Department of Conservation (pers. comm.), buyers and collectors do not care which species they obtain as, "one species is in as much demand as another" for the herb trade.

Reports of illegal collection of ladyslippers are extremely common and have concerned plant conservationists for years (Anderson 1990; Brumback 1990; McMahan and Walter 1988). Foster and Duke (1990) believe that the widespread medicinal use of ladyslipper orchids in the 19th century is partly responsible for their scarcity today. This tradition continues in some parts of the country, where wild harvesting is still quite heavy. In Tennessee, for example, Jones (1990) reports that one wildcrafter routinely collected as many as 2,000 ladyslipper rhizomes per customer. Although many of these plants probably end up in the horticultural trade, where they are prized for their unusually showy flowers, some are also destined for medicinal markets (Jones pers. comm.).

Some dealers tempt consumers with offers of cultivated ladyslipper, but these claims are mostly spurious (Brumback 1990; Luer

1975). Several horticulturists have made progress in propagating ladyslippers by rhizome division (Whitlow 1990) or seed germination (Anderson 1990), although these techniques have yet to be applied on a commercial scale (Brumback 1990).

Conservation groups have sounded the alarm on false claims of orchid cultivation that has apparently been heard by a number of herb companies. Nature's Way, for instance, has dropped ladyslipper orchids from its annual purchase contracts. According to Loren Israelsen (pers. comm.), "This early step led many other companies to discontinue using Lady Slipper, and today I am aware of no company in our industry which continues to sell this product." Despite claims made by the herb industry, ladyslipper is still on the market. Eight different price lists reviewed in this study, or about 15 percent of all catalogs received, offered ladyslipper (primarily *C. calceolus* var. *pubescens*).

Goldenseal (*Hydrastis canadensis*)

Goldenseal is among the most valuable of wild medicinal commodities in trade (see figures 10 and 11). Reports of its growing scarcity (Churchill pers. comm.; Foster and Duke 1990) underscore the need for monitoring and propagation. Herbalists employ goldenseal for cleansing the liver, blood, and kidneys and to restore digestive functions. The root has traditionally been used to treat bronchitis, jaundice, and gonorrhea. Moreover, athletes and others have used it to mask the presence of illegal drugs in urine, although it is ineffective for this purpose (Foster 1989).

All goldenseal in trade originates from wild sources. Goldenseal's popularity as an herbal remedy on the retail market is apparent by its regular appearance in catalogs and price lists. The quantity required to meet present demand appears to be quite large, although the overall extent of supply and consumption of goldenseal is not known (Foster 1991a). Nature's Way, just one of many companies, purchases 25 tons of goldenseal root and "herb" annually to fulfill its own needs (Israelsen 1990). Some wholesale distributors are sanguine about heavy harvest levels and even assert that upon digging, goldenseal "hair rootlets and broken roots" left in the ground often produce new plants in subsequent growing seasons (Lockard 1990). Because of the dependence on wild sources, however, other herb companies are growing concerned about potential supply shortages, and at least one is sponsoring an effort to propagate it in Wisconsin (Israelsen pers. comm.).

Periodic shortages of wild goldenseal are perhaps one of the reasons that goldenseal prices have fluctuated markedly over the past decade (Foster 1991a). Foster (1991a) cites several other related explanations for recent supply shortages, namely 1) harvesters shifting to digging of higher-priced commodities; 2) a recent three-year drought that made digging difficult; and 3) disinterest in harvest due to price fluctuations.

Reports of scarcity in goldenseal have prompted some state agencies to track the species' population dynamics (Ludwig pers. comm). The Virginia Natural Heritage Program (VNHP), for example, considers goldenseal very rare to rare/uncommon in its state.[6] As mentioned above, rarity of goldenseal, while linked to the herbal trade, is also believed to have resulted from low rainfall over the past few growing seasons (Foster 1990c). Despite the reports of scarcity, goldenseal is still considered relatively common in many parts of its range (Ludwig pers. comm.; USDI 1985).

THE SUSTAINABILITY OF WILDCRAFTING

Wildcrafting is a tenuous business. It is often practiced by poor rural inhabitants seek-

6. "Very rare" by VNHP's definition means that only 5 to 20 populations remain, or there are many individuals in fewer populations, making the species "susceptible to becoming endangered."

ing to supplement their incomes during times of underemployment (Lockard 1990). The vagaries of nature and the market often conspire to prevent herb gatherers from accumulating sufficient surpluses for later resale. In addition, in the case of the southern Appalachian region, wildcrafters are often beholden to a small number of wholesale distributors, with monopoly control over prices (Bannerman 1990). By maintaining artificially low wildcraft prices, wholesale distributors may in fact be forcing plant harvesters to overcollect in order to obtain a reasonable return on their investments.

The mere fact that many wildcrafters are poor may cause them to overharvest from particular populations and to harvest at inappropriate times of the growing season (Bannerman 1990). Improper harvesting practices are not widely acknowledged in the industry, but many experts believe that significant improvements could be made to attain greater sustainability (Foster pers. comm.; Lewis 1980). Lewis (1980) has written guidelines on sustainable ginseng harvesting and describes the problem as it applies to *Panax quinquefolius*:

> Because ginseng root is valuable, many overzealous collectors dig all plants from wild populations. They often fail to reseed, and as a consequence, there is serious concern about the survival of American ginseng in the forest ecosystem. Some diggers consider wild ginseng free to exploit, but such collecting is a criminal act in Missouri and many other states unless one owns the land or has permission to dig.

Some herbalists have gone to considerable lengths to promote improved methods of wildcrafting. Thie (1989) has published a pamphlet on the proper times and methods to be used for some 50 species of native and exotic herb species. Only two of these are considered "sensitive" to overcollection—ladyslipper and pipsissewa (*Chimaphila umbellata*). Such guidelines are an invaluable and unique source of information on sustainable harvesting practices.

Aside from the taking of entire plants, which entails the loss of individuals from a population, removal of plant organs may weaken or damage multiple individuals. Defoliation generally does not present a significant threat to healthy plants, which are often able to produce a new flush of leaves after intensive herbivory (Harper 1977). Of particular concern is the removal of perennial plant parts such as bark, roots, and rhizomes (underground stems), where secondary compounds are often concentrated. The loss or removal of these tissues may impair transport of photosynthates and nutrients and may weaken plant resistence to pests and diseases. In the case of tree species, sufficient quantities of bark are most easily obtained by simply toppling the entire plant. In some parts of Appalachia, bulldozers are allegedly used to demolish whole groves of oaks and other valuable species (Bannerman 1990). Of the medicinals listed in figure 8, some 45 species are used for plant parts of this type. Herbalists in the industry are sensitive to such concerns and have attempted to minimize damage to certain species. Israelsen (pers. comm.) writes that:

> Two bark crops, cascara sagrada [*Rhamnus purshiana*] and slippery elm *[Ulmus rubra*], raise interesting questions about harvesting practices. As the inner bark is required from slippery elm, we specify a strip harvesting method to preserve the tree while still obtaining the choice inner bark material. In this way, the existing tree population remains intact with harvests rotated between trees. Whether this practice is universally carried out I can't say, although we specify it.

The implications are clear: methods of sustainable harvest are known and sometimes practiced, but not necessarily enforced.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

The sections above provide a broad overview of the trade in native medicinal plants. In many respects, harvesting of common wild plants should be encouraged because it demonstrates the often-cited value of plant diversity as a storehouse of exploitable products with pharmaceutical, industrial, and nutritional value. It would certainly be hard to argue that wildcrafters, who in many cases live a marginal existence, should be denied access to income-producing plants around them. Legal or policy mechanisms to deny them such access would only render their existence more precarious and would probably prove untenable over the long term.

Instead, prudent collection should be encouraged, along with propagation and cultivation. Ginseng is a model plant in this regard in that growing international demand has created an incentive to farm the plant in large quantities. As for other botanicals, many wildcrafters eventually may seek to cultivate them because doing so is much more lucrative than "roaming the woods" (Churchill pers. comm.). But information on both propagation and cultivation are scarce and diffuse. For example, in his book on wildflower propagation Phillips (1985) lists only 11 of the taxa in figure 8, although it is apparent that many botanic gardens are currently growing many native medicinal species in their collections (e.g., the North Carolina Botanic Garden in Chapel Hill). Without sufficient information, entrepreneurial wildcrafters may be discouraged in their attempts to raise herbal crops (Foster 1990a). A systematic effort to collect and publish methods of medicinal plant cultivation needs to be made, and the published product should be distributed to agricultural extension services throughout the country.

An additional source of missing information is the extent of international trade in native medicinal plants. Amid anecdotal reports of increased foreign investment in U.S. herb businesses, it would be helpful to have taxon-specific data on international commerce. To redress this lack of data, evidence of international trade should be sought and, for those species traded internationally, CITES Appendix II proposals should be prepared. Meaningful quantitative data on international trade at the species

level are often hard to come by; a CITES listing would greatly improve the quantity and quality of data for such heavily exploited taxa as *Hydrastis canadensis*, *Sanguinaria canadensis*, *Echinacea* spp., and *Rhamnus purshiana*, among others.

The long-term impacts of herb collecting on wild populations are largely unknown. It has been suggested that a systematic study of selective thinning be done over several growing seasons so that sustainable levels of harvest may be determined. Such a study could include a number of sympatric herb species, possibly from the southern Appalachian region, and would need to be controlled for such variables as microclimate, soil nutrients, substrate, and genotype. A proposal of this nature is reportedly being developed by the Eastern Native Plant Alliance for submission to the National Science Foundation.

An additional proposal put forth by Bannerman (1990) is to organize wildcrafters in the southern Appalachian region into cooperatives, so that they may gain greater control over prices of wildcrafted herbs. A venture of this sort could result in lessened pressure on wild populations through increased wildcraft prices and would provide a means of farming some of the more valuable and scarce species.

Each of these proposals is in need of financial support. Each has been advanced by well-intentioned conservationists, who often lack the time and financial resources to see their ideas through to fruition. Moreover, the issue of herb conservation must compete in a forum dominated by many other pressing environmental concerns (e.g., climate change, deforestation, pollution, etc.) and may seem trivial when compared to global problems. But as this report demonstrates, the costs of inaction are much larger than they might seem. Why else would international pharmaceutical companies be showing greater interest in these resources if their potential value were not worth the investment in research and development? The conservation community must seek to be an equal partner in developing these genetic resources in a sustainable manner, otherwise steady impoverishment of populations and ecosystems is certain to occur and, over the long term, the prospects for novel medicinal products will grow increasingly dim.

APPENDIX

A number of individuals generously answered correspondence and provided published information on herb trade across the country. They are:

Arkansas: David Blackburn, Arkansas State Plant Board;William M. Shepherd, Arkansas Natural Heritage Commission; Steven Foster, American Botanical Council.

California: Ken Berg, Department of Fish and Game, State of California; Halli Mason, California Native Plant Society.

Illinois: John Schwegman, Illinois Department of Conservation.

Kentucky: Lauren E. Schaaf, Department of Fisheries and Wildlife Resources.

Maryland: Gordon Cragg, Natural Products Branch, National Cancer Institute.

Massachusetts: Bruce Sorrie, Division of Fisheries and Wildlife.

Missouri: Virginia Wallace, Missouri Department of Conservation; Tim E. Smith, Missouri Department of Conservation.

North Carolina: Marjorie Boyer, North Carolina Department of Agriculture.

Ontario: Tom Atkinson, Canadian Wildflower Society.

Oregon: Sue Vrilakas, The Nature Conservancy.

Pennsylvania: J. I. Sitlinger, Bureau of Land Management.

Tennessee: John A. Churchill, Tennessee Native Plant Society; Walter A. Jones, Tennessee Department of Conservation.

Utah: Loren Israelsen, Nature's Way.

Virginia: Daniel J. Schweitzer, Office of Plant Protection; J. Christopher Ludwig, Virginia Natural Heritage Program.

Washington: A. R. Kruckeberg, Washington Native Plant Society; John Gamon, Washington State Department of Natural Resources; Krista Thie, Longevity Herb Press.

REFERENCES

Anderson, A. 1990. "Asymbiotic Germination of Seeds of Some North American Orchids." In *North American Native Terrestrial Orchid Propagation and Production.* Chadds Ford, Pa.: Brandywine Conservancy.

Bailey, A. 1985. "The Economic Botany of Vascular Plants Found in Southern Appalachia." Master's thesis, Tennessee Tech University.

Bannerman, J. 1990. Address delivered at the SAMAB/Forest Service Workshop on Botanicals and Pharmaceuticals, Asheville, N.C., March 1990.

Bennett, B., C. R. Bell, and R. T. Boulware. 1990. "Geographic Variation in Alkaloid Content of Sanguinaria canadensis (Papaveraceae)." *Rhodora* 92, No. 870:57-69.

Berg, K., personal communication, 8 March 1990.

Blume. 1989. "Investigators Seek to Increase Taxol Supply." *Journal of the National Cancer Institute* 81, No. 15.

Blumenthal, M. 1991. "European Harmony in Phytotherapy." *Herbalgram* 24:41-43.

_____. 1989. "Third International Poisonous Plant Symposium." *Herbalgram* 21, Fall 1989.

Brumback, B. 1990. "Commercial Propagation of Terrestrial Orchids—What's Being Done?" In *North American Native Terrestrial Orchid Propagation and Production.* Chadds Ford, Pa.: Brandywine Conservancy.

_____.personal communication, March 1990.

Campbell, F. T., personal communication, January 1990.

Case, F. W. 1990. "Native Orchid Habitats: The Horticulturists Viewpoint." In *North American Native Terrestrial Orchid Propagation and Production.* Chadds Ford, Pa.: Brandywine Conservancy.

Churchill, J. A., personal communication, 30 January 1990.

Clavio, L. 1990. "The Eclectic Institute: Carrying on a Fresh Tradition." *HERBS! The Journal of Useful Plants and Healthful Living* 2, 1:41-43.

Conrow, R., and A. Hecksel. 1983. *Herbal Pathfinders: Voices of the Herbal Renaissance.*

Santa Barbara, Ca.: Woodbridge Press.

Cragg, G., personal communication, September 1990.

Davis, S., et al. 1986. *Plants in Danger: What Do We Know?* Switzerland: IUCN.

Der Marderosian, A. 1990. "The European Congress on Phytotherapy, Conference Report." *Herbalgram* 22, Spring 1990.

Duke, J. A. 1986. *Handbook of Northeastern Medicinal Plants.* Lincoln, Mass.: Quarterman Publications.

_____. 1985. *CRC Handbook of Medicinal Herbs.* Boca Raton, Fla.: CRC Press.

Elias, T. 1980. *The Complete Trees of North America: A Guide to Field Identification.* New York: Van Nostrand Rheinhold.

Farnsworth, N., and D. D. Soejarto. 1985. "Potential Consequences of Plant Extinction in the United States on the Current and Future Availability of Prescription Drugs." *Economic Botany* 39, 3:231-240.

Fitzgerald, S. 1989. International Wildlife Trade: Whose Business is It? Washington, D.C.: World Wildlife Fund.

Foster, S. 1991. "Harvesting Medicinals in the Wild: The Need for Scientific Data on Sustainable Yields." *Herbalgram* 24:10-16.

_____. 1991a. *Goldenseal: Hydrastis canadensis.* Botanical Series No. 309. Austin, Tex.: American Botanical Council.

_____. personal communication, various times from March to December, 1990.

_____. 1990. Address delivered at the Eastern Native Plant Alliance Meeting, Holden Arboretum, Mentor, Ohio, August 1990.

_____. 1990a. "Notes on the Undeveloped Potential of Medicinal Plants for the Southern Appalachians: A Discussion Paper." Paper submitted to the SAMAB/Forest Service Workshop on Botanicals and Pharmaceuticals, March 1990.

_____. 1990b. *Echinacea: Nature's Immune Enhancer.* Rochester, Vt.: Inner Traditions International.

_____. 1990c. "On the Harvest of Wild Medicinal Plants: The Need for Scientific Data on Sustainable Yields." Paper submitted for publication in *Herbalgram* 24.

_____. 1989. "Goldenseal Masking of Drug Tests". *Herbalgram* 21, Fall 1989.

Foster, S., and J. A. Duke. 1990. *A Field Guide to Medicinal Plants: Eastern and Central North America.* Peterson Field Guide Series #40. Boston, Mass.: Houghton Mifflin Co.

Fuller, D. 1986. "American Ginseng: Harvest and Export, 1982-1984." *TRAFFIC USA* 7, No. 1:3,14.

Giese, D., personal communication, September 1990.

Gleason, H., and A. Cronquist. 1963. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada.* Princeton, N.J.: Van Nostrand Company.

Gunther, E. 1973. *Ethnobotany of Western Washington: The Knowledge and Use of Indigenous Plants by Native Americans.* Seattle, Wa.: University of Washington Press.

Harper, J. L. 1977. *Population Biology of Plants.* New York: Academic Press.

Holmes, P. 1989. "The Energetics of Western Herbs: Integrating Western and Oriental Medicines." *HERBS! The Journal of Useful Plants and Healthful Living* 1, No. 4:10-14.

Israelsen, L. 1990. "Medicinal Plants: Returning to Our Roots." Paper presented at the SAMAB/Forest Service Workshop on Botanicals and Pharmaceuticals, 20 March 1990.

_____. personal communication, 27 September 1990.

Jones, W. A. 1990. "The Good, the Bad, and the Ugly: Rare Plant Protection in Tennessee." Paper presented at the Nurseryman's Association Meeting, February 1990.

_____. personal communication, 21 February 1990.

Joyce, C. 1990. "Cancer Drug Found in Bark of American Tree." *New Scientist,* 6 October 1990.

Kruckeberg, A. R., personal communication, 20 February 1990.

Landes, P. 1989. "Upswing Predicted for Spices,

Botanicals." *Herbalgram* 21, Fall 1989.

Lewis, W. 1980. *American Ginseng: A Forest Crop.* Jefferson City, Mo.: Missouri Department of Conservation.

Lewis, W. H. and M. P. H. Lewis. 1977. *Medical Botany.* New York: John Wiley.

Little, E. 1971-81. *Atlas of United States Trees 1-6.* Washington, D.C.: U.S. Forest Service.

Lockard, A. L. 1990. "Production and Sales of American Botanicals." In Simon, J. E. et al., eds. *Proceedings of Herbs '90: The Fifth Annual Conference of the International Herb Growers and Marketers Association.* Silver Springs, Pa.: IHGMA.

Ludwig, J. C., personal communication, 30 January 1990.

Luer, C. A. 1975. *The Native Orchids of the United States and Canada, Excluding Florida.* Bronx, New York: The New York Botanical Garden.

McMahan, L., and K. Walter. 1988. "The International Orchid Trade." In W. J. Chandler ed. *Audubon Wildlife Report 1988/1989.* San Diego, Calif.: Academic Press.

Manheim, B., et al., personal communication, 19 September 1990.

Mars, B. 1989. "Herbal Wanderings: Switzerland." *The American Herb Association Quarterly Newsletter* 4, No. 3:3.

McNeely, J. 1988. *Economics and Biological Diversity: Developing and Using Incentives to Conserve Biological Resources.* Switzerland: IUCN.

Moore, M. 1979. *Medicinal Plants of the Mountain West.* Santa Fe, N.M.: Museum of New Mexico Press.

Moos, E. 1987. *The Herb Gardener's Mail Order Source Book.* New Hope, Pa.: Woodsong Graphics.

"New York Ginseng Business Takes Root". *Herbalgram* 21, Fall 1989.

Norse, E. A., personal communication, 1990.

Oldfield, M. 1984. *The Value of Conserving Genetic Resources.* Washington, D.C.: U.S. Department of the Interior.

Phillips, H. 1985. *Growing and Propagating Wild Flowers.* Chapel Hill, N.C.: University of North Carolina Press.

Scarborough, J. 1991. "Folklore and Folk Medicines." *Herbalgram* 24:24-29.

Shetler, S. G. and L. E. Skog. 1978. *A Provisional Checklist of Species for Flora North America.* St. Louis, Mo.: Missouri Botanical Garden.

Shephard, W. M., personal communication, 20 September 1990.

Smith, T. E., personal communication, 17 September 1990.

Smith-Jochum, C. C., and M. L. Albrecht. 1987. "Field Establishment of Three Echinacea Species for Commercial Production." In Simon, J. E. et al., eds. *Acta Horticulturae: Sixth International Symposium on Medicinal and Aromatic Plants.* No. 208:115-120.

Sorrie. B. A., personal communication, 6 February 1990.

Stuart, M. 1982. VNR *Color Dictionary of Herbs and Herbalism.* New York: Van Nostrand Rheinhold and Company.

"Taxol Debut Threatened by Short Supply." Washington *Insight: Newsletter for Natural Products Scientists.* III, No. 3, September 15, 1990.

Tennessee Ginseng Management Program (TGMP). 1989. *The Annual Report of the Tennessee Ginseng Management Program 1988-89.* Nashville, Tenn.: Tennessee Department of Conservation.

Thie, K. 1989. *A Plant Lover's Guide to Wildcrafting: How to Protect Wild Places and Harvest Medicinal Herbs.* White Salmon, Wash.: Longevity Herb Press.

U.S. Department of Agriculture (USDA). 1981. "Foreign Agricultural Circular: Ginseng." Washington, D.C.: USDA, Foreign Agriculture Service.

U.S. Department of the Interior (USDI). 1981-87. "CITES Annual Reports." Washington, D.C.: U.S. Fish and Wildlife Service.

_____. 1985. "Endangered and Threatened Wildlife and Plants; Review of Plant Taxa for Listing as Endangered or Threatened

Species." Federal Register 50, No. 188.
Vertolli, M. 1989. "Herbal Reflections: Regulating Herbalism. Is There a Better Way?" *The Herbalist Magazine* 2, No.3, Fall 1989.
Vrilakas, S., personal communication, 11 September 1990.
Wallace, V. K., personal communication, 1 March 1990.
Whitlow, C. E. 1990. "Asexual Propagation Techniques for Several Genera of Native Hardy Terrestrial Orchids." In *North American Native Terrestrial Orchid Propagation and Production.* Chadds Ford, Pa.: Brandywine Conservancy.
Wijnstekers, W. 1990. *The Evolution of CITES,* 2nd edition. Lausanne, Switzerland: the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.