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Medicinal Forest Herbs: Conservation and Economic Development in the Appalachian Mountains

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The medicinal plant industry, and the people of Appalachia, have relied on the rich natural resources of the Appalachian Mountains for centuries, collecting plants for food, medicine, and livelihood. By the 1700s, Appalachia had become a major supplier of medicinal plants and recognized internationally as a source of American ginseng. Today, the value of these products is substantial, with more than $11 billion in 2020 U.S. sales. There is growing concern, however, that many medicinal herbs are disappearing. We review current research on wild-harvesting, forest cultivation, and efforts to create markets for sustainably-sourced Appalachian medicinal herbs. There is critical need for ecologically sound management and sustainable economies in Appalachia, to support our natural resources and communities.

Keywords: *forest farming; herbal economy; non-timber forest products; wild harvesting*

1. Introduction

The medicinal plant industry, and the people of Appalachia, have relied on the rich natural resources of the Appalachian Mountain forests for centuries. These mountains are home to some of the most biologically diverse forests in the temperate world (Ricketts et al. 1999), and the gathering of local forest plants has been central to the culture and economics of the region throughout its history (Manget 2016). Hundreds of medicinal plant species occur in these mountains, with 50 or more species commonly harvested for sale and distribution (Chamberlain 2006). Many Appalachian plants first were used by Native Americans, and later adopted by European settlers (Yoakley 1932). By the late 18th and early 19th centuries, American ginseng (*Panax quinquefolius*) had become one of the most valuable and widespread forest products in trade, collected from these mountain forests for sale nationally and internationally in European and Asian markets (Chamberlain et al. 2019b). Not long after, this region became a major supplier of other medicinal species, owing to its rich forest diversity and availability of these

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plants as open access resources (Manget 2016). By the 1930s, roughly 75% of the raw materials leaving North America for international herbal markets were gathered from forests in just four Appalachian states – those of western North Carolina, southwestern Virginia, eastern Kentucky, and eastern Tennessee (Yoakley 1932).

For centuries, hundreds of forest plants have been used for subsistence, as sources of food, medicine, and income (Chamberlain, Small, and Baumflek 2019b). In a region faced with poverty, food insecurity, and economic challenges of unstable coal, timber, and tobacco industries, medicinal plants have been a constant. Mountain farmers collected ginseng root, slippery elm (*Ulmus rubra*) and cherry (*Prunus serotina*) bark, and galax (*Galax urceolata*) leaves to trade for needed goods or store credit. Forest botanicals also have contributed to Appalachian well-being and cultural identity, providing essential nutrition and medicine, and the traditions of gathering, preparing, and sharing these materials playing important roles in strengthening family and community connections (Chamberlain, Small, and Baumflek 2019a).

While many Appalachian forest products are collected for personal use, some enter product markets and contribute significantly to international, state, and household economies (Kruger et al. 2020). Tremendous volumes of edible fruits, nuts, sap, and craft products are extracted from Appalachian forests each year. Although volumes and sales of non-timber forest products are rarely tracked, the contribution of forest botanicals economic markets is sizable. In 2018, herbal and dietary supplements generated nearly $9 billion in U.S. retail sales, and in 2020, sales exceeded $11 billion (Smith et al. 2021). In this most recent survey, elderberry fruits (*Sambucus canadensis* and *S. nigra*) were a top selling product, used in jams, wines, and increasingly in as herbal supplements for immune and respiratory health.

Appalachian mountain forests support the people of the region and a thriving medicinal plant industry. But, there is growing concern that many medicinal forest plants are being depleted. Despite their economic value, use of these products is rarely monitored or managed in natural resource planning. For centuries, most non-timber products been ‘wild-harvested’, extracted from natural populations without replanting or replacement (Chamberlain, Small, and Baumflek 2019b). Open access and lack of market integration has contributed further to the decline of many herbal species (Chamberlain, Prisley, and McGuffin 2013). Today, there is a critical need for ecologically sound management to protect the rich diversity and cultural history of Appalachian forest botanicals, and for the creation of fair and accessible herbal markets to support and sustain economic opportunity throughout the region.

2. Appalachian forest botanicals

2.1. Diversity of plants and products

Appalachian forests are home to a diversity of wild plant species harvested for medicinal, edible, decorative, and cultural uses (Chamberlain, Small, and Baumflek 2018b). Edible plants and fungi are among the best-recognized and most widely used. These include morel mushrooms (*Morchella* spp.), black walnuts (*Juglans nigra*), blueberries (*Vaccinium* spp.), elderberries, pawpaw (*Asimina triloba*), persimmon (*Diospyros virginiana*), ramps (wild leeks; *Allium tricoccum*), and sugar maple for maple syrup (*Acer saccharum*). Many others are collected for medicinal uses, supporting significant national and international markets. American ginseng is one of the best known and most economically valuable species, collected for the medicinal properties of its roots and rhizomes (storage roots). Like ginseng, many other medicinal herbs are harvested for roots, such as black cohosh (*Actaea racemosa*), goldenseal (*Hydrastis canadensis*), bloodroot (*Sanguinaria canadensis*), and wild yam (*Dioscorea villosa*). Medicinal products also are derived from other plant components including slippery elm, willow (*Salix alba*), and sassafras (*Sassafras albidum*) bark and stinging nettle (*Urtica dioecia*) leaves.

Collection and use of wild plants is not unique to Appalachia. An estimated 80% of the world's population uses herbal medicinal products as their primary source of healthcare, notably in rural and developing regions (Ekor 2014). Many Appalachian species have closely related and widely used counterparts worldwide. For example, blackberry and raspberry (*Rubus fruticosus* and *R. idaeus*), European elder (*Sambucus nigra*), European wild garlic (ramsons; *Allium ursinum*), wild ginger (*Asarum europaeum*), Saint John's Wort (*Hypericum perforatum*), and stinging nettle (*Urtica dioecia*) are used medicinally, as foods or flavorings, and as sources of income across Eastern Europe, including the Carpathian Mountains. As in Appalachia, these species have deep connections to cultural identities and a long history of use that connect traditional and local knowledge to rural economies, ecosystem services, and international markets (Vári et al. 2020).

2.2. Vulnerability of plants to wild-harvesting

Most marketed forest botanicals have been collected from wild Appalachian plant populations for centuries. Without management, and available to all regardless of land ownership, many species have experienced long-term and significant declines (Chamberlain 2006). In the late 1700s, surviving records indicate that a root digger could harvest more than 40 pounds of American ginseng in a single day; today, this

plant is rarely seen in the wild (Manget 2016). Today we recognize that wild-harvesting can be sustainable only if it supports the long-term viability of harvested species and surrounding ecosystems. The sheer range of products collected from Appalachian forests makes sustainable use challenging, but some guidelines have been identified (Ticktin 2015).

The vulnerability of plants to wild-harvesting depends in large part on their growth and reproductive rates and the components harvested. Many highly valued medicinal plants, like American ginseng, goldenseal, and black cohosh, are slow-growing (requiring years to decades to reach harvestable size) and collected for roots or other below-ground structures (e.g., bulbs, rhizomes). Root harvest removes entire plants and limits seed and bulb production, contributing to loss of genetic diversity, population declines, and local extinction (Ticktin 2015; Chamberlain, Small, and Baumflek 2019a). An assessment of North American medicinal plants ranked species such as ginseng, goldenseal, lady's slipper orchids (*Cypripedium* spp.) and false unicorn root (*Chamaelirium luteum*) as especially vulnerable to overharvesting due to high demand, long plant lifespans, small populations or habitat threats, and destructive root harvests (Castle et al. 2014). These species are considered 'At-Risk' (UPS 2022), and both ginseng and goldenseal are regulated by the Convention on International Trade in Endangered Species of Wild Flora and Fauna for overharvesting concerns. In contrast to plants harvested for roots, those used for edible or medicinal fruits (e.g., elderberry) or leaves (e.g., stinging nettle) generally can be harvested with little impact on natural populations (Castle et al. 2014; Ticktin 2015). Below, case studies highlight several widely used Appalachian forest botanicals, describing threats and progress towards sustainability.

3. Case Studies: uses, threats, and the future of medicinal herbs

3.1. American ginseng

American ginseng has played an important role in the culture and economy of Appalachia over the past three centuries, and typifies the impacts of overharvesting, open access, and lack of management (Chamberlain, Prisley, and McGuffin 2013). Ginseng is a long-lived and slow-growing medicinal forest herb harvested for the immune-boosting properties of its roots. The center of its natural distribution lies in the central and southern Appalachian Mountains, in the rich deciduous forest habitats shared by other valuable medicinal herbs including goldenseal, bloodroot, black cohosh, and wild yam (Kruger et al. 2020). From 1750

to 1900, the U.S. exported over nine-million kilograms of American ginseng roots, largely for use in traditional Chinese medicine. During this time, ginseng was treated as a common resource, with unrestricted access, harvest season, and volumes (Manget 2016; Chamberlain, Small, and Baumflek 2019a). This lack of management resulted in precipitous population declines by the early 1900s.

In 1975, ginseng was listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora, regulating its export and requiring assurances that international trade would not be detrimental. Today, 19 U.S. states are certified to export ginseng root and have state-level management plans limiting harvest season (late season, after seed set) and requiring annual reporting of harvest volumes (Chamberlain, Prisley, and McGuffin 2013). The majority of ginseng is harvested from eastern Kentucky, West Virginia, North Carolina, Tennessee, and Virginia, in the core of its ecological range (Chamberlain, Small, and Baumflek 2019a). In 2012, the value of American ginseng roots to harvesters was estimated at more than US$27 million annually, indicating substantial value at all levels of the economy. Despite harvest restrictions, however, wild ginseng has continued to decline. Our research on medicinal herbs with similar life histories (e.g., black cohosh, goldenseal) suggests that the effects of wild-harvesting and open access resource use may be long-lasting, and ginseng populations may require decades or longer to recover (Chamberlain, Small, and Baumflek 2019b).

3.2. Black cohosh

Black cohosh is another Appalachian medicinal herb with a long history of use. Today, it is sold worldwide as an herbal remedy for hot flashes and other menopausal symptoms. Since 2002, black cohosh has been listed as a top 10 selling herbal supplement (Small and Chamberlain 2018). Annual surveys by the American Herbal Products Association found harvest quantities of black cohosh to exceed nearly all other medicinal species monitored, and produce nearly $40 million in annual sales (Smith et al. 2019). Like ginseng and ramps, black cohosh is threatened by intense wild harvesting, with only a tiny fraction of rhizomes derived from cultivated sources and considerable amounts from illegal collection (NatureServe 2020). Although the species remains relatively abundant, wild populations have declined by 10 to 50% in recent decades due to slow growth, high market demand, and lack of regulation (Small and Chamberlain 2018). Today, black cohosh is considered “at-risk” by the United Plant Savers (2022) and a priority for conservation research by the American Herbal Products Association, U.S. Forest Service, and other agencies (Small and Chamberlain 2018).

Experimental harvest research emphasizes the sensitivity of black cohosh to wild harvesting. Small and Chamberlain (2018) found that after just 2 to 3 years of harvests, plant size decreased by 65 to 90%. After 6 to 10 years without additional harvests, populations still failed to improve and few juvenile plants had emerged, suggesting that intense harvesting may have long-term impacts. Experimental studies such as these emphasize that many medicinal forest plants, particularly those harvested for root products (e.g., ginseng, black cohosh, goldenseal), require years to decades for populations to recover (Chamberlain, Small, and Baumflek 2019b). These results make it clear that alternate approaches are needed to manage these resources for long-term viability. Continuing research on black cohosh cultivation and market trends is discussed below.

3.3. Ramps

Ramps (wild leeks) are a species of wild onion traditionally associated with Appalachian culture. Earliest documented uses were by Native Americans, including the Cherokee, who foraged and consumed the plant in the spring for its rich garlic and onion flavor and to cleanse the body after long winters without fresh foods. These and other uses were later adopted by European settlers (Rivers, Oliver, and Resler 2014). For more than a century, ramps have contributed to local economies through spring ramp festivals and plant sale in roadside stands, especially in the mountains of North Carolina and Tennessee. In recent decades, growing demand has led to tremendous harvest pressure, with hundreds of thousands of pounds of spring ramp bulbs dug for sale at specialty grocery stores, farmers markets, and restaurants across the country (Baumflek and Chamberlain 2019).

Ramps are slow-growing spring ephemerals, often requiring five to seven years to reach harvestable size and produce seeds (Chamberlain, Small, and Baumflek 2019b). Plants are dependent on a short, roughly eight-week period in early spring to emerge, develop leaves, and set seed before dying back. This life cycle is important because harvest timing greatly influences sustainability, and negligent practices can destroy entire populations. Like other plants harvested for roots, collection typically results in plant mortality. Harvest research has shown that ramp populations are very sensitive to wild collection, indicating that only 5 to 15% of bulbs can be removed without population decline and that harvest frequency should be limited to once every 10 years (Nault and Gagnon 1993; Rock et al. 2004). Although ramps can form extensive patches in moist, shaded forests, today the species is ranked as vulnerable to critically imperiled in some Appalachian states, particularly near the boundaries of its range (e.g., Tennessee, Alabama), due to harvesting concerns (NatureServe 2020).

Effectively managing harvested plants requires sustainable collection practices, stewarding of wild populations, and supplementing wild-harvest pressures through cultivation (Chittum et al. 2019). For ramps, local and traditional knowledge may provide insights into sustainable wild collection. Conventional harvesting removes the entire plant, including the bulb. In contrast, harvesting by the Eastern Band of Cherokee Indians involves cutting selected leaves and leaving a portion of the bulb and root in the ground (Chamberlain, Small, and Baumflek 2019a). This leaf harvest appears to have little impact on plant mortality and provides a more sustainable option over total plant removal. Other conservation practices involve limiting harvest frequency and quantities (Rock et al. 2004), timing harvests to maximum bulb growth, and cultivating plants or spreading seeds in suitable habitats to off-set wild harvest pressures (Chamberlain, Small, and Baumflek 2019b).

3.4. Goldenseal

Goldenseal is a long-lived Appalachian forest herb used for treatment of inflammation, digestive issues, and immune function (Mulligan and Gorchov 2004). Once abundant, today goldenseal occurs only in scattered populations. Overharvesting is the primary threat and has contributed to long-term population declines across much of its natural range (NatureServe 2020). As with American ginseng, goldenseal was listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora in 1997, and requires permits for all root exports. More recently, it was ranked by IUCN as globally vulnerable, signifying a high risk of extinction in natural populations, and listed as endangered, vulnerable, or threatened in at least 10 states across its range (Oliver and Leaman 2018). Historically, most goldenseal root entering trade markets was collected from wild populations, but cultivation has increased in recent years due to scarcity (in 2010, 17 to 40% of root from cultivated sources) (NatureServe 2020).

Like other root-based medicinal plants, goldenseal is slow to recover from wild-harvesting. Research by Mulligan and Gorchov (2004) suggests that as little as 10% harvest removal can cause localized extinction. With thousands of pounds of goldenseal needed annually to meet growing consumer demand, herbal products companies are beginning to recognize the need for a sustainable supply chain. To offset wild-harvesting pressure, we are currently conducting forest farming trials in Appalachian forests of eastern Kentucky and Ohio to determine effective methods of forest cultivation for this and other medicinal herbs (Small, Chamberlain, and Nuckols 2014). Goldenseal rhizomes and root fragments have been transplanted

into forest cultivation plots and survival and regrowth tracked over a 5-year period. Goldenseal leaves also will be evaluated for comparative chemistry. Although roots and rhizomes are typically preferred, goldenseal leaves are occasionally harvested and recent evidence suggests that alkaloid concentrations may warrant their use (Chamberlain, Small, and Baumflek 2019). As with ramps and other botanical harvests, leaf harvests are a much more sustainable option – and could supplement extractive root harvests for this and other medicinal herbs.

4. Conservation, cultivation, and economic sustainability in Appalachia

4.1. Forest farming: conservation through cultivation

Forest farming refers to the cultivation or management of non-timber products in a natural forest environment (Chamberlain et al. 2009). Although these practices have been used throughout Appalachian history, today they are often replaced by large-scale or monocultural farming. Forest farming practices range in intensity from ***wild-stewarding*** (tending existing populations of forest botanicals by spreading seeds, dividing rhizomes, or harvesting limited quantities to ensure long-term viability); to ***wild-simulated*** (cultivating medicinal herbs in natural forest settings by planting rootstock and potentially removing competing plants or modifying the forest canopy to enhance growth); and ***woods-grown*** (more intensive cultivation and management of forest herbs, using fertilization, weeding, pest control, and/or forest thinning to produce higher yields) (Filyaw 2019).

Forest farming can provide numerous ecological and economic benefits. These include conservation rather than clearing of forested lands; increased wildlife habitat; land owner revenue; and reduced harvest pressures on wild plant populations (Chamberlain et al. 2009). This is particularly important for species collected almost entirely from wild populations, like black cohosh. Another benefit of forest farming is reduced adulteration of products (Chittum et al. 2019). For example, several closely related species occur with black cohosh and can be difficult to distinguish. These differ in chemical constituents, and the efficacy and impacts of mixing these products is poorly understood. Cultivation from known root stock can prevent mixing of incorrect species and support optimal harvest practices to maximize product quality and medicinal constituents.

Although cultivation in forested habitats tends to produce smaller yields than traditional and highly managed agricultural systems, forest farming offers several benefits. For example, production costs often are much lower. Since most

medicinal herbs require shade, artificial shading is not required but is provided by forest trees (Burkhart and Jacobson 2009). Forest grown plants also may have reduced need for pesticide use, supporting production of organic products. In addition, forest farming (especially wild-simulated) mimics the slow growth that occurs under natural conditions. The resulting products are more similar to wild-harvested plants in appearance and medicinal efficacy, creating higher demand and prices in the marketplace. This similarity to wild-harvested material is especially important in some markets, such as American ginseng, where wild roots sell for 20 to 25 times more than cultivated roots (Chamberlain et al. 2009).

Despite these benefits, cultivation of medicinal herbs may not be profitable (Burkhart and Jacobson 2009). Many species grow slowly and may require a decade or more before producing saleable products. Years of production costs prior to harvest may not be feasible for some farmers. In addition, historically low prices and continued availability of wild plants can make wild-harvesting more economically feasible than cultivation. For example, high market demand and low prices support continued wild-harvesting of black cohosh (Small and Chamberlain 2018). Despite its relatively high retail value, only a fraction is paid to harvesters. In 2015, black cohosh generated more than $35 million in total retail value, yet harvesters received less than $1 million (Kruger et al. 2020). High harvest volumes and lower revenue than other medicinal herbs suggest that black cohosh is still sufficiently common to favor wild-harvesting over cultivation. In contrast, goldenseal cultivation has increased in recent years. As wild populations become scarce, cultivation has become more profitable (NatureServe 2020).

4.2. Developing a sustainable herbal economy in Appalachia

Many valuable Appalachian species are threatened not only by overuse, but by lack of market integration. Demand for forest botanicals has increased consistently over the past two decades, yet prices for most species, aside from American ginseng, remain low (Kruger et al. 2020). Traditional supply chains significantly undervalue the labor, processing, and production costs to bring medicinal forest herbs to market, providing little economic incentive for wild-stewarding or cultivation. As a result, wild-harvesting continues as the industry norm (ASD, n.d.; Chamberlain, Small, and Baumflek 2019a). The future of the herbal products industry, however, depends on the sustainable sourcing of raw materials. We have an urgent need to develop secure and stable markets for Appalachian medicinal herbs, and to contribute to the economic sustainability of this region.

As global demand increases, concerted efforts are needed to ethically and sustainably source forest botanicals. Supported by a Conservation Innovation Grant from the USDA Natural Resources Conservation Service and the American Herbal Products Association, our current research is examining ways to ensure long-term sustainable sourcing of raw materials for Appalachian medicinal herbs, in support of local economies and the herbal products industry. With a broad range of research partners led by Appalachian Sustainable Development (ASD), we are working to increase adoption of agroforestry practices. This will require not only understanding of effective forest cultivation practices, but development of market-based incentives to make forest cultivation feasible and profitable for small-scale Appalachian farmers (over wild-harvesting).

Appalachian Sustainable Development, a U.S. non-governmental organization, was developed in 1995 with the mission of building healthy food and agricultural systems and thriving local and regional economies across Appalachia (ASD, n.d.). This organization is working to build a network of local forest farmers to reduce pressures on wild herb populations and support local economic development in central Appalachia – to achieve conservation through profitable agroforestry cultivation. In 2017, ASD created the *Appalachian Harvest Herb Hub* in the mountains of southwest Virginia, providing training, technical assistance, and other resources for family farmers to sustainably grow and process medicinal herbs. The ASD Herb Hub provides local growers with access to planting stock and commercial root washing and drying equipment, helping herb farmers to reduce labor costs and increase processing efficiency and quality. Using these resources, one local grower reduced black cohosh processing labor costs by $34 per dry pound in 2016, making forest farming profitable for the first time (ASD, n.d.).

The ASD Herb Hub also provides aggregation and marketing services to help local growers meet volume minima and to connect to buyers seeking high quality and sustainably grown forest botanicals. This approach has created niche markets that provides premium prices to local producers. For example, black cohosh root certified as sustainably forest-farmed and sold through the Herb Hub generated $45 per dry pound, as compared to just $5 per pound for wild-harvested root. Niche markets for other herbal products also are being created, such as sustainably forest-farmed ginseng leaf ($350-700 per dry pound) and root ($1,150 per dry pound).

Connecting local farmers to cost share programs and product certifications also can help to make cultivation and environmentally sustainable practices profitable (Chittum et al. 2019). In 2010, Appalachian farmers earned $40 per dry

pound for certified organic goldenseal rhizomes, as compared to $30 to 35 for cultivated rhizomes, and just $20 to 25 for wild-harvested (Greenfield and Davis 2003). Certifications also provide a potential pathway to sustainability – verifying that collection and production practices are safe and effective; support biological diversity; and provide fair compensation and market accessibility at all levels of the supply chain (American Botanical Council, n.d.). Certifications for medicinal herbs, such as the National Organic Program's *Organic Certification*, USDA National Resources Conservation Service's *Environmental Quality Incentives Certification*, and United Plant Savers' *Forest Grown Verification* are establishing guidelines for ethical and sustainable harvesting, cultivation, and production, and helping to create markets for sustainably-sourced forest botanicals. These efforts are allowing local farmers to stay on their land, conserve their forests, and derive economic benefit from production of forest botanicals – thus, contributing to a sustainable supply of herbal products and building economic opportunity in Appalachia.

5. Conclusion

Foods, medicines, crafts, and cultural products have been collected for centuries from the rich forests of the Appalachian Mountains, and are deeply connected to the cultures and livelihoods of these mountain communities. These plants support a thriving, global medicinal plant industry, yet many of the species are facing severe declines. Today, we have a critical need to protect forest biodiversity and the cultural connections these forests provide. Our research is working to better understand wild-harvest sustainability for Appalachian medicinal plants; to develop forest cultivation approaches to offset extractive resource use; and to create herbal markets that contribute economic opportunity and sustainability across the region.

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