



# United States Department of the Interior



## FISH AND WILDLIFE SERVICE

International Affairs  
5275 Leesburg Pike, MS: IA  
Falls Church, VA 22041-3803

SEP 15 2015

To: Chief, Division of Management Authority

From: Chief, Division of Scientific Authority *Rosemarie Green*

Subject: General Advice for the export of whole and sliced roots and parts of roots of wild and wild-simulated American ginseng (*Panax quinquefolius* L.) legally harvested during the 2015 harvest season in the approved States and Tribe.

Advice: The Division of Scientific Authority (DSA) finds that the export of whole and sliced roots and parts of roots, excluding manufactured parts or derivatives, such as powders, pills, extracts, tonics, teas and confectionery, of wild and wild-simulated American ginseng legally harvested during the 2015 harvest season in: Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Minnesota, Missouri, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and the Menominee Indian Tribe of Wisconsin, is not detrimental to the survival of the species, provided the following CONDITION is implemented:

All wild and wild-simulated American ginseng roots for export must be from plants that are 5-years of age or older (i.e., 4 or more stem scars on the rhizome connected to the root).

The age of American ginseng plants can be determined by counting the stem scars present on the rhizome (also called root neck) connected to the root. A stem scar is formed from the abscission of the aerial stem of the plant. Plants with 3 compound leaves, each leaf has 3 to 5 leaflets, are most likely to be 5-years of age or older.

This General Advice is valid unless DSA receives new information on the management or status of the species that suggests that this General Advice is no longer valid, and should be suspended and reconsidered by the DSA. If, after reconsideration, the DSA finds that the General Advice is no longer valid, we will issue a new General Advice.

### Basis for advice:

1. This finding is based on our review of the annual State and Tribe harvest reports for American ginseng (henceforth, referred to as ginseng), information from State and other Federal agencies, available scientific and commercial information including published and unpublished sources, and direct and indirect information about the status and trade of this species, to ensure that this finding is inclusive of the most current and relevant information. The ginseng management programs in the aforementioned States and Tribe are approved under the U.S. Fish and Wildlife Service (Service) CITES (Convention on International

Trade in Endangered Species of Wild Fauna and Flora) Export Program (CEP) for this species (50 C.F.R. 23.68).

### **International Trade and CITES Regulation**

2. International trade of wild-harvested ginseng roots began shortly after ginseng was discovered in Montreal in 1716 (Nash 1895; Carlson 1986), and has continued for nearly 300 years. Due to the high volume of wild ginseng roots annually exported and the concern of over-harvest for the export market, *Panax quinquefolius* was included in Appendix II of the CITES in 1975. The listing covers the export/re-export of plants, whole and sliced roots, and parts of roots (including root fibers and hairs), but excludes manufactured parts or derivatives such as powders, pills, extracts, tonics, teas, and confectionary. The harvest of wild ginseng is regulated in the aforementioned States and Tribe. Wild-harvested roots are primarily exported to China and other Asian countries.
3. As a result of the inclusion of this species in CITES Appendix II, the DSA is responsible for ensuring that the export of wild ginseng will not be detrimental to the survival of the species, and for monitoring exports to ensure that the species is maintained throughout its range at a level consistent with its role in the ecosystems and well above the level at which it might become eligible for inclusion in CITES Appendix I (Article IV of the Convention). Since 1999, the DSA has conditioned the export of wild roots to roots of plants that are 5-years of age or older, so that plants produce seeds necessary for regeneration and population growth.

### **Distribution and biological information**

4. Ginseng is a perennial understory herb plant that occurs in eastern North American deciduous forests (Anderson et al. 1993; McGraw et al. 2003). The species' historic range is from southern Canada (Ontario and Quebec), southwest to Oklahoma to northern Georgia and east to Maine (Gleason and Cronquist 1991). In the United States, the species' core range is the southern Appalachian region (Lockstadt 2012). Ginseng is found on a variety of slopes, aspects, elevations, and latitudinal and longitudinal gradients, and grows under numerous tree species (Anderson et al. 1993; McGraw et al. 2003, Young et al. 2013).
5. Ginseng is a slow-growing, long-lived species (Anderson et al. 1984; Charron and Gagnon 1991, adapted to the dynamic light environment of old growth deciduous forests (Wagner and McGraw 2013). Without disturbance, including harvest, survival rates of mature plants are considered high (Charon and Gagnon 1991). Plants produce a single aerial stem per growing cycle, if it is damaged a new stem is not produced during the growing cycle. Following the seedling stage, plants produce 3 to 4 (rarely 5) palmately compound leaves, each leaf has 3 to 5 leaflets, arranged in a whorl (Radford et al. 1981). Ginseng leaves, thus the size of an individual plant, are commonly called "prong" (e.g., 2-prong, 3-prong).
6. The aerial stem grows from the underground rhizome connected to the taproot. A permanent scar is formed on the rhizome as a result of the abscission of the aerial stem. The age of a root can be determined by counting the number of stem scars on the rhizome (Lewis and Zenger 1982; Anderson et al. 1993).
7. The size of a plant is a positive indicator of its capacity to flower and produce berries; larger

plants produce more flowers and berries than smaller plants (Lewis and Zenger 1982; Schlessman 1987; Anderson et al. 1993; Mooney and McGraw 2009). Plants with 2-compound leaves (2-prong) often produce flowers, but seed production is low and intermittent (Carpenter and Cottam 1982; Schlessman 1987; Souther and McGraw 2011). Plants are considered to be reproductive after five or more growing season when plants have 3- or 4- compound leaves (Mooney and McGraw 2007).

8. Plants produce a solitary umbel of perfect (i.e., both male and female reproductive parts), small white flowers in early summer (Carpenter and Cottam 1982; Lewis and Zenger 1982; Schlessman 1985). Ginseng has a mixed-mating system, meaning plants can reproduce by self- or cross-pollination (outcrossing) (Carpenter and Cottam 1982; Lewis and Zenger 1983; Schlessman 1985). Following fertilization, berries (botanically known as drupes) are formed in mid-July, changing in color from green to bright red when mature. Seeds from red berries are much more likely to germinate than seeds from green berries (McGraw et al. 2005). Berries are gravity dispersed, typically falling within 2 meters (6.5 feet) of the parent plant (McGraw et al. 2005; Van der Voot 2005). Recent work has shown that thrushes (*Hylocichla* spp.), particularly the wood thrush (*H. mustelina*), are the primary vector for short-distant (< 100 meters (328 feet)) dispersal of berries, and that regurgitated seeds remain viable (Hruska et al. 2014).
9. Berries can have 1 to 3 seeds; most common are 2-seeded (Lewis and Zenger 1982; Anderson et al. 1984). Seeds require a warm and cold stratification period of 18 to 22 months before germination (Lewis and Zenger 1982; Charon and Gagnon 1991; McGraw et al. 2003), and can remain viable for up to four years in the soil (Souther and McGraw 2011). The natural fecundity of the species has been reported to be low (Carpenter 1980; Carpenter and Cottam 1982; Lewis and Zenger 1983; Schlessman 1985); however, high seed viability and germination have been reported (Hu et al. 1980; Lewis and Zenger 1982; Schlessman 1985; Charron and Gagnon 1991; McGraw et al. 2010). Seedlings are reported to be the most vulnerable stage of the species' life cycle (Charron and Gagnon 1991).
10. As a consequence of nearly 300 years of intensive harvest (Carlson 1986) and habitat loss, ginseng abundance has been reduced throughout its range. Using export and harvest data as proxies for ginseng abundance, from 1821 to 1899, an average of 381,000 pounds of dried ginseng were exported annually (Carlson 1986). The current 10-year average harvest of wild ginseng roots is 63,766 lbs., a difference of 142.65%. Even accounting for the larger ginseng roots than root sizes today, the export amount indicates that ginseng was much more abundant than it is today. Furthermore, unoccupied ginseng habitat exists throughout the species' range (Thatcher et al. 2006; McGraw et al. 2013; Young et al. 2013).
11. Ginseng occurs in thousands of small populations of 200 or fewer plants with a clustered spatial distribution (Cruse-Sanders and Hamrick 2004a; McGraw et al. 2013; Young et al. 2013). A single population can cover from 0.04 to 4 hectares (1-9.8 acres), comprised of smaller patches of plants (termed "clusters" by Dr. McGraw), which range from 1 plant to more than 100 plants/m<sup>2</sup> (1 m<sup>2</sup> = 10 ft<sup>2</sup>) (McGraw et al. 2013; Wagner and McGraw, 2013).

## **Genetic information**

12. Genetic diversity (heterogeneity) gives species the ability to adapt to changing environmental conditions including climatic conditions. Ginseng plants tend to be genetically related indicating limited pollen flow (i.e., limited gene exchange) between populations (Cruse-Sanders and Hamrick 2004b; Grubbs and Case 2004; Cruse-Sanders et al. 2005; Schlag and McIntosh 2012; Young et al. 2013). Small, geographic distant populations increase the likelihood of genetically related plants through inbreeding, which can result in a loss of genetic diversity and reduced fitness within the population (Hackney and McGraw 2001; Cruse-Sanders and Hamrick 2004 a, b; Mooney and McGraw 2007). Harvest pressure has also shown to reduce the genetic diversity within populations by the removal of mature plants (Cruse-Sanders et al. 2005).
13. Ginseng populations have evolved to local environments and are adapted to local temperature conditions (Souther and McGraw 2011). Loss of genetic diversity may result in populations with lower competitive ability to adapt to changing climatic conditions (Souther and McGraw 2014).
14. Cultivated ginseng has higher levels of genetic diversity than wild plants (Bai et al. 1997; Boehm et al. 1999; Schluter and Punja 2002; Grubbs and Case 2004; Schlag and McIntosh 2012), and the plants are genetically more similar to each other than to wild plants (Boehm et al. 1999; Schluter and Punja 2002; Grubbs and Case 2004; Lim et al. 2007; Obae and West 2011; Schlag and McIntosh 2012). Ginseng has been intensively cultivated for over 100 years, thus the higher genetic diversity found in cultivated plants is likely due to greater pollen exchange between closely spaced plants, and the continual mixing of seed lots by growers (Schlag and McIntosh 2012).
15. The introduction of plants derived from cultivated-sourced seeds into wild populations has genetic consequences due to the introduction of genotypes that are not locally adapted, which can result in maladapted alleles or the breakup of co-adapted gene complexes in wild populations, and may lead to outbreeding depression and reduced fitness (Grubbs and Case 2004; Mooney and McGraw 2007 and 2009; Souther and McGraw 2011; Schlag and McIntosh 2012). Cross-pollination among wild and non-wild plants allows for the exchange and recombination of genes, resulting in progeny that may be less adapted to the forest environment. As with other wild-harvested species (e.g., game spp., fish spp.), the genetic issues are cause for concern for ginseng conservation.
16. Genetic research has elucidated the genetic variation within and among wild populations, genetic structure of populations in various landownership classes and management regimes, the genetic distinctness of wild and cultivated plants, and the evolutionary lineage of the species. However, research is needed to better understand the genetic consequences of introducing cultivated genotypes into wild populations. Research is also needed to develop genetically local provenance seed collection and transfer zones for the establishment of seed production areas for restoration and cultivation purposes.

## **Threats**

17. Although the scale of illegal harvest of ginseng is unknown, it is widespread and often associated with high unemployment rates in rural communities, illegal drug use, and other criminal activities. Illegal harvesters target areas where ginseng is known to occur, such as

- National Parks, Federal and State forests, and privately owned lands, and are known to dig roots of plants of all ages during the closed harvest season (McGraw et al. 2010).
18. Illegal harvest is a threat to ginseng populations because it puts more pressure on wild populations as plants are killed before seeds are produced, which are necessary for regeneration and population growth (Van der Voort and McGraw 2006, McGraw et al. 2010). We continue to be concerned about the scale of illegal harvest and its negative effect on wild populations. This is of particular concern as some do not view poaching as illegal, and regard wild ginseng as the property of the finder regardless of landownership (Price 1960; Pokladnik 2008).
  19. White tail deer (*Odocoileus virginianus*) browse (McGraw and Furedi 2005; Farrington et al. 2008), climate change (Souther and McGraw 2011), land-use-change (McGraw et al. 2013), and invasive non-native plant species are also threats to the species (Wixted and McGraw 2008).
  20. McGuffin (2009) reported that ginseng dealers annually provide approximately 6 to 17 million cultivated-sourced ginseng seeds to diggers to plant in forest woodlands. The practice of planting cultivated seeds in existing wild ginseng populations threaten populations by introducing genotypes that are not locally adapted, which may adversely affect the genetic diversity of wild populations and the long-term viability of the species (Grubbs and Case 2004; Mooney and McGraw 2007).

### Conservation Status

21. Since 2000, the conservation status of ginseng is ranked as vulnerable/apparently secure (N3N4) in the United States (NatureServe 2015). In Canada, the species is nationally listed as “endangered” due to overharvest and significant loss of population size (COSEWIC 2015).
22. The State conservation status of ginseng in 21 CEP States, is as follows (NatureServe 2015):
  - Imperiled/ Vulnerable – Maryland and Michigan;\*
  - Vulnerable/apparently secure – Kentucky, New York, North Carolina, Tennessee, Virginia, and West Virginia;
  - Vulnerable – Georgia, Illinois, Indiana, Iowa, Maine,\* Minnesota, and Vermont; and
  - Apparently secure – Alabama, Arkansas, Missouri, Pennsylvania, and Wisconsin.
  - Conservation status not assessed – Ohio.

\*Wild-harvest of ginseng is prohibited in the State; only the harvest of artificially propagated ginseng is allowed.

23. The State conservation status of ginseng in the remaining States within the species’ range, is as follows (NatureServe 2015):
  - Critically imperiled – Kansas, Nebraska, Louisiana, Oklahoma, Rhode Island, and South Dakota;
  - Imperiled – Connecticut, Delaware, New Hampshire, and New Jersey;
  - Vulnerable – Massachusetts, Mississippi; and

Apparently secure – South Carolina.

### **States and Tribe regulations of ginseng**

24. The 19 CEP States and Tribe regulate the harvest, selling, and certification of wild ginseng roots within their borders. State and Tribe regulations are designed to promote sustainable harvest and regeneration of ginseng through the designation of an appropriate harvest season start date; a harvest size limit (i.e., 3-leaf, 4-leaf plants) and/or a minimum age limit; planting berries of harvested plants in the vicinity of the harvested roots; and other related requirements (see Table 1). Harvested roots must be certified by the designated State and Tribe officials prior to interstate transport of the roots.
25. As of December 2014, Vermont amended its regulations for wild ginseng. The regulations now required wild ginseng roots to be harvested from plants 10 years of age with three compound leaves and plants must have red berries. A provision for the harvest of wild roots from 7, 8, and 9 year-old plants on land owned by the harvester is permitted, if the land is at least 5 contiguous acres in size or the property meets other State requirements as defined by regulation. In addition, the harvest season start date was changed from August 20 to September 1.
26. The harvest season start date is now September 1 in all 19 States and the Tribe. The harmonized start date will help to discourage illegal harvest and transport of ginseng roots across neighboring borders.
27. Sixteen of the 19 States prohibit the harvest of ginseng on State lands (e.g., State parks and forests, natural areas, and wildlife management areas), while three States restrict harvest to certain public lands, and require diggers to obtain and possess State issued harvest permits. Although most States require harvesters to obtain landowners' permission to harvest ginseng on land not their own, most do not require written permission by the landowner.
28. States and the Tribe provide information (e.g., web pages, pamphlets) to inform the public on the laws and regulations relating to the harvest, selling, and buying of ginseng. Most States' web sites include information about the Service's role in the international export of ginseng as a CITES-listed species, as well as provide a link to the Service's ginseng web pages. In addition, most States' web sites provide a link to the American Herbal Products Association's (AHPA) web site, where informational brochures for each of the 19 States are posted. The brochure, titled "Good Stewardship Harvesting of Wild American Ginseng," include harvest regulations and good stewardship harvest practices for wild ginseng, and were jointly developed by the Service, AHPA, and other partners.
29. Only a few States track separately the harvested amounts of wild and wild -simulated roots, and report the weights separately in their annual reports to the Service. Although most States do not require harvesters and dealers to report wild-simulated root and wild root weights separately, the information is important for the analysis of the non-detriment finding.

### **USDA Forest Service management of ginseng**

30. The Forest Service (FS) is responsible for the conservation and management of ginseng and its habitat in National Forest lands, as directed by regulation and directive (36 CFR 223.219; FSH 2409.18\_87.1). The National Forests are required to determine sustainable harvest levels of all native plants referred to as ‘special forests products’ (i.e., non-timber forest products), which includes ginseng. National Forests are located within 18 CEP States, but not all National Forests allow the harvest of ginseng. The National Forests that issue ginseng harvest permits, track the permits through an agency-wide database to prevent the issuance of more than the allowable amount of permits to an individual.
31. The FS Eastern Region includes 13 National Forests in 12 States (Illinois, Indiana, Maine, Michigan, Missouri, New Hampshire, New York, Ohio, Pennsylvania, Vermont, West Virginia, and Wisconsin). Since 2000, 10 of the 13 National Forests in the Region include ginseng on the Region’s Sensitive Species List. Species designated as “sensitive” are considered rare on the National Forest, and harvest of plants/roots is prohibited except for research purposes and tribe agreements. Due to concerns about the over-harvest and decline of the species, many of the National Forests in the Region prohibited the harvest of ginseng before it was officially designated as ‘sensitive’ (Kauffman 2006). Of the other three National Forests, harvest is allowed on two the Forests, the Monongahela NF (in West Virginia) and the Wayne NF (in Ohio). Both National Forests limit the number of permits issued and the harvest amount based on estimated population sizes within the respective Forest. Both Forests have long-term monitoring plots to assess the status of ginseng; however, not all plots are monitored annually due to budgetary and resource constraints.
32. The Southern Region includes National Forests in 10 States (Alabama, Arkansas, Georgia, Kentucky, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Virginia). The species is not listed as “sensitive” in the Region; however, harvest is prohibited in National Forests in Alabama, Arkansas, South Carolina, and Virginia due to concern about the decline of the species (Kauffman 2006). Ginseng harvest is allowed in five National Forests in four States (Georgia, Kentucky, North Carolina, and Tennessee). The National Forests in North Carolina (Nantahala NF and Pisgah NF) and Tennessee (Cherokee NF) have long-term monitoring plots; however, not all plots are monitored annually due to budgetary and resource constraints. In 2013, due to concern over reductions in the abundance of wild ginseng, the five National Forests implemented restrictions on the number of permits issued and the harvest amount to conserve wild populations, which remain in effect.
33. Due to concern about the status of ginseng in the Southern Region, a conservation assessment of the species within the Region is being conducted, and is expected to be completed in the latter half of 2016. A multi-year demographic and genetic study is also being conducted by the U.S. Geological Survey; scheduled to be completed in 2016. The study includes ginseng populations on the Monongahela, Wayne, Nantahala, and Pisgah National Forests. The Forest Service will use the results of the two studies to improve the management of ginseng in the National Forests in the Northern and Southern Regions.

#### **Law enforcement efforts**

34. State, Tribe, and Federal law enforcement officials enforce the laws designed to protect wild ginseng, and thus play a critical role in the conservation and management of this species.

With the advent of the televised reality shows that sensationalize the illegal harvest and poaching of wild ginseng, and the ease and profitability of wild roots, there has been an increase in the level of poaching reported on private and public lands over the past two years, and an increase in violations for illegally harvested ginseng and related activities. Law enforcement officials also see a link in some cases, between poaching and illegal drug use in Appalachian communities (Maher 2014).

35. Law enforcement officials are concerned that penalties alone do little to deter poachers, as well as having adequate resources to police extensive forest lands (Maher 2014; Hanson 2015). The financial gain by selling wild ginseng roots is likely to continue to drive poachers, particularly as fresh ginseng roots can bring up to \$200 per pound on the black market (Service Law Enforcement Special Agent 2014). According to one ginseng expert, "it's so easy to sell ginseng illegally" (R. Beyfuss cited in Maher 2014).
36. In 2014, State and Federal officials reported ginseng violations, including poaching on private and public lands, harvest during closed season, harvest without a license, and harvest of under-aged roots. While we do not have a comprehensive list of all law enforcement efforts to apprehend and prosecute offenders, the following cases were reported in 2014.
  - Indiana reported the arrest of 25 people in possession of illegal ginseng roots harvested during the closed season.
  - Iowa Department of Natural Resources reported 161 charges for illegal harvest on State land; 12 charges for under aged roots; 1 charge for harvest during closed season; 3 charges for possession without a license; and 140 charges for failure to retain plant stems with harvested roots.
  - Ohio Department of Natural Resources (OHDNR) reported a 230% increase in ginseng violations (the most common was harvest during closed season) from 2013 to 2014.
  - OHDNR Wildlife Officers seized more than 60 pounds of illegally harvested ginseng root and issued more than 125 summonses for illegal activity related to harvesting wild ginseng.
  - Tennessee Department of Environment and Conservation reported a significant increase in the number of ginseng violations issued in 2014 compared to previous years; 46 violations were issued for illegal ginseng activities, including 22 violations for harvest during closed season.
  - West Virginia Division of Natural Resources reported 190 pounds of illegal wild ginseng roots were seized before the September 1 harvest season start date, and 11 related arrests were made.
  - West Virginia Division of Forestry reported 49 violations and 46 convictions were made relating to illegal ginseng.
  - Wisconsin Department of Natural Resources reported 37 citations were issued for illegal ginseng activities, including trespassing and harvest without a license.
  - The U.S. Department of Justice sentenced an individual to 80 days and a \$1000 dollar fine for possession of 298 wild ginseng roots.
37. In August 2014, an individual was sentenced to over five months in prison for the possession of 83 wild ginseng roots illegally dug from the Great Smoky Mountains National Park (GSMNP) (DOJ 2014). In August 2015, the same person was sentenced to six months

in prison for possessing more than 500 wild ginseng roots illegally dug from the GSMNP. It was the person's fifth conviction for illegal harvest of wild ginseng (Hanson 2015).

38. By July 2015, Forest Service law enforcement officials had issued several citations for illegal harvest of ginseng roots on the Daniel Boone National Forest (in Kentucky), which included a repeat offender (Bonaccorso 2015).
39. We continued to be concerned over the illegal harvest of wild ginseng roots as reported by States, Federal agencies, and private landowners.

### **Wild-simulated American ginseng**

40. Wild-simulated ginseng refers to plants and roots that are derived from cultivated-sourced seeds intentionally planted in natural forest habitat (Beyfuss 1999; Persons and Davis 2005). Accordingly, plants grow in the forest environmental under natural conditions with little to none human intervention, as such the roots have wild-like characteristics which can be physically indistinguishable from roots of wild plants.
41. Forest-based wild-simulated ginseng is widely promoted by State extension offices, land-grant universities, local community organizations, and ginseng growers' associations. Seeds produced from commercial field ginseng operations in Canada and the United States are readily available, as well as seeds, rootlets, and transplants from woods-grown ginseng operations in the United States.
42. Privately-owned forest lands dominate the eastern and southern United States, with public forest lands (State and Federal lands) representing approximately 20% of the total forested land (USDA Forest Service 2002). Although planting cultivated-sourced seeds is prohibited on most State and all Federal lands, such lands are accessible and planting seeds for future harvest occurs; however, the full extent is unknown. Reportedly, approximately 6 to 17 million cultivated-sourced ginseng seeds are annually provided to diggers to plant in forest woodlands (McGuffin 2009).
43. The production of wild-simulated ginseng on privately-owned forest lands provides an alternative source of ginseng roots to the export market that may take harvest pressure off wild ginseng populations (Burkhart and Jacobson 2008), and may contribute to price stabilization as a result of reliable harvest yields (Burkhart 2013). Although there is strong interest in forest-based wild-simulated ginseng, the lack of transparency in the industry weakens the legitimacy of this important sector of the trade.
44. While we recognize the conservation benefits of forest-based wild-simulated ginseng, we are concerned over the planting of cultivated-sourced seeds on State and Federal lands and private conservation lands because introduced non-local genotypes pose a risk to existing wild populations and the long-term viability of the species. We are also concerned that most States do not track and report the harvested amounts of wild-simulated and wild roots separately in their annual reports to the Service. This continued practice may lead to misleading conclusions about the sustainability of wild populations due to harvest pressure.

### **Annual harvest and export of ginseng**

45. Based on harvest data compiled from the State and Tribe annual reports for the 2014 ginseng harvest season, the 2014 season was the largest harvest reported since 1997 and earlier harvest years (Figure 1). A total of 89,847 dried pounds (lbs.) of wild ginseng roots were harvested during the 2014 harvest season; representing approximately 19,766,340 harvested plants with 3-leaves (3-prong) or more (220 dried roots/lb. average). The 2014 harvest was an 18.4 % increase (13,955 lbs.) over the 2013 harvest, resulting in an additional 5% more plants (ca. 945,124) harvested than the previous season. Although not as high as the previous two harvest season, dealer prices paid for wild ginseng averaged ca. \$700 per pound (Persons 2015).
46. The 2013 harvest amount was a 37.6% increase over the 2012 harvest amount. With the exception of the 2009 harvest, the past two harvest seasons have exceeded all annual harvests in the past 10 years. In particular, the 2014 harvest was nearly a 41% (40.90%) increase over the 10-year average harvest amount of 63,766 lbs. (ca. 14,985,000 plants).
47. The top five harvesting States continue to be Kentucky (23.4%), Tennessee (14.3%), North Carolina (12.5%), West Virginia (10.9%), and Indiana (8.7%). With the exception of three States (Alabama, New York, and Tennessee), the States' 2014 harvest exceeded their 2013 harvest, and all but four States (Alabama, Iowa, Missouri, and Wisconsin) exceeded their 10-year average harvest amount (Figure 2).
48. Indiana was the only State that reported the increase in harvest was likely due to favorable growing conditions for ginseng. Whereas, many States reported increases in the number of harvesters and licensed dealers, particularly new comers to the ginseng trade. North Carolina reported an increase of over 3,000 more harvesters in 2014 compared to previous years; from ca. 10,350 in 2011 to ca. 16,700 harvesters in 2014. The number of licensed harvesters in Wisconsin increased by nearly 42% in 2014, compared to the three previous harvest seasons. Ohio reported a 42.8% increase in the number of licensed dealers and a 93% increase in the number of diggers from 2013 to 2014. Tennessee also reported the highest annual increase in the number of licensed dealers in the State in 2014.
49. For the second year in a row, many States reported that the increase in the number of harvesters and dealers was most likely related to the televised reality shows that exaggerate the profitability of wild roots, as well as popularizing unethical and illegal harvest on public and private lands. The heightened interest in ginseng has resulted in a "ginseng fever." Of concern is the rapid increase in the amount of wild roots harvested over the past two seasons, and the increase in violations reported. The additional harvest pressure resulted in a greater quantity of low quality, small roots harvested in 2014, compared to previous harvest seasons (Persons 2015).
50. To date, 79,579 lbs. of 2014 wild-harvested ginseng roots have been legally exported from the United States. Although export data vary year-to-year depending on market influences and international demand for wild roots, it does provide trend information that we monitor (Figure 1). Fewer exports of 2014 wild roots were mostly attributed to the shutdown of the Hong Kong ginseng market during the protests in the fall of 2014 (W. Hsu, pers. comm. February 11, 2015; [www.wildgrown.com](http://www.wildgrown.com)).

51. Over the past two harvest seasons, there has been a significant increase in the amount (weight) of green (fresh) wild roots reported by States in their annual reports. In particular, the top three harvesting States, Kentucky, North Carolina, and Tennessee, reported large increases in the amount of green roots reported in 2014 compared to previous years. A standard conversion factor and methodology does not currently exist among the 19 CEP States and Tribe to convert green weight to dried weight. As such, there is variation among the States as to the conversion factor used.
52. Green roots have a high moisture content that is approximately three times the weight of dried roots. The moisture content of fresh roots varies due to environmental factors (e.g., climate, soil, habitat), and the genetic makeup of individual plants. The post-harvest care of the roots and the duration from harvest to when the roots are weighed can significantly affect the moisture content of the roots. Therefore, to ensure accurate reporting of roots harvested and certified, we will recommend to the States and Tribe that they report dry and green weights separately, and not convert green weight to dry weight in their annual reports to the Service.
53. Only three States reported harvest of wild-simulated roots: North Carolina reported 28 lbs.; Tennessee reported 17.2 lbs.; and West Virginia reported 112 lbs. For the 2014 harvest season, a total of 157.2 lbs. of wild-simulated ginseng roots were reported. We know that the amount of harvested roots reported by many States as “wild” may actually represent wild and some amount of wild-simulated ginseng roots. By not reporting the weights separately, it is difficult to fully assess the effects of harvest, and thus the export, on wild populations. Therefore, to improve our analysis, we will discuss with the States measures for tracking and reporting the harvest amounts separately in the annual reports to the Service.
54. We continue to request the 19 CEP States and Tribe to report the number of roots per pound because the data is used to estimate the number of plants annually harvested, and it provides trend information that we monitor annually in order to be aware of any irregularities that would be of concern.
55. To better inform ginseng dealers and exporters, the Service published an informational brochure that covers good stewardship practices to be implemented by harvesters, dealers, and exporters to ensure the continued sustainable harvest of wild ginseng; how to age ginseng roots; the export requirements under CITES; and important contact information. In 2014, a limited number of the brochures were published and distributed to the CEP programs and CITES exporters. In 2015, the brochure was revised based on feedback from the States and others. The second printing of brochure was again distributed to the CEP programs and exporters. The brochure is also available on the Service’s ginseng web page (<http://www.fws.gov/international/pdf/factsheet-american-ginseng-harvesters-dealers-exporters.pdf>).

## Summary

56. Ginseng has a late reproductive maturity of five or more growing seasons, and high seed and seedling mortality rates. These biological factors mean that population growth rates are low and that if populations are excessively harvested and greatly reduced in size, it can take many years for populations to return to sustainable population levels. To offset these

factors, the 19 CEP States and Tribe have regulations in place to limit the size and/or age of harvested plants, the start date of the harvest season, and require harvesters to plant the seeds of harvested plants in the vicinity of harvested roots. In addition, the National Forests that allow harvest have further restrictions to protect the species from over-harvest. To ensure that the export of wild and wild-simulated ginseng roots is not detrimental to survival of this species, roots must be of plants 5-years of age or older, so that plants produce seeds necessary for regeneration and population growth.

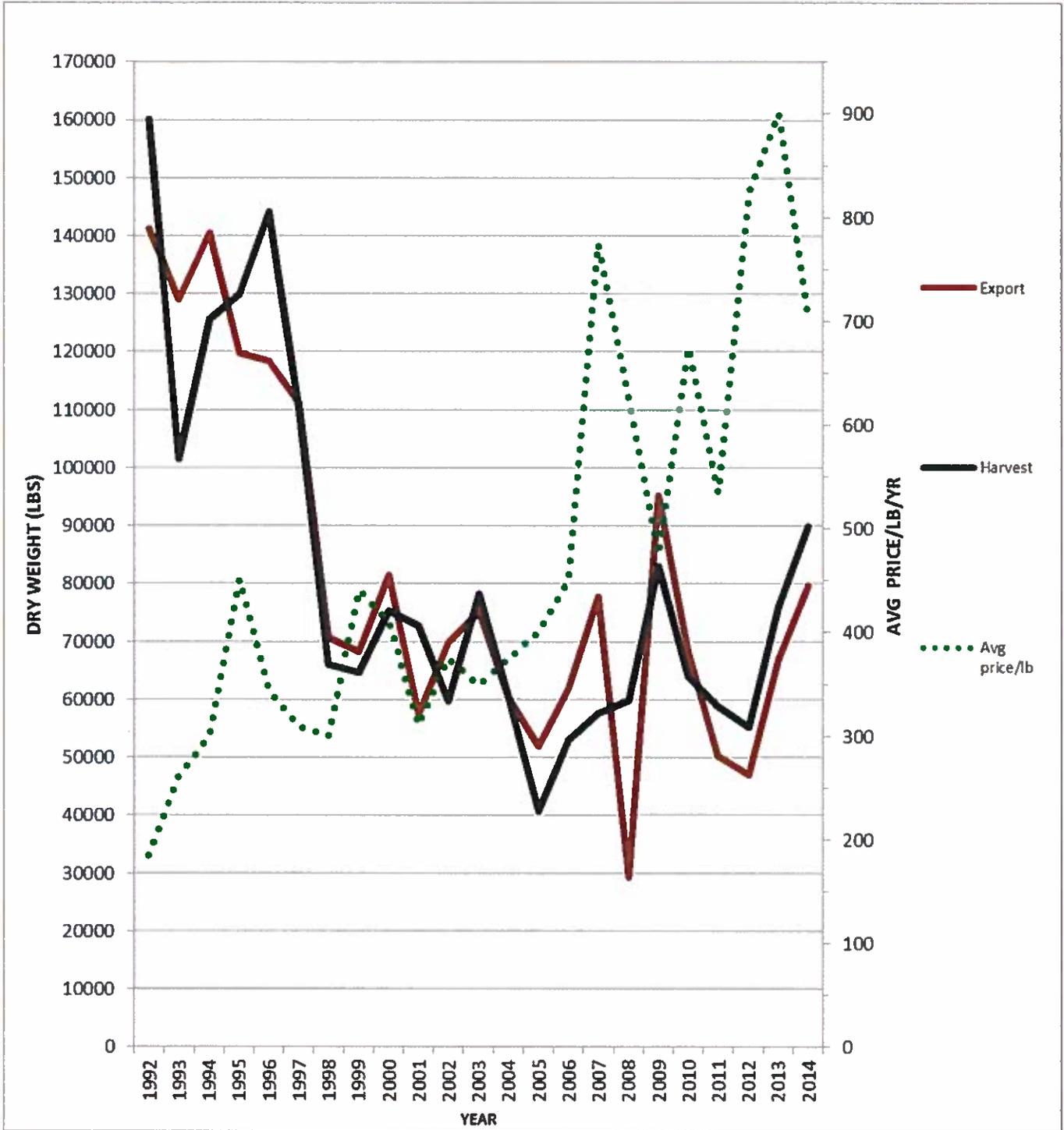
57. We note with concern the large increase in the amount of wild roots harvested over the past two harvest seasons, which could impact the sustainability of wild populations of ginseng. As a result of the recent increased interest in harvest of wild ginseng, and the continued high prices paid for wild roots, many States reported increases in the number of new diggers and dealers over the past two seasons. The increase in diggers resulted in a greater amount of low quality, small roots compared to previous harvest seasons (Persons 2015). We believe this may indicate increased harvest pressure on wild populations.
58. New diggers may not ascribe to the traditional “steward” values of many long-term diggers. This stewardship is consistent with harvest regulations and contributes to the long-term sustainability of wild ginseng. With the influx of new diggers, it may be prudent for States to issue harvest licenses or permits, as a means for providing diggers with harvest information and regulatory requirements, among other things.
59. Most States do not track and report the harvested amounts of wild-simulated and wild roots separately in their annual reports to the Service. We continued to be interested in development of a transparent way to distinguish wild-simulated ginseng from wild ginseng in order to best understand the impact of harvest on wild populations.
60. The illegal harvest of wild ginseng roots as reported by States, Federal agencies, and private landowners is notable. Several States that reported increases in the number of diggers and dealers, also reported increases in the number of illegal ginseng violations (e.g., North Carolina, Ohio, Tennessee). Illegal ginseng violations included roots dug out of season, the harvest of under-sized/under-age plants, and poaching on public and private lands. Illegal harvest directly undermines the efforts of the State and the Forest Service to conserve and manage ginseng in a sustainable manner. In particular, ginseng roots harvested out of season, prevent the plants from producing the necessary seeds for regeneration and population growth. Poaching ginseng on National Park Service lands is of particular concern as parks provide critical refugia essential for the conservation of this species.

#### **Future actions**

61. We will continue to monitor the impact of harvest on wild populations, including the following actions:
  - a. Monitor the status of wild ginseng and assess further progress relating to the harvest and management of ginseng at the State and Federal level in our finding for 2016;
  - b. Engage with the ginseng industry and the States and Tribe to better understand and address the impacts of the two most recent record harvest years on wild populations;

- c. Explore with the ginseng industry and the States and Tribe options for ensuring that new diggers are contributing to the long-term sustainability of the species, including harvest licenses and permits and outreach;
- d. Develop with the State and Tribe a practical system to allow for the separate reporting of the harvest amounts of wild-simulated roots and wild roots in the annual reports; and
- e. Participate in industry efforts to develop a ginseng seed bank that would supply local provenance seeds to growers and harvesters.

Figure 1: 1992-2014: Harvest, export, and price data for wild ginseng roots.



Price data provided by W. S. Persons, Tuckasegee, NC.

Figure 2: 2014 harvest amounts and the 10-year average harvest amounts by State.

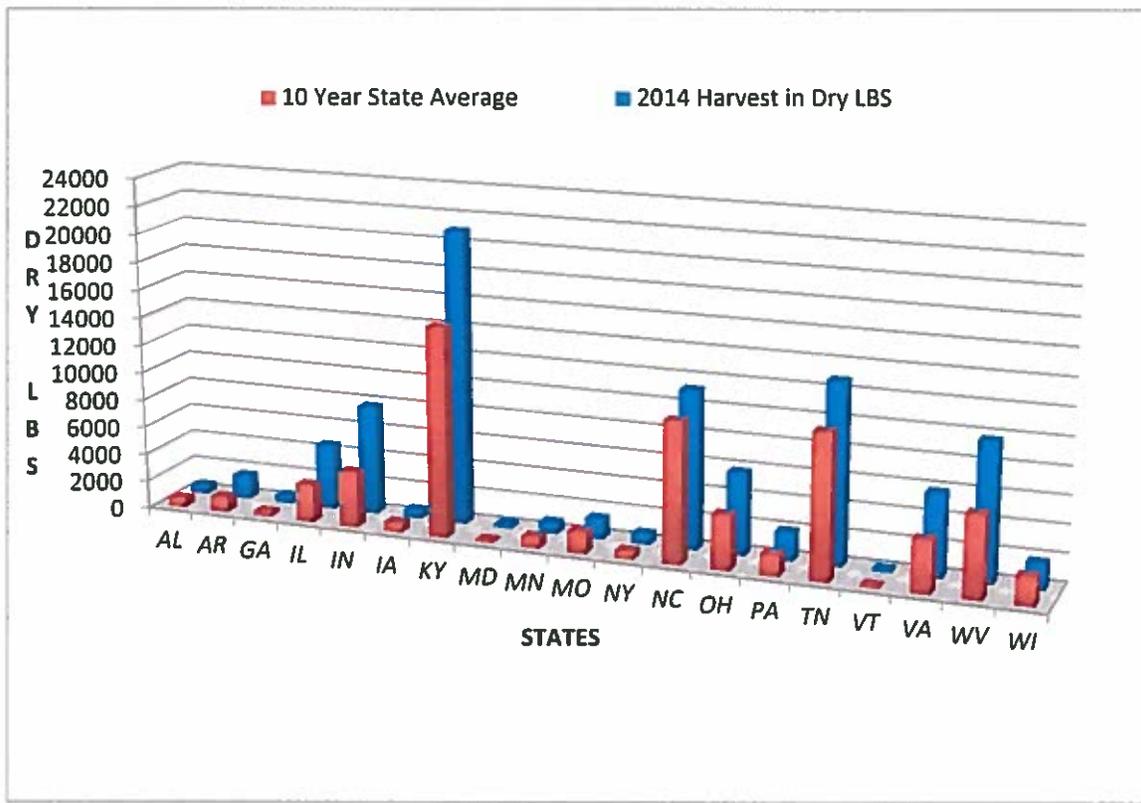


Table 1. Current State and Tribe harvest regulations for American ginseng.

State	Harvest Season	Harvest permitted on State/Tribe lands	Monitoring ginseng on State/Tribe lands	Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required	Harvest regulations
Alabama	Sept 1–Dec 31 Harvest dates do not apply to ginseng harvested for personal use on land owned or managed by the collector.	No	No	Landowner's written permission is required. Harvesters must register annually with the State.	Plants with 3 leaves and ripe berries (red). Seeds of harvested plants must be planted at harvest site.

<b>State</b>	<b>Harvest Season</b>	<b>Harvest permitted on State/Tribe lands</b>	<b>Monitoring ginseng on State/Tribe lands</b>	<b>Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required</b>	<b>Harvest regulations</b>
Arkansas	Sept 1–Dec 1	No	No	Landowner's permission is not required. State-issued harvest license is not required.	Plants with 3 leaves, 5 years of age or older, and red berries. Seeds of harvested plants must be planted at harvest site.
Georgia	Sept 1–Dec 31	No	No	Landowner's written permission is required. State-issued harvest license/permit is not required.	Plants with 3 leaves and the stalk of plant present. Seeds of harvested plants must be planted at harvest site.
Illinois	First Saturday in Sept–Nov 1	No	No	Landowner's permission is required. State-issued harvest license/permit is not required.	Plants with 4 leaves and are 10 years of age years or older. Seeds of harvested plants must be planted in the vicinity of parent plants.
Indiana	Sept 1–Dec 31	No	No	Landowner's permission is required. State-issued harvest license/permit is not required.	Plants with 3 leaves and a flowering or fruiting stalk present or 4 internodes on rhizome. Seeds of harvested plants must be planted in the vicinity of parent plants.

<b>State</b>	<b>Harvest Season</b>	<b>Harvest permitted on State/Tribe lands</b>	<b>Monitoring ginseng on State/Tribe lands</b>	<b>Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required</b>	<b>Harvest regulations</b>
Iowa	Sept 1–Oct 31	No	No	Landowner’s permission is not required. State-issued harvest permit is required.	Plants with 3 leaves with red berries. Rhizome must have 5 or more stem scars. The entire plant except the berries/seeds must be retained. Seeds of harvested plants must be planted within 100 feet (ft) of parent plants, and cannot be removed from harvest site.
Kentucky	Sept 1–Dec 1	No	Yes	State-issued harvest license is required.	Plants with 3 leaves and 5-years of age. Seeds of harvested plants must be planted within 50 ft of harvested plants.
Maryland	Sept 1–Dec 1	No	Yes	State recommends landowner’s permission is obtained. State-issued harvest permit is required.	Plants with 3 leaves and mature berries (red). Seeds of harvested plants must be planted in the vicinity of harvested plants. Planting locally grown seed is recommended.

<b>State</b>	<b>Harvest Season</b>	<b>Harvest permitted on State/Tribe lands</b>	<b>Monitoring ginseng on State/Tribe lands</b>	<b>Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required</b>	<b>Harvest regulations</b>
Minnesota	Sept 1–Dec 31	Harvest is allowed on all State forest land. Harvesters must have in their possession a State-issued permit. No harvest is allowed in State parks and State scientific and natural areas.	No	Landowner's permission is not required. State-issued harvest license/permit is not required.	Plants with 3 leaves with 15 leaflets. Seeds of harvested plants must be planted at or near harvest site.
Missouri	Sept 1–Dec 31	No	Yes	Landowner's permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves. Seeds of harvested plants must be planted within 100 ft. of parent plants.
New York	Sept 1–Nov 30	No	No	Landowner's permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves and mature berries (red). Seeds of harvested plants must be planted within 50 ft. of harvest.

<b>State</b>	<b>Harvest Season</b>	<b>Harvest permitted on State/Tribe lands</b>	<b>Monitoring ginseng on State/Tribe lands</b>	<b>Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required</b>	<b>Harvest regulations</b>
North Carolina	Sept 1–Dec 31	No	Yes	Landowner's written permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves or at least 5 bud scars. Seeds of harvested plants must be planted within 100 ft. of harvest.
Ohio	Sept 1–Dec 31	No	Yes	Landowner's written permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves. Seeds of harvested plants must be planted at harvest site.
Pennsylvania	Sept 1–Nov 30	No	Yes	Landowner's permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves and red berries. Seeds of harvested plants must be planted in the vicinity of harvest site.
Tennessee	Sept 1–Dec 31	No on majority of State lands.	No	Landowner's permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves and mature berries (red). Seeds of harvested plants must be planted at or near harvest site.

<b>State</b>	<b>Harvest Season</b>	<b>Harvest permitted on State/Tribe lands</b>	<b>Monitoring ginseng on State/Tribe lands</b>	<b>Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required</b>	<b>Harvest regulations</b>
Vermont	Sept 1–Oct 31	Yes. Harvesters must have in their possession a State-issued permit.	No	Landowner's permission must be obtained. State-issued harvest permit is required.	Plants 10-years of age with 3 leaves, & red berries; or plants 7-9-years of age with 3 leaves, & red berries harvested on harvesters' own land of at least 5 contiguous acres or the property meets other State requirements.
Virginia	Sept 1–Dec 31	No	No	Landowner's permission must be obtained. State-issued harvest license/permit is not required.	Plants must be 5 years of age or older, and seeds of harvested plants must be planted at harvest site.
West Virginia	Sept 1–Nov 30	No	Yes	Landowner's written permission must be obtained. State-issued harvest license/permit is not required.	Plants with 3 leaves and 15 leaflets, and red berries. Seeds of harvested plants must be planted at harvest site.
Wisconsin	Sept 1–Nov 1	No	No	Landowner's permission must be obtained; State-issued harvest permit is required.	Plants with 3 or more leaves; and flowering/fruitletting stalk must be retained. Seeds of harvested plants must be planted near parent plants.

State	Harvest Season	Harvest permitted on State/Tribe lands	Monitoring ginseng on State/Tribe lands	Landowner permission required to harvest ginseng and/or State/Tribe issued harvest license required	Harvest regulations
Menominee Indian Tribe of Wisconsin	Sept 1 –Oct 31	Yes	Yes	MITW-issued harvest license is required.	Plants 10-years of age with red berries. Seeds of all harvested plants must be planted in the vicinity of parent plants. Importing and planting of non-local (i.e., foreign) ginseng seed within the MITW Reservation is prohibited.

## References

- Anderson, R. C., J. S. Fralish, J. Armstrong, and P. K. Benjamin. 1984. Biology of ginseng (*Panax quinquefolium*) in Illinois. Illinois Department of Conservation, Division of Forest Resources and Natural Heritage. Springfield, Illinois.
- \_\_\_\_\_, J. S. Fralish, J. Armstrong, and P. K. Benjamin. 1993. The ecology and biology of *Panax quinquefolium* L. (Araliaceae) in Illinois. *American Midland Naturalist* 129: 357-372.
- \_\_\_\_\_, M. R. Anderson, and G. Houseman. 2002. Wild American ginseng. *Native Plants Journal* 3(2): 93-105.
- Bai, D., J. Brandle and R. Reeleder. 1997. Genetic diversity in North American ginseng (*Panax quinquefolium* L.) grown in Ontario detected by RAPD analysis. *Genome* 40: 111-115.
- Beyfuss, R. L. 1999. Agroforestry Notes 14. USDA Forest Service and USDA Natural Resources Conservation Service.
- Boehm, C. L., H. C. Harrison, G. Jung, and J. Nienhuis. 1999. Organization of American and Asian ginseng germplasm using randomly amplified polymorphic DNA (RAPD) markers. *Journal American Society Horticulture Science* 124: 252-256.
- Bonaccorso, K. Illegal harvest occurring on national forest lands. USDA Forest Service Daniel Boone National Forest. Press release July 14, 2015.
- Burkhart, E. P. and M. G. Jacobson. 2008. Transitioning from wild collection to forest cultivation of indigenous medicinal forest plants in eastern North America is constrained by lack of profitability. *Agroforest Systems*. DOI 10.1007/s10457-008-9173-y.

- Burkhart, E. P. 2013. American ginseng (*Panax quinquefolius* L.) floristic associations in Pennsylvania: guidance for identifying calcium-rich forest farming sites. 2013. *Agroforest Systems* Vol. 87, No. 3. DOI:10.1007/s10457-013-9627-8.
- Carlson, A. W. 1986. Ginseng: America's botanical drug connection to the Orient. *Economic Botany* 40(2). New York Botanical Garden, Bronx, New York.
- Carpenter, S. G. and G. Cottam. 1982. Growth and reproduction of American ginseng *Panax quinquefolius* in Wisconsin. *Canadian Journal of Botany* 60: 2692-2696.
- Chamberlain, J. L., S. Priskey, M. McGuffin. 2013. Understanding the relationships between American ginseng harvest and hardwood forests inventory and timber harvest to improve co-management of the forests of eastern United States. *Journal of Sustainable Forestry* 32: 605-624.
- Charron, D. and D. Gagnon. 1991. The demography of northern populations of *Panax quinquefolium* (American ginseng). *Journal of Ecology* 79(2): 431-445.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). Status of ginseng (*Panax quinquefolius*) in Canada. On-line at: [http://www.cosewic.gc.ca/eng/sct5/index\\_e.cfm](http://www.cosewic.gc.ca/eng/sct5/index_e.cfm). Accessed on August 21, 2015.
- Cruse-Sanders, J. Mand J. L. Hamrick. 2004a. Spatial and genetic structure within populations of wild American ginseng (*Panax quinquefolius* L., Araliaceae). *Journal of Heredity* 95(4): 309-321.
- \_\_\_\_\_, and J. L. Hamrick. 2004b. Genetic diversity in harvested and protected populations of wild American ginseng (*Panax quinquefolius* L., Araliaceae). *American Journal of Botany* 91(4): 540-548.
- \_\_\_\_\_, J. L. Hamrick, and J.A. Ahumada. 2005. Consequences of harvesting for genetic diversity in American ginseng American ginseng (*Panax quinquefolius* L.): a simulation study. *Biodiversity and Conservation* 14: 493-504.
- DOJ (Department of Justice). 2014. Ginseng poacher sentenced to jail time. August 28, 2014. On-line at: <http://www.usdoj.gov/usao/ncw>.
- Farrington, S. J., R. Muzika, D. Drees, and T. M. Knight. 2008. Interactive effects of harvest and deer herbivory on the population dynamics of American ginseng. *Conservation Biology* 23 (3):719-728.
- Gleason, H. A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd edition. The New York Botanical Garden, New York.
- Grubbs, H. J. and M. A. Case. 2004. Allozyme variation in American ginseng (*Panax quinquefolius* L.): variation, breeding system, and implications for current conservation practice. *Conservation Genetics* Vol. 5: 13-23.
- Hackney, E.E. and J.B.McGraw. 2001. Experimental demonstration of an Allee effect in American ginseng. *Conservation Biology* 15: 129-136.
- Hanson, C. 2015. NC wages battle against ginseng poachers. The Charlotte Observer. On-line at: <http://www.charlotteobserver.com/news/local/article33788664.html#storylink=cpy>.
- Hruska, A. M., S. Souther, and J. B. McGraw. 2014. Songbird dispersal of American ginseng (*Panax quinquefolius*). *Ecoscience* 21(1): 46-55. DOI:10.2980/21-1-3679.
- Hu, Y. H., L. Rudenberg, and P. D. Tredici. 1980. Studies of American ginseng. *Rhodora*. Vol. 81: 627-635.
- Kauffman, G. 2006. Conservation assessment for American ginseng (*Panax quinquefolius*) L. USDA Forest Service, Eastern Region. Retrieved from: <http://www.fs.fed.us/r9/wildlife/tes/ca-overview/docs/Plants/Ginseng2003.pdf>. Accessed on July 25, 2012.

- Lewis, W. H. and V. E. Zenger. 1982. Population dynamics of the American ginseng *Panax quinquefolius* (Araliaceae). *American Journal of Botany* 69: 1483-1490.
- \_\_\_\_\_ and V. E. Zenger. 1983. Breeding systems and fecundity in the ginseng, *Panax quinquefolium* (Araliaceae). *American Journal of Botany* Vol. 70: 466-468.
- Lim, W., K. W. Mudge, and L. A. Weston. 2007. Utilization of RAPD markers to assess genetic diversity of wild populations of North American ginseng (*Panax quinquefolium*). *Planta Medica* 73(1), 71-76.
- Lockstadt, C. M. 2012. Phylogeography of American ginseng (*Panax quinquefolius* L., Araliaceae): implications for conservation. M.S. thesis of Appalachian State University, North Carolina.
- Maher, K. 2014. Demand for ginseng roots boosts prices, tempts poachers. *The Wall Street Journal*. On-line at: <http://www.wsj.com/articles/demand-for-ginseng-boosts-prices-tempts-poachers-1410971637>.
- McGraw, J. B., S. M. Sanders, and M. Van der Voort. 2003. Distribution and abundance of *Hydrastis canadensis* L. (Ranunculaceae) and *Panax quinquefolius* L. (Araliaceae) in the central Appalachian region. *Journal of the Torrey Botanical Society* 130 (2): 62-69. DOI:10.2307/3557530.
- \_\_\_\_\_ and M. A. Furedi. 2005. Deer browsing and population viability of a forest understory plant. *Science* Vol. 307(5711):920-922. DOI:10.1126/science.1107036.
- \_\_\_\_\_, M. A. Furedi, K. Maiers, C. Carroll, G. Kauffman, A. Lubbers, J. Wolf, R. C. Anderson, M. R. Anderson, B. Wilcox, D. Drees, M. E. Van der Voort, M. A. Albright, A. Nault, H. MacCulloch, and A. Gibbs. 2005. Berry ripening and harvest season in wild American ginseng. *Northeastern Naturalist* 12 (2). Humboldt Field Research Institute, Steuben, Maine.
- \_\_\_\_\_, S. Souther, and A. E. Lubbers. 2010. Rates of harvest and compliance with regulations in natural populations of American ginseng (*Panax quinquefolius* L.) *Natural Areas Journal* 30(2): 202-210.
- \_\_\_\_\_, A. E. Lubbers, M. Van der Voort, E. H. Mooney, M. A. Furedi, S. Souther, J. B. Tuner, and J. Chandler. 2013. Ecology and conservation of ginseng (*Panax quinquefolius*) in a changing world. *Annals of New York Academy of Sciences*. The Year in Ecology and Conservation Biology. New York Academy of Science.
- McGuffin, M. 2009. The "wild" American ginseng industry: collectors & cultivators. Presentation presented at the U.S. Fish and Wildlife Service American ginseng meeting. February 24, 2009. Bristol, Virginia. On-line at: <http://www.fws.gov/international/publications-and-media/archive.html>.
- Mooney, E. H. and J. B. McGraw. 2007. Effects of self-pollination and outcrossing with cultivated plants in small natural populations of American ginseng, *Panax quinquefolius* (Araliaceae). *American Journal of Botany* 94(10):1677-1687.
- \_\_\_\_\_ and J. B. McGraw. 2009. Relationship between age, size, and reproduction in populations of American ginseng, *Panax quinquefolius* (Araliaceae), across a range of harvest pressures. *Ecoscience* 16:84-94.
- Nash, G. V. 1895. American ginseng: Its commercial history, protection, and cultivation. USDA Bulletin No. 16. Government Printing Office, Washington D.C. Cited in Kauffman, G. 2003. Conservation assessment for American ginseng (*Panax quinquefolius*) L. USDA Forest Service, Eastern Region. Available at: <http://www.fs.fed.us/r9/wildlife/tes/ca-overview/docs/Plants/Ginseng2003.pdf>. Accessed on July 25, 2012.

- NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [Web application]. Version 4.6. NatureServe, Arlington, Virginia. Retrieved from: <http://www.natureserve.org/explorer/>. Accessed on August 21, 2015.
- Obae, S.G, and T.P. West. 2011. Effects of anthropogenic activities on genetic diversity and population structure of American ginseng (*Panax quinquefolius* L.) growing in West Virginia. *Journal of Horticulture and Forestry* 3(9): 270-281.
- Persons, W. S. and A. M. Davis. 2005. Growing and marketing ginseng, goldenseal and other woodland medicinals. Bright Mountain Books, Inc. Fairview, North Carolina.
- Persons, W. S. 2015. Ginseng News from Green Gold Enterprises. Tuckasegee Valley Ginseng, Tuckasegee, NC.
- Pokladnik, R. J. 2008. Roots and remedies of ginseng poaching in central Appalachia Ph.D. dissertation. Antioch University New England, Keene, New Hampshire.
- Price, E. T. 1960. Root Digging in the Appalachians: The Geography of Botanical Drugs. *Geographical Review*, Vol. 50, No. 1, pp. 1-20.
- Radford, A., E., H. E. Ahles, and C. R. Bell. 1981. *Manual of the Vascular Flora of the Carolinas*. The University of North Carolina Press, Chapel Hill, North Carolina, USA.
- Schlag, E.M. and M.S. McIntosh. 2012. RAPD-based assessment of genetic relationships among and within American ginseng (*Panax quinquefolius* L.) populations and their implications for a future conservation strategy. *Genetic Resources and Crop Evolution*. Published online: February 1, 2012. DOI: 10.1007/s10722-011-9784-4.
- Schlessman, M. A. 1985. Flora biology of American ginseng (*Panax quinquefolium*). *Bulletin of the Torrey Botanical Club* 112:29-133.
- \_\_\_\_\_. 1987. Gender modification in North American ginsengs. *BioScience* 37: 469–475.
- Schluter, C. and Z., K. Punja. 2002. Genetic diversity among natural and cultivated field populations and seed lots of American ginseng (*Panax quinquefolius* L.) in Canada. *International Journal of Plant Sciences* 163 (3):427-439.
- Souther, S. and J. B. McGraw. 2011. Vulnerability of wild American ginseng to an extreme early spring temperature fluctuation. *Population Ecology* 53: 119-129.
- \_\_\_\_\_. and J.B. McGraw. 2014. Synergistic effects of climate change and harvest on extinction risk of American ginseng. *Ecological Applications* Vol. 24 (6): 1463-1477.
- Thatcher, C. A., J. Young, and F. T. van Manen. 2006. Habitat characterization and population abundance of internationally traded plants. U.S. Geological Service final report to the U.S. Fish and Wildlife Service, Division of Scientific Authority. Arlington, Virginia.
- Van der Voort, M. E. 2005. An ecological study of *Panax quinquefolius* in central Appalachia: seedling growth, harvest impacts and geographic variation in demography Ph.D. dissertation, University of West Virginia, Morgantown, West Virginia.
- \_\_\_\_\_. and J. B. McGraw. 2006. Effects of harvester behavior on population growth rate affects sustainability of ginseng trade. *Biological Conservation* 130:505-516. DOI:10.1016/j.biocon.2006.01.010.
- Wagner, A. and J. B. McGraw. 2013. Sunfleck effects on physiology, growth, and local demography of American ginseng (*Panax quinquefolius* L.). *Forest Ecology and Management* 291: 220-227. <http://dx.doi.org/10.1016/j.foreco.2012.11.038>.
- Wixted, K. and J. B. McGraw. 2008. A *Panax*-centric view of invasive species. *Biological Invasions*. DOI: 10.1007/s10530-008-9301-7.
- Young, J. A., T. L. King, F. T. van Manen, and M. S. Eackles. 2013. Habitat characterization, genetic diversity, and population abundance of American ginseng. U.S. Geological Survey agency memo to the U.S. Fish and Wildlife Service, Division of Scientific Authority. Arlington, Virginia.