Plant Element Decision Form

Element Name: Panax quinquefolius L.
Common Name: Ginseng, Sang
Element Code: PDARA09010
Synonyms: *P. quinquefolium*, an orthographic variant.

Category = Watchlist **Grank** = G3G4 **Srank** = S3

Type of decision/action.

___	Adopt as element		
___	Delete as element		
___	Change name	From: _______________	to _______________
__x_	Change rank	From: ____S3___________	to ______S2S3_______
_x__	Other	Recommend closure of Ginseng harvests on state lands.	

Action Summary: Upgrade state rank to S2S3 commensurate with reduced viability of populations and increased threats from harvest and deer browse. Recommend closure of state wildlife management areas and state forests to American ginseng harvest.

Background

Panax quinquefolius L. (American ginseng) is an herbaceous perennial plant that is widely distributed in deciduous forests from Maine west to Ontario and south to Alabama, Louisiana, and Kansas. Previous reports from Manitoba are in error according to Kauffman (2006). It is a forest understory species adapted to low light levels and is most characteristic of the Appalachian and Ozark regions that form the core of the species' range. Wild plants are known to reach more than 30 years of age, although field studies rarely find plants older than 20 years (McGraw 2001; Mooney and McGraw 2009). Ginseng is commonly classified into growth stage classes based upon the number of leaves. Seedlings have a single compound leaf (1-prong); juvenile plants typically have two compound leaves (2-pronged) and adult plants tend to have three or four compound leaves (3 or 4-pronged). Growth rates of individual plants vary due both biotic and abiotic factors (McGraw and Furedi 2005; Van der Voot and McGraw 2006; Anderson 2009). Reproduction in ginseng is by seeds; it does not spread by vegetative or asexual means (Charron and Gagnon 1991). Seeds exhibit 18-20 month dormancy before germination, and seedling establishment appears to be the most vulnerable stage of the species' life-cycle (Charron and Gagnon 1991). Ginseng generally takes three to eight years to reach sexual maturity (Charron and Gagnon 1991). This slow-growing plant demonstrates low seed production coupled with relatively high seed viability and germination (Carpenter and Cottam 1982; Lewis and Zenger 1983; Charron and Gagnon1991; McGraw et al. 2010).

American ginseng has been harvested commercially for the last few centuries as the wild root is revered in Asian cultures practicing traditional medicine. Market demand has driven the wild harvest of ginseng with the intensity of harvest pressure fluctuating with market prices and the unemployment rate in rural communities (Bailey 1999). Wild and wild-simulated root fetches significantly higher prices than either woods-grown or field-cultivated root[1] as wild root is believed to more closely resemble Asian ginseng (*Panax ginseng*). In addition, older roots tend to be valued higher than younger roots as the older plants are believed to contain greater medicinal compounds. Traditionally, harvesters determine the plant's age by counting the number of leaves (commonly called prongs), but the relationship is imperfect (Mooney and McGraw 2009). Typically, adult plants (3 or 4 pronged) are considered reproductive and legally harvestable. Ginseng roots may also be aged by counting permanent scars formed by the annual abscission of the aerial stem; however, correct aging of dried roots is difficult as the crown of the root is often lost or damaged during drying and processing (R. Trumbule, Maryland Department of Agriculture, Ginseng Management Program, pers. comm.). The number of plants needed to produce one pound of dried root is substantial, ranging from 205-330 (mean = 262.5) plants (USFWS data 1998-2010). Ginseng harvesters report that periodic droughts impact successful reproduction and population sizes in subsequent years (R. Trumbule, pers. comm.).

[1] For a discussion of the market categories see Persons and Davis (2005) or the web content at http://www.dcnr.state.pa.us/FORESTRY/wildplant/ginsenghusbandry_6.aspx or http://www.nfs.unl.edu/documents/SpecialtyForest/Persons.pdf

NatureServe (2011) reports that American ginseng occurs at generally low densities over a very broad range, with the major stress factors being clearing of forest habitat, deer browse, and, particularly, the commercial harvest of roots.

Summary of Regulatory Actions at the Federal and State levels

Wild American ginseng roots have been harvested for international trade for over 250 years (Pritts 1995), but harvest regulation began only in 1975 when American ginseng was included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In the United States, individual states are mandated to provide a ginseng conservation program that maintains records of annual harvests, sets harvest dates, and certifies roots for sale through licensed dealers with oversight from the U.S. Fish and Wildlife Service-Division of Scientific Authority (USFWS-DSA). The USFWS-DSA is tasked with evaluating individual states' ginseng management programs and must make a non-detriment finding in order for the state to continue ginseng harvest programs. In 1999, the USFWS-DSA determined that only ginseng roots five years of age or older may be exported. In 2000, NatureServe revised the global conservation status from G4 to G3G4 citing declines across the range of the species. This change in global status prompted renewed attention from state Natural Heritage Programs because priorities for inventory, monitoring and research are usually assigned to species with a G1-G3 (or globally rare) status. A proposal to limit harvest of wild collected plants to no less than 10 years age (non-detriment finding 3 August 2005) was later withdrawn by USFWS-DSA. In 2010, Kentucky, Maryland and North Carolina amended their harvest dates to September 1and the USDA Forest Service, Monongahela (West Virginia) and Wayne National Forests (Kentucky) implemented harvest permit systems based upon estimated population sizes. Maryland Department of Agriculture (MDA) regulations require that ginseng diggers possess a Ginseng Collectors Permit to legally harvest wild American ginseng in the state. All Maryland collected wild ginseng root destined for export must be certified by MDA staff through the Maryland Ginseng Management Program prior to export. Before the beginning of each collecting season MDA sends previously licensed ginseng diggers a questionnaire that accompanies the application for a new seasonal collectors permit. This questionnaire requests data that are useful in making a required annual report to the U.S. Fish and Wildlife Service, Division of Scientific Authority (USFWS-DSA) which, in accordance with CITES regulations, MDA submits annually to USFWS-DSA.. In 2011, diggers were required to obtain permission from the land managers of individual state forests and wildlife management areas in Maryland. In 2012, Pennsylvania amended their harvest date to September 1, resulting in regional consistency of harvest dates.

NatureServe (2011) states that despite protection via numerous regulatory agencies ginseng populations continue to decline chiefly due to illegal harvesting and lax enforcement of regulations (see also McGraw et al. 2010). Ginseng occurs as a native plant in 34 states (Figure 1). Twenty states list the species as of conservation concern (Figure 2) as either S3 (Watchlist), S2 (imperiled) or S1 (critically imperiled). Fifteen states prohibit the harvest and sale of wild ginseng (Figure 3). The remaining 19 states allow the harvest and export of wild ginseng, as long as they fulfill Federal and CITES mandates. As of 2012, 18 of the 19 states where wild ginseng harvest is legal have size and/or age restrictions in place. All ginseng roots for export must meet the 5-year minimum age requirement established by the USFWS-DSA (Gram 2011).

History of American ginseng in the Maryland Natural Heritage Program

American ginseng appears in the first list of Maryland's Rare, Threatened and Endangered Species (see Norden et al. 1984) as a Watchlist species (state rank = S3) defined by the Maryland Natural Heritage Program (MDNHP) as "rare to uncommon with the number of occurrences typically in the range of 21-100. It may have fewer occurrences but with a large number of individuals in some populations and it may be susceptible to large-scale disturbances." The S3 rank was assigned by inspection of available data sources, including expert opinion weighted towards MDNHP ecologists' field experience. The earliest state ranking form, dated 5 October 1981, justified the Watchlist rank (under the summary reasons section) as [ginseng] "widespread, infrequent, locally depleted but generally stable." Species with the S3 rank are not actively tracked by the MDNHP meaning that precise population data (counts) using standard reporting forms and geospatial mapping is not performed. Monitoring Watchlist plants like ginseng has always been problematic for the MDNHP as these species require a substantial investment of resources, yet have the lowest conservation rank. MDNHP's limited resources are generally focused on monitoring endemic, globally rare, federally-listed and/or state-listed (Threatened or Endangered) species. Watchlist species like ginseng represent an unusual form of rarity; there may be many small populations comprising thousands of individuals over a broad geographic range yet densities are low, perceived threats are high, and probability of persistence at individual sites is uncertain. Despite (and perhaps because of) the long-term Watchlist status, the MDNHP has had little quantifiable data relating to ginseng. MDNHP records were generally observations of occurrences at small spatial scales and usually the population extent was not reported.

Ginseng occurs in all five physiographic provinces in Maryland. Small, remnant populations occurred, at least during the last 20 years, on Maryland's Coastal Plain (Caroline, Talbot, Charles, Prince Georges) and Piedmont (Baltimore, Cecil, Montgomery; reported from Carroll and Harford) but the species, as a viable component of flora, is restricted to western Maryland in the Ridge and Valley (Allegany, Frederick, Washington) and Allegheny Plateau (Allegany, Garrett) Physiographic Provinces (Figure 4). Historical declines in statewide abundance have resulted from the direct conversion of forested habitats to agriculture and urban development on the Coastal Plain and Piedmont. Declines from earlier surveys are common and have been characterized by lack of occurrence in survey plots perceived as "good habitat", plants "missing" in previously occupied sites, and very low densities in heavily sampled forests (MDNHP, field forms). For example, ginseng was "fairly characteristic" of shell marl ravines in Chapman's State Park in Charles County, but those populations have not been observed for several years, presumably due to predation by white-tailed deer (Rod Simmons, Botanist, City of Alexandria Parks and Recreation, pers. comm.).

Concerns regarding wild ginseng harvest in Maryland extend over several decades. In 1983, botanist Larry Morse (The Nature Conservancy) expressed concerns that Maryland was one of the few states were wild collection was allowed on state-owned lands and questioned whether continued harvest was advisable. In 1997, MDNHP ecologist Ken Hotopp expressed concerns that the 1996 ginseng harvest was the highest on record and suggested that an analysis of the harvest data at the Maryland Department of Agriculture be considered as a NHP project. In 2002, MDNHP botanist, Chris Frye, requested status surveys for this species citing the poor documentation available in the MDNHP records, the paucity of herbarium specimens and the general secrecy that has historically shrouded site-specific details. In 2005, under the conditions of a scientific collection permit, a graduate student at Frostburg State University collected 37 GPS point locations of ginseng while performing field work and status surveys of goldenseal (*Hydrastis canadensis*). Inspection of these 37 points resulted in a mean "population" size of 2 plants. However, these results were interpreted cautiously as ginseng encounters since the student did not perform exhaustive searches for ginseng. The addition of 30 points assembled from MDNHP field forms and other data sources, nevertheless, suggested a highly negatively skewed demography (Figure 5) typical of a declining species. In 2010, prompted in part by concerns from conservation partners that collection activities on state forests and wildlife management areas were inadequately monitored, the MDNHP forwarded an opinion to the director of the Wildlife and Heritage Service requesting that harvests on state lands be suspended pending a thorough investigation. However, the State Botanist was unable to quantify population trends and threats to the species in a convincing manner, and no action was taken.

Cooperation within DNR agencies on the general topic of vulnerable and exploitable species has been more than sufficient. The State Botanist held meetings with the Natural Resource Police in western Maryland to address concerns about illegal harvest and meetings with state forest managers in 2011 were held to discuss improving data collection on state forests. At the inter-agency level, the Maryland Department of Agriculture (MDA) has been very responsive to the MDNHP, and we have successfully resolved issues regarding permit applications.

While long-term trends are necessary to make confident management decisions, only one Maryland population has had long-term monitoring (Crabtree Cave, 2004-present; James McGraw, West Virginia University). At this location there is a low level of harvest and the annual population growth rate is low (λ=1.053). The Crabtree Cave population, as defined by McGraw, spans 2-3 hectares and so previous small-scale surveys may have contributed to an impression of low population sizes. McGraw (West Virginia University, interview October 2011) suggested that the low numbers of plants reported to MDNHP may be artifacts of detectability, that is, survey dates must be timed appropriately to be meaningful (May 25-June 15) and a thorough survey is required to detect more than 5-10 plants in any individual habitat patch. McGraw opined that there are probably hundreds of individual populations in western Maryland—most of them with low numbers, which he attributes to both harvest and intense deer predation. Harvest records from the Maryland Department of Agriculture, Ginseng Management Program (1979-present) comprises the only long-term harvest data source currently available, but these data exist only in paper form and needs to be digitized and appropriately analyzed. At the time, neither the MDNHP nor the MDA had the resources necessary for such a large data extraction project.

In 2012, funding for ginseng harvest data analysis and status surveys were made available by a generous grant (Heritage Grant) from the University of Maryland Arboretum and Botanic Garden to principal investigators Dr. Christopher Puttock and Ms. Rochelle Bartolomei. The principals for the Heritage Grant met on January 27, 2012: in attendance were Dick Bean and Robert Trumbule of MDA, Dr. Christopher Puttock of the Smithsonian Institution, Rochelle Bartolomei of Chesapeake Natives and Christopher Frye of MDNHP. The initial meeting focused on a work plan for extracting, digitizing and analyzing three decades of harvest data. Data extraction involved sorting all of the annual reports to the USFWS—these reports contained the summary statistics for each harvest year. The raw data were reviewed to extract any meaningful variables. The final part of the Heritage Project undertook systematic surveys of ginseng focusing on known or previously reported locations provided by the MDNHP and cooperators.

Analysis of trends in American ginseng harvest data (1979-2010)

This section of the report focuses on statewide trends in ginseng harvest from data archived at the Maryland Department of Agriculture (MDA), Ginseng Management Program (1979-2010). The first section details the interrelationship between harvest permits, the pounds of wild ginseng root harvested and the average price per pound of ginseng root (price data from W. Scott Persons, Tusckasegee Valley Ginseng, Tuckasegee, NC). The second section details trends in annual harvest, and the final section contains an analysis of trends in county-level harvest data. The following information includes excerpts or summaries of the data compiled and analyzed by Gelner et al. (2012); the reader should refer to that document for details.

Gelner et al. (2012) compiled data from three MDA sources: (1) diggers' questionnaires returned to MDA, (2) ginseng dealer transaction records, and (3) ginseng certification records. Additionally, the authors consulted the CITES reports as the primary data source whenever they were available. The raw data from the diggers' and dealers' reports were audited to verify the accuracy of the annual tallies for the CITES reports. These tallies proved to be accurate within each year that the diggers' certification records were timely received. Missing years CITES data points were assembled from the raw data held at the MDA. The summary data used for Figures 6-7 are shown in Table 1. Simple correlation analyses (Pearson's r) were performed in Microsoft Excel™; trend lines, where shown, are simple linear regressions (R^2). Years where data could not be confidently assembled (wild-certified root and average price per pound in 1979-1981 and number of permits issued in 1979) were omitted from analyses.

The number of permits issued by MDA is positively correlated with the amount of wild ginseng harvested and certified by MDA as wild-collected ($r = 0.59$) over a 31 year period (1980-2010); this category is hereafter referred to as "wild-certified". Ginseng price data shows a low correlation with the amount of wild-certified ginseng over the course of a 29 year (1982-2010) time period ($r = 0.47$). The relationship between average price per pound and the number of harvest permits (1982-2010) shows a positive correlation ($r = 0.59$). These results were surprising because the expectation was, a priori, that there would be very strong correlations (>0.6) between these factors. Figure 6 shows how similar the trends are over time, but especially from 1980-1999. Gelner et al. (2012) noted dissonance between these factors over the last decade (see arrow in Figure 6) and examined more closely the correlation between these factors during the last decade versus the previous 18-20 years. They discovered a higher correlation between the number of harvest permits and the amount of wild-certified ginseng from 1980-1999 ($r = 0.71$) that drops during 2000-2010 ($r = 0.62$). Similarly, the correlation between average price per pound and wild-certified ginseng from 1982-1999 ($r =0.66$) drops during 2000-2010 ($r = 0.51$). Finally, the relationship between average price per pound and the number of collecting permits is significant ($r = 0.61$) during the period 1982-1999 but drops for the period 2000-2010 ($r = 0.50$). The record prices per pound for ginseng during the 1990s are concomitant with a peak of 433 harvest permits in 1997 and higher than average ginseng harvests. After about 1999, the quantity of wild-certified ginseng decreases despite prices and harvest permits issued remaining above historical averages. The fact that ginseng harvests have not increased significantly despite record prices per pound over the last decade leads to a conclusion that wild populations have not recovered from the increased harvest intensity during the 1990s. Ginseng harvest trends from 1979-2010 support this conclusion. The 31year mean is 154 pounds per year (Std. Dev. ±86 pounds). For the decade 1981-1990, the average ginseng wild harvest was 100 pounds, for 1991-2000 230 pounds and from 2000- 2010 125 pounds. This is a decline of 17.6% over the 31 year average of 151.67 pounds and a 46% decline from the peak harvest period (1991-2000). Overall, the statewide harvest of ginseng certified as wild-collected shows an overall decrease despite another peak harvest in 2009 (Figure 6). However, when the total ginseng harvest is examined and ginseng sold as "wild-simulated" is combined with "wild-collected", there has been a precipitous decline (~ 90%) from peak harvest in 1999 (Figure 7), mirroring the national trends (Figure 8).

Ginseng harvest in Maryland constitutes less than 0.2% of the national export (Gelner et al. 2012). Although the majority of forested lands to the north and west of the Fall Line remain as potential ginseng habitat, very few populations are known outside of Garrett, Allegany and Washington Counties. The current flora of Frederick County (Wiegand 2005) records only six populations, mostly restricted to Catoctin Mountain Park (see next section). Since 1989, the mountainous counties of Garrett and Allegany have produced the majority of the State's ginseng with 71.9% attributed to Garrett County and 26.3 % attributed to Allegany County. Much of Allegany County, particularly the dry forests over shale and sandstone, is not prime ginseng habitat and, as such, it is rarely observed. For example, Green Ridge State Forest (the largest public land unit in the county) received a single request to dig in 2011. By contrast, Savage River State Forest managers received 28 requests. Ginseng harvests from Allegany County have likely been sourced from the western-most part of the county along the Allegheny Front (Dan's Mountain). Gelner et al. (2012) report a 56.6% decline in harvest from Allegany County from a peak of 57.2 pounds in 1996 to 6.8 pounds in 2010. Alternative explanations include the variation in diggers' questionnaires, particularly the amount of ginseng reported with unknown provenance. However, upon examination of the trend lines, there is a clear monotonic decline of harvest over years in Allegany County ($R^2 = 0.6907$) whereas Garrett County harvest levels have remained fairly flat ($R^2 = 0.0002$), with no clear pattern in variation (Figure 9).

Results of field surveys

Puttock et al. (2012) performed systematic surveys for ginseng in Maryland over four weeks from May 24-June 21. The field surveys targeted 10 randomly-selected sites from a set of 35 locations provided by the State Botanist and other cooperators. During the surveys, ginseng plants were recorded in search areas covering a one hectare grid. The first ginseng plant found in the vicinity of the known point became a random point in the grid. Overall, the Puttock survey teams recorded 338 ginseng plants in 8 of the 10 sites (Table 2). Plants were assigned to one of five age categories (Table 2) based upon the number of prongs, leaflets, inflorescence and stem thickness below the leaves. The majority of plants surveyed were seedlings and immature plants, between 24 and 80 per site. Only a few mature adults were found, between 0 and 4 per site. Only one site had plants that were more than 10 years old and significantly more adults than young.

Puttock et al. (2012) quantified their assessments of harvest regimes by calculating the ratio of pre-reproductive plants to mature/reproductive plants (syi/m in Table 2). A high ratio (> 5) indicates that the population age structure is skewed towards immature/pre-reproductive plants. Ratios nearer to one indicate that the size classes are more evenly distributed, whereas a ratio less than one indicates that the population is skewed to mature (reproductive) plants. The size class distribution averaged across all 8 sites is highly skewed towards immature plants as are the majority of sites individually (Figure 10). Two populations in Savage River State Forest (New Germany and Asa Durst) show a more even size-class distribution, but the total number of plants (N = 23 and N = 16 respectively) is too low to draw conclusions. One site, Dan's Mountain WMA (syi/m = 0.3), is an outlier dominated by mature plants but with little evidence of recruitment and reproduction.

In addition to the Puttock surveys, the State Botanist and volunteers searched (unsuccessfully) two sites in Green Ridge State Forest and one site in Billmeyer Wildlife Management Area in Allegany County; these areas were reported by diggers as harvest locations. Similarly, small populations at Fort Washington Park (Prince Georges County) and at Chapmans State Park (Charles County) were not relocated and are presumed extirpated (Charles Davis and Rod Simmons correspondence with MDNHP, 2012).

Analysis of size class distributions under different harvest regimes

Size class distribution (number of leaves or prongs) in populations is commonly recorded among studies, thus making it possible to make some comparisons. For this analysis, data from three Maryland populations were used. The data are as follows:

1. Historical data from a large population (Wheaton) in Montgomery County (Broome 1980).
2. Recent data from James McGraw (2004-2009) from a protected population (Crabtree Cave) in Garrett County.

3. Recent data from two of the largest Puttock et al. (2012) populations (Crooked Run and Greenbrier State Park), Garrett County and Washington County, respectively.

The Wheaton population represents a natural size class structure distribution found in unharvested populations. The Crabtree Cave population represents the largest known population in Maryland where there is occasional low levels of harvest. The current survey data from Crooked Run and Greenbrier State Park represents populations experiencing annual harvests according to Puttock et al. (2012). The data for Crabtree Cave are averages of each size class over the years 2004-2009. In contrast, Puttock et al. (2012) divided three-pronged individuals into immature/pre-reproductive individuals and mature/reproductive individuals; these categories were lumped in order to make comparisons. Sample sizes vary among the studies: Crabtree Cave (N = 176); Wheaton (N = 740); Crooked Run (N = 84); and Greenbrier State Park (N = 58). Because of this factor, the raw counts for each size class were converted to percentages.

Trends in age-class structure over sites/studies are insightful (Figure 11). The Wheaton population is symmetrical around a dense cohort of three-pronged plants. The Crabtree Cave population is somewhat similar with a peak around three-pronged plants and a smaller peak at two-pronged plants but is heavily skewed by a large number of seedlings that occurred in 2009. The latter is reported to be a natural occurrence that was frequently observed at other sites in 2009 and was not the result of active stewardship (K. Wixted, pers. comm.). The two Puttock sites (Crooked Run and Greenbrier) are heavily skewed to immature two-pronged plants with few mature/reproductive individuals. Following the calculations in Puttock et al. (2012), the ratio (I/M) of immature or pre-reproductive plants (I = seedlings + two-pronged plants) to mature, presumably reproductive plants (M = 3, 4 and 5-pronged plants) was calculated. Although the calculation is likely too simplistic, e.g., some two-pronged plants flower and not all three-pronged plants flower and fruit (see McGraw et al. 2010); the data provides insight into the relative shapes of the distributions shown in Figure 11. Crooked Run (I/M = 2.5), Greenbrier S.P. (I/M = 2.4) and Crabtree Cave (I/M = 2.3) populations are very similar and the ratios indicate a strong skew towards pre-reproductive plants. By contrast, the ratio for the Wheaton population (I/M = 0.29) indicates a symmetrical curve centered on a large cohort of mature, presumably reproductive three-pronged plants.

Discussion

Analysis of ginseng harvest data provides indirect evidence of population decline in the wild but present clear trends. The number of harvest permits issued, the market price for ginseng root and the amount of wild-certified ginseng are all closely associated from 1980 to 1997 but become increasingly dissonant from about 1998-2010 (Figure 6). Comparisons of the correlations between these factors in the recent decade (2000-2010) versus the two previous decades (~1980-1999) show that these factors have become decoupled during the last decade. For example, despite the high market prices for ginseng root and above average issuance of harvest permits in the recent decade, wild-certified poundage has declined to pre-1990 levels. Statewide, wild-certified ginseng harvests have declined 17.6% over the 31 year period and show a 46% decline from peak harvest in 1997. Most significantly, the total ginseng harvest, combining wild-certified with wild-simulated and woods-grown ginseng shows a precipitous decline of 90% from peak harvest in 1997 and a 79% decline over the 22 year average (data in Table 1). The latter is important because there is a lack of concordance between trends in amounts of wild-certified ginseng and total harvest (all categories) over years that pose questions regarding the accuracy of the certification process. It appears that there has been an evolving interpretation of what should be recorded as wild ginseng, that is, wild-certified. There is an obvious economic benefit for diggers to have their product certified as wild versus woods grown or cultivated as the price differential may be ten-fold or higher (Robbins 2000). As a consequence, there have been differences in what wild-certified ginseng data are reported to CITES as the total for the state from year to year. For example, wild-certified root averages only 12.9 % of the harvest over the 22 year period (1989-2010) but has increased to an improbable 67 % in 2009 and 49 % in 2010 (Table 1). Using the data from 2009, wild-certified root is recorded as 143 pounds (67% of the total ginseng harvest), which according to mean number of plants to obtain one pound dry root (262.5) would require the harvest of approximately 37,537 wild plants. Assuming the maximum density recorded by Puttock et al. (2012) of 84 plants per hectare holds over large areas of forest, it would require the harvest of every plant occurring in 447 hectares. Given that a large proportion of the plants encountered are immature, presumably with small roots having less dry weight, 447 hectares is clearly an underestimate. I conclude that much of the ginseng sold in Maryland as wild is in actuality cultivated root and/or “wild-simulated” or “woods grown” and that it is not possible to monitor trends independently. Thus, the effects of harvest have been obscured by the certification process, which are best described as substantial declines of 90% since peak harvest and 79%

over the 22 year average. These declines that do not seem attributable to any other cause such as low market price or lack of interest by diggers as both the price per pound and interest (as expressed by permit applications to MDA) have remained strong.

Trends in harvests from Allegany and Garrett Counties that comprise greater than 98% of all ginseng exported from Maryland are of immediate concern. Harvest of wild root in Allegany County shows a monotonic decline representing a 56.6% reduction since 1989. While harvest trends in Garrett County remain fairly flat the linear trend is influenced by an abrupt rise in harvest in 2009 (Figure 9). These harvest trends are worrisome given that the total number of harvest permits remain above historical averages and market prices for ginseng continue to rise. These factors will likely result in increased harvest intensity in Garrett County that may be presaged by the peak harvest in 2009.

Puttock et al. (2012) recorded very low ginseng densities in the 8 sites found to be occupied. A total of 338 plants occurred at 8 sites in four western-Maryland counties (Frederick, Washington, Allegany, and Garrett) comprising a total census area of more than 8 hectares. These 338 plants required 160 person hours of field survey effort, 112 person hours travel time by vehicle and 40 person hours travel time on foot to locate. All populations showed evidence of harvest including those at protected sites (Federal and State Parks) where harvest is prohibited; a result similar to that found by McGraw et al. (2010). Simulation studies of harvests have concluded that low rates of harvest (1%-8%) may be sustainable if harvests are accompanied by stewardship (Charron and Gagnon 1991; Nantel et al. 1996). However, simply complying with regulations is not sufficient to ensure sustainable populations with positive growth (Van der Voort and McGraw 2006). The largest known population in Maryland (Crabtree Cave, N =176 as of 2010), loosely defined as plants scattered over nearly two hectares, shows only marginal annual growth ($\lambda = 1.053$) and thus cannot withstand additional harvest pressure. Additionally, several studies have determined minimum viable population size (MVP), and it appears there are few in the ginseng's natural range that meet these requirements (Nantel et al. 1996; NatureServe 2011). For example, in West Virginia, the MVP is 800 plants due to deer browse (McGraw and Furedi 2005), and by this measure, there are no viable populations in Maryland and likely none in West Virginia, either.

The size class distribution curves for Maryland ginseng populations demonstrate that relative to a large population (Wheaton), the extant populations documented by McGraw and Puttock et al. (2012) are skewed to immature, non-reproductive plants. The relative proportions of seedlings and juvenile plants reflect harvest pressure, and the intensity of harvest affects recovery of pre-harvest size structure in populations (Mooney and McGraw 2009). While it is not possible to measure annual population growth rates with a single season's data, the density and size class distributions of Puttock et al. (2012) populations are indicative of human-altered population structures that cannot withstand continued harvest. The single exception may be a population on Dan's Mountain WMA (N= 37) that was dominated by mature three and four-pronged plants. However, this small population showed little evidence of recruitment (<10% juvenile plants) and no evidence of recent reproduction (no seedlings were found). The latter is consistent with harvest of all individuals that were observed by diggers (including immature individuals), early harvest before seeds are ripe, and/or the absence of stewardship behavior. Alternatively, the resulting population structures may be due to intense deer browse. For example, Farrington et al. (2009) concluded that the net effect of harvesting was dependent on the level of browsing by white-tailed deer. However, there should be no selective pressure on plants of a particular age, that is, mature plants should be browsed as often as immature ones. So using the Dan's Mountain WMA population as an example, there is no a priori reason why the 29 three and four-pronged plants escaped browse whereas seedlings and two-pronged plants did not.

Studies by Anderson and Loews (2009) highlight the crucial importance of large, older plants. Annual reproductive output was found to be a function of plant height that is largely associated with plant size class as three and four-pronged plants produce the largest numbers of flowers (Lewis and Zenger 1983). The absence of mature plants (>20 y age) is indicative of more intensive harvests. Mooney and McGraw (2009) calculated a harvest index based on the proportion of seedlings and juveniles in the total population where harvest indices less than 0.75 had at least one plant 20 years of age or older whereas no plants of that age group were found in the four populations with harvest indices greater than 0.75. These harvest indices are easily calculated from Table 2; the results are low harvest index for Dan's Mountain WMA (0.23), moderate harvest at Asa Durst (0.69) and New Germany (0.78) and intense harvests at Catoctin N.P. (0.96), Greenbrier S.P. (0.95), Elk Lick (0.92), Dan's Mountain S.P. (0.96) and Crooked Run (0.95).

Even though age is a reliable predictor of flowering, it is a poor predictor of the probability of fruit production and number of seeds (Mooney and McGraw 2009). Lack of pollinator service, particularly in diffuse populations requiring long pollinator flights may greatly affect seed set. Thus, even if reproductively mature plants are present in a population it does not necessarily correspond to high levels of reproduction. For example, the Dan's Mountain WMA population has the highest proportion of mature plants (one plant estimated a >10 y age) but reproduction and recruitment are very low (Table 2). Other than harvest, factors such as deer browse and weather (e.g., good years for seed germination) may be responsible for the population structure at Dan's Mountain WMA. While deer browse was noted during the field surveys it would have been disproportionately concentrated on seedlings and juveniles, which doesn't seem likely, although browsed seedlings and juvenile plants, having smaller stature, may have rendered them less detectable. Harvesting models have determined that low intensity harvesting, even in large populations, is the most sustainable program, but not the most profitable (Milner-Gulland et al. 2001). This is the crux of the problem because when ginseng collectors can earn up to $500/lb (Robbins 2000) they have little incentive to leave legally harvestable roots in the ground.

In the long-term skewed population structures result in altered patterns of genetic diversity and mating systems that may impact population recovery. For example, Cruse-Sanders and Hamrick (2004) found that juvenile plants had lower genetic diversity than reproductively mature plants, an indication of the effects of repeatedly removing the oldest individuals from populations. Grubbs and Chase (2004) found extensive differentiation between wild populations and high inbreeding estimates; the overall pattern was consistent with the effects of repeated bottlenecks as would result from harvest events. Mooney and McGraw (2007) found evidence of inbreeding depression, expressed as reduced leaf areas and plant heights, in self-pollinated plants. In small populations, reduced fecundity resulting from pollen-limitation of fruit set may be particularly acute in harvested populations where plant densities are artificially manipulated. This is an example of an Allee effect, which increases extinction rates of small or low density populations (Groom 1998). An experimental demonstration of an Allee effect with ginseng found that fruit production per flower and per plant increased in proportion to flowering population size, suggesting that small populations of ginseng are susceptible (Hackney and McGraw 2001). Further harvest of small, scattered populations may exacerbate this effect. Pollination failure is one of the common deterministic threats to small plant populations, second only to habitat destruction (Nason and Hamrick 1997).

<u>Conclusions</u>

The combined data analyses paint a picture of declining (and even disappearing) ginseng populations throughout Maryland while prices and number of permits continue to rise. Allowing harvest to continue will likely further decrease population sizes of this slow-growing species to a point at which it may not recover. Therefore, I concur with Gelman et al. (2012) that the combination of harvest, habitat loss and predation by white-tailed deer has reduced populations to very low densities and that continued harvest represents a direct threat to continued viability of ginseng populations in Maryland. The situation in Maryland is mirrored nationally, with 15 states now prohibiting wild harvest of ginseng; not surprisingly nearly all these states are on the periphery of the core range (see Figure 3). Regionally, Maryland is the only state that allows ginseng harvest on state owned lands.

To prevent losing this economically important plant from Maryland's landscape, re-establishing the reproductive capacity of harvested populations should be a priority for land managers. Strengthening enforcement to check illegal harvest is also important, particularly within state parks. Controlling for deer browse is important for all sites although there will be practical limits to employing exclosures as the chief means of control. The immediate priorities are to establish well-controlled no harvest zones in Maryland and to track recovery of both plant abundance and population age structures. While I understand that enforcement options are not likely to succeed and that this decision may have little impact on the actual harvest rates it is incumbent upon the Department of Natural Resources to set the standards for plant conservation, particularly for highly exploitable species.

<u>Needs</u>: Meet with Natural Resources Police, western region to discuss ramping up enforcement regarding illegal collection. [meeting held June 28, 2011, Fort Frederick State Park]

Meet with statewide forest managers to discuss issues surrounding vulnerable and exploitable species. [meeting held October 19, Patapsco State Park]

Interview Jim McGraw, West Virginia University regarding the advisability of continued harvest in Maryland and field survey protocols. [teleconference interview ~ 1 hour on October 25, 2011]

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Decision made by: Christopher T. Frye Date: 15 August 2012

Kerry Wixted (MDDNR), Gwen Brewer (MDDNR), Robert Trumbule (MDA), and Christopher Puttock (Smithsonian Institution) all contributed critical comments that greatly improved this document.

ESR created: 1981-10-05 (S3) Updated: 2012-08-17 (S2S3)

Attachments:

Tables:

Table 1. Harvest of wild ginseng, number of harvest permits issued, average price per pound of ginseng, total Maryland harvest (all certifications), and percent of total harvested recorded as wild harvested from 1979-2010.
Table 2. Ginseng observed in each hectare and ratio of immature to mature plants. Data from Puttock et al. (2012).

Figures:

Figure 1. County distribution of American ginseng (*Panax quinquefolius L.*) in North America.
Figure 2. Conservation status of American ginseng in North America.
Figure 3. American ginseng harvest status by state.
Figure 4. Physiographic Provinces of Maryland.
Figure 5. Demography of American ginseng populations reported to the Maryland Natural Heritage Program, 1984-2010.
Figure 6. Trends in wild ginseng harvest, number of harvest permits issued and average price per pound of ginseng root, 1979-2010.
Figure 7. Trends in total harvest of American ginseng certified in Maryland as wild, wild-simulated and woods grown from 1989-2010.
Figure 8. National and Maryland trends in wild ginseng harvest from1992-2010.
Figure 9. Trends in wild harvest of American ginseng from Allegany and Garrett Counties, Maryland.
Figure 10. Distributions of size classes at eight Maryland sites surveyed in 2012.
Figure 11. Comparison of size class distributions among studies and sites.

Table 1. Harvest of wild ginseng, number of harvest permits issued, average price per pound of ginseng, total Maryland harvest (all certifications) and percent of total harvest recorded as wild harvested from 1979-2010. Dashes indicate years of missing data. Data source: Maryland Department of Agriculture, Ginseng Management Program.

YEAR	Wild Harvest (lbs dry root)	Number of harvest permits issued	Average price per pound	Total MD harvest, wild+wild-simulated+woods grown (lbs dry root)	Percent of total harvest recorded as wild harvested
1979	7	-	-	-	-
1980	139	94	-	-	-
1981	120	211	-	-	-
1982	81	136	142.5	-	-
1983	123	141	178.5	-	-
1984	109	149	157	-	-
1985	101	178	138.5	-	-
1986	152	178	139	-	-
1987	89	137	202.5	-	-
1988	65	144	270	-	-
1989	154	156	235	1049	14.7
1990	197	176	245	1597	12.3
1991	113	200	280	865	13.1
1992	285	231	280	1863	15.3
1993	175	320	260	1608	10.9
1994	284	311	300	1656	17.2
1995	305	322	450	2426	12.6
1996	423	422	342.5	2828	15
1997	244	433	307.5	1861	13.1
1998	152	409	300	1379	11
1999	221	283	440	2889	7.7
2000	227	336	410	2376	9.6
2001	64	302	310	905	7.1
2002	110	259	250	1297	8.5
2003	110	251	300	1532	7.2
2004	160	249	250	795	20.1
2005	96	229	250	556	17.3
2006	62	210	300	1129	5.5
2007	148	230	400	898	16.5
2008	75	230	250	519	14.5
2009	196	303	300	291	67.4
2010	143	298	400	292	49

Table 2. Ginseng observed in each hectare and ratio of immature to mature plants. Data from Puttock et al. (2012).

Site #	**Site**	**a-1Ps**	**b-2Py**	**c-3Pi**	**d-3Pm**	**e-4Pm**	**Total**	**Ratio syi/m**
1	**Little Seneca Creek RP**	0	0	0	0	0	**0**	**0**
2	**Gunpowder River**	0	0	0	0	0	**0**	**0**
3	**Catoctin Mt NP**	2	24	14	2	0	**42**	**20**
4	**Greenbrier SP**	6	35	14	2	1	**58**	**18.3**
5	**Dan's Mt SP**	1	34	12	2	0	**49**	**23.5**
6	**Elklick Ck Dan's Mt WMA**	2	12	10	2	0	**26**	**12**
7	**Dan's Mt WMA**	0	4	5	12	19	**40**	**0.3**
8	**Asa Durst Savage River SF**	2	3	6	5	0	**16**	**2.2**
9	**Crooked Run Potomac SF**	20	40	20	4	0	**84**	**20**
10	**New Germany Savage R SF**	5	6	7	3	2	**23**	**3.6**
	Totals	**38**	**158**	**88**	**32**	**22**	**338**	

Figure 1. County distribution of American ginseng (*Panax quinquefolius* L.) in North America. Dark green color indicates states within native range. Counties in yellow indicate species present, native and rare in the county; counties in light green indicate species present, native and not rare in the county.

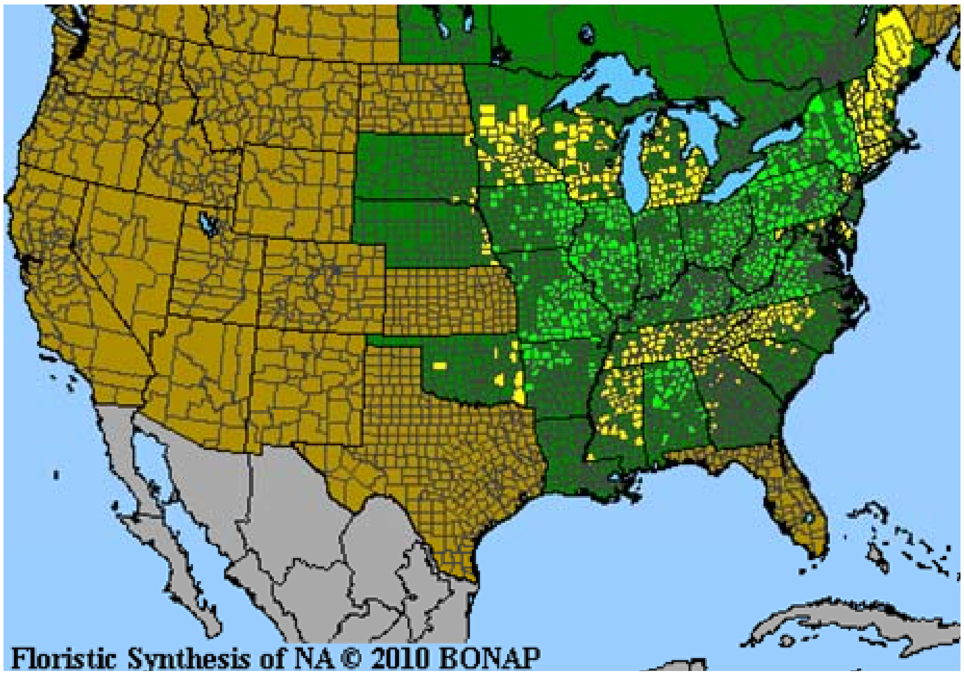

Figure 2. Conservation status of American ginseng in North America (From NatureServe. 2012. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: July 20, 2012)).

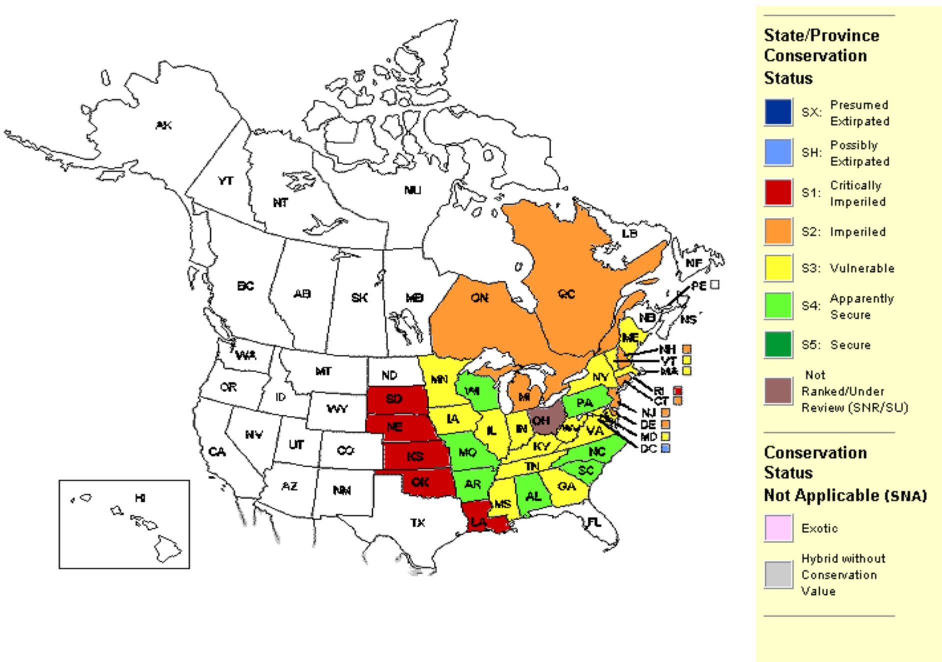

Figure 3. American ginseng harvest status by state (from G. Kauffman 2006).

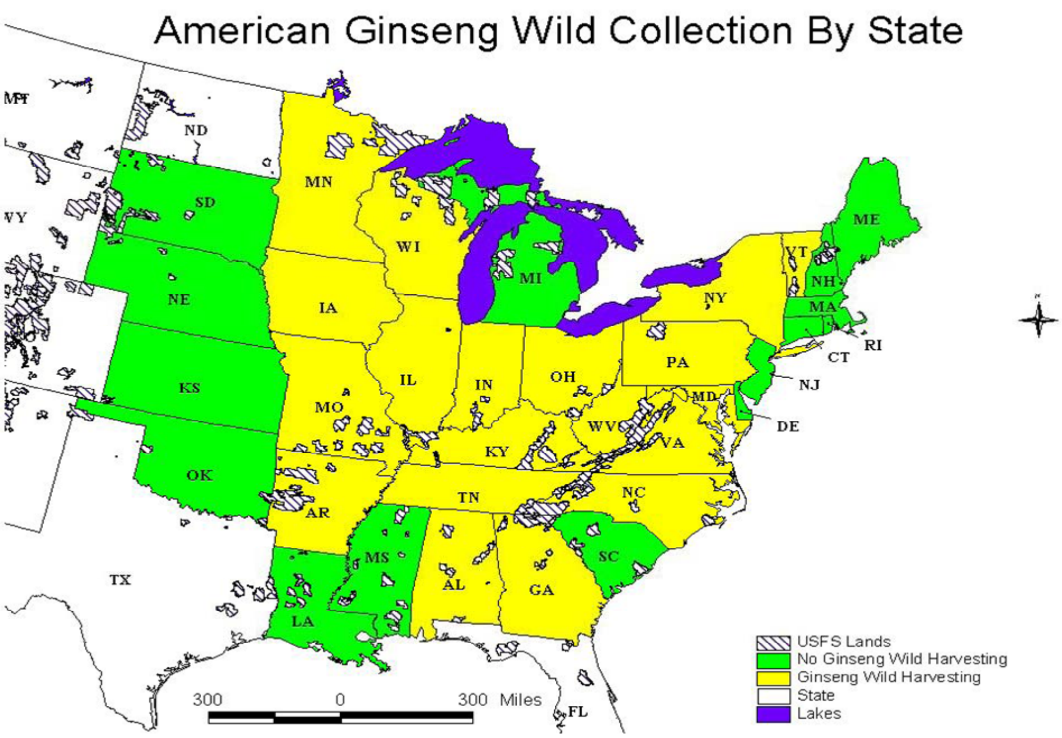

Figure 4. Map of Maryland's Physiographic Provinces (Maryland Geological Survey 2007).

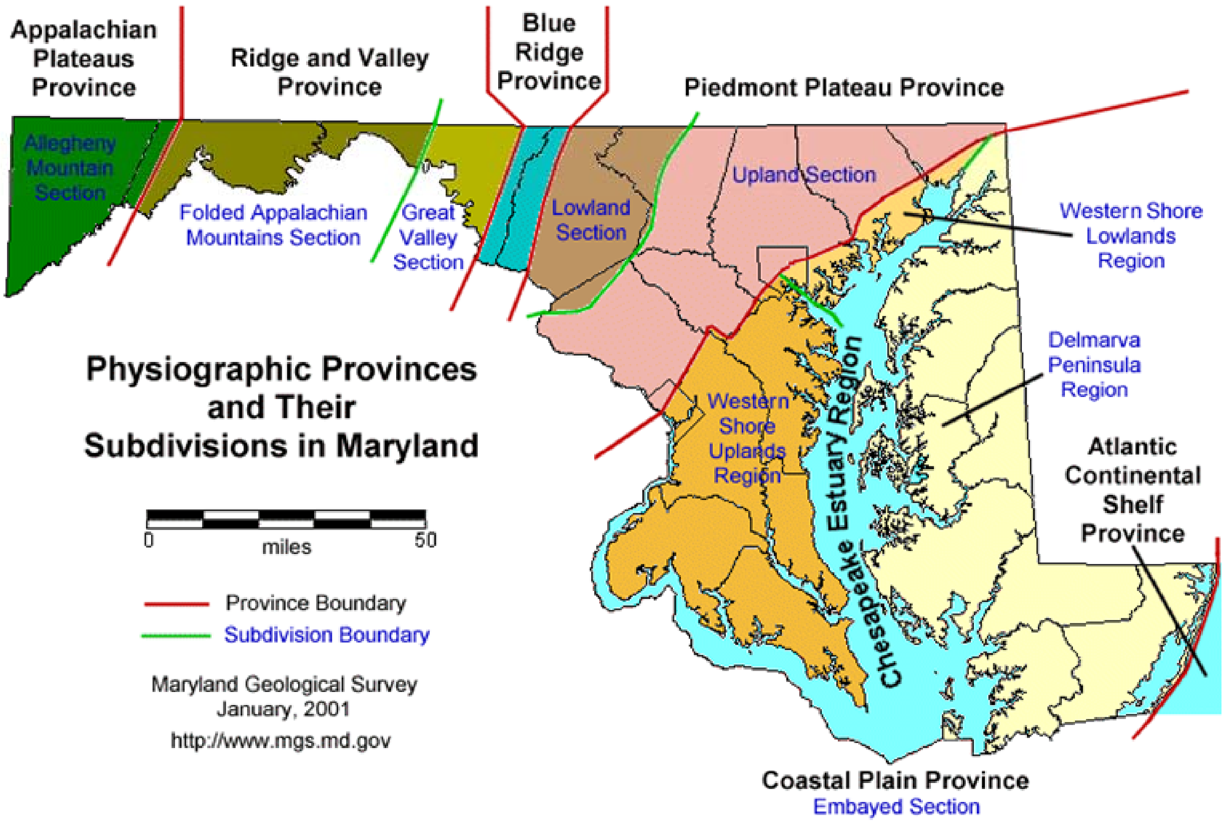

Figure 5. Histogram showing the demography of populations reported to the Maryland Natural Heritage Program (MDNHP) from 1984-2010.

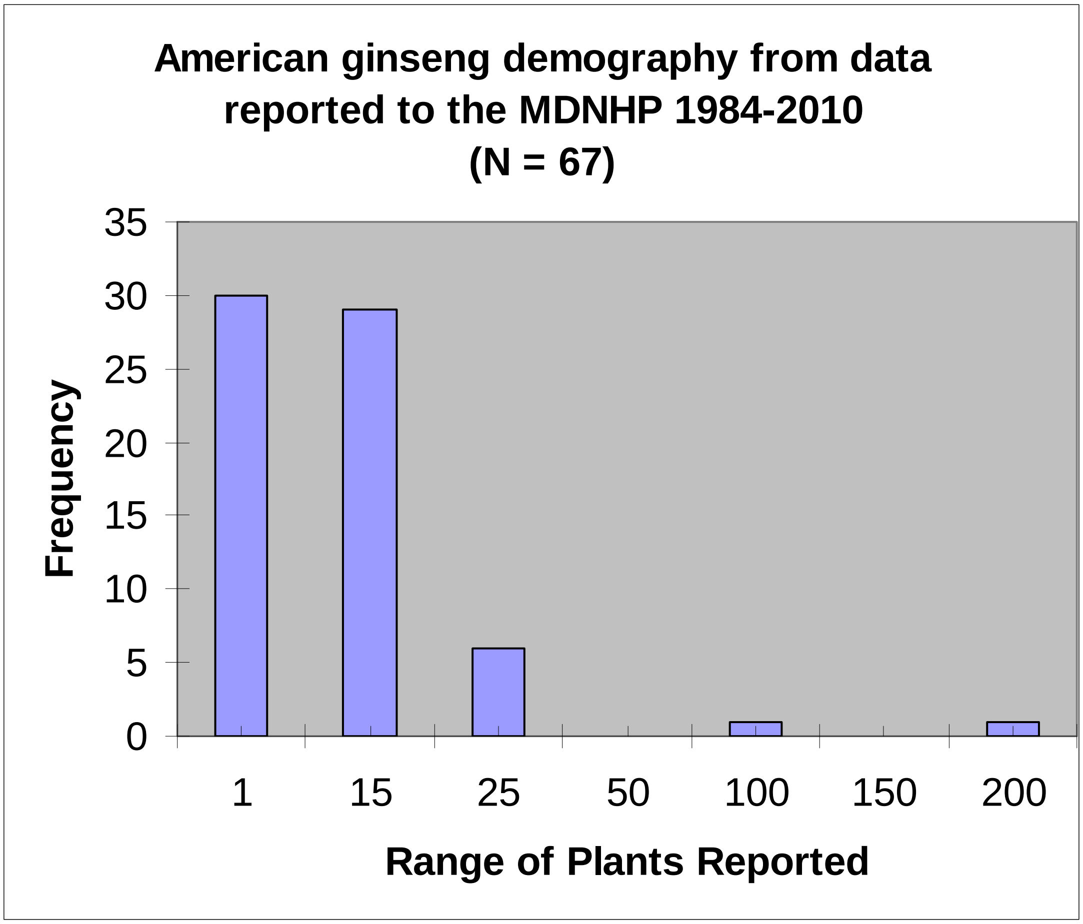

Figure 6. Trends in harvest of wild certified ginseng, number of harvest permits issues and average price per pound of dried root 1979-2010. The arrow indicates the start of dissonance in the trends.

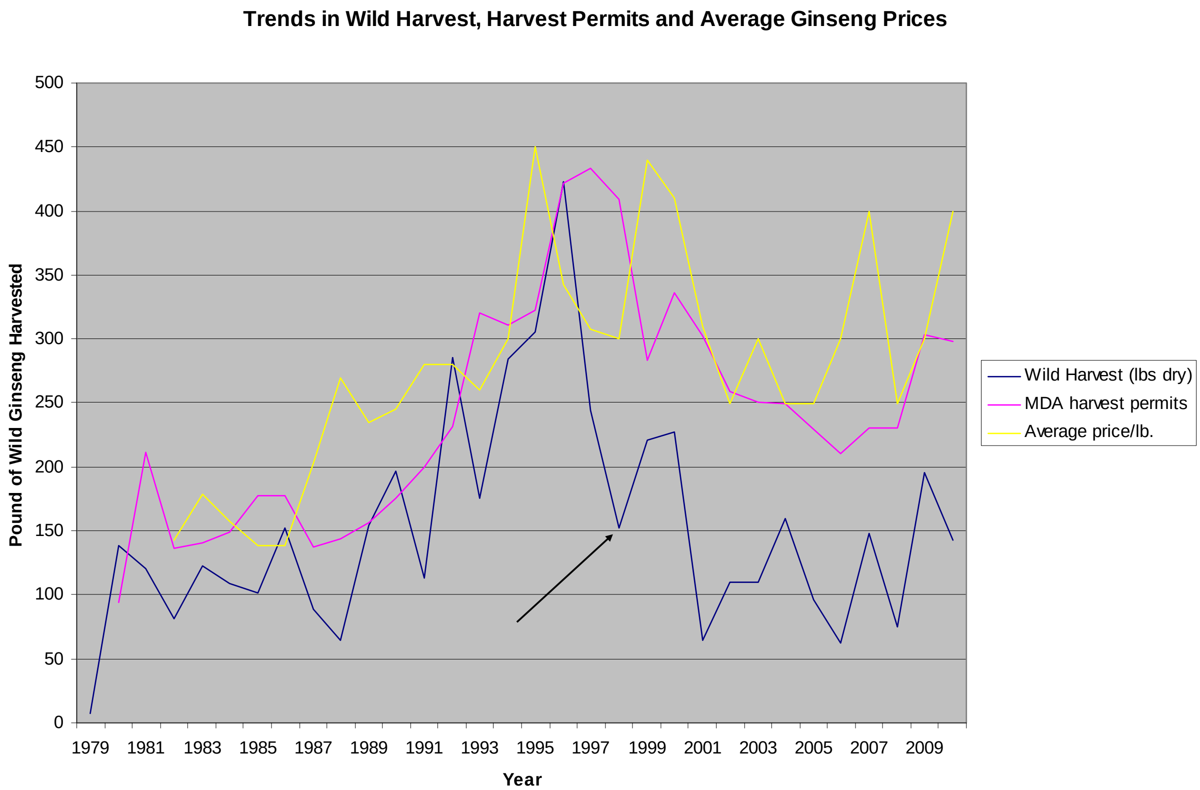

Figure 7. Trends in total harvest of American ginseng certified in Maryland as wild, wild-simulated and woods grown from 1989-2010.

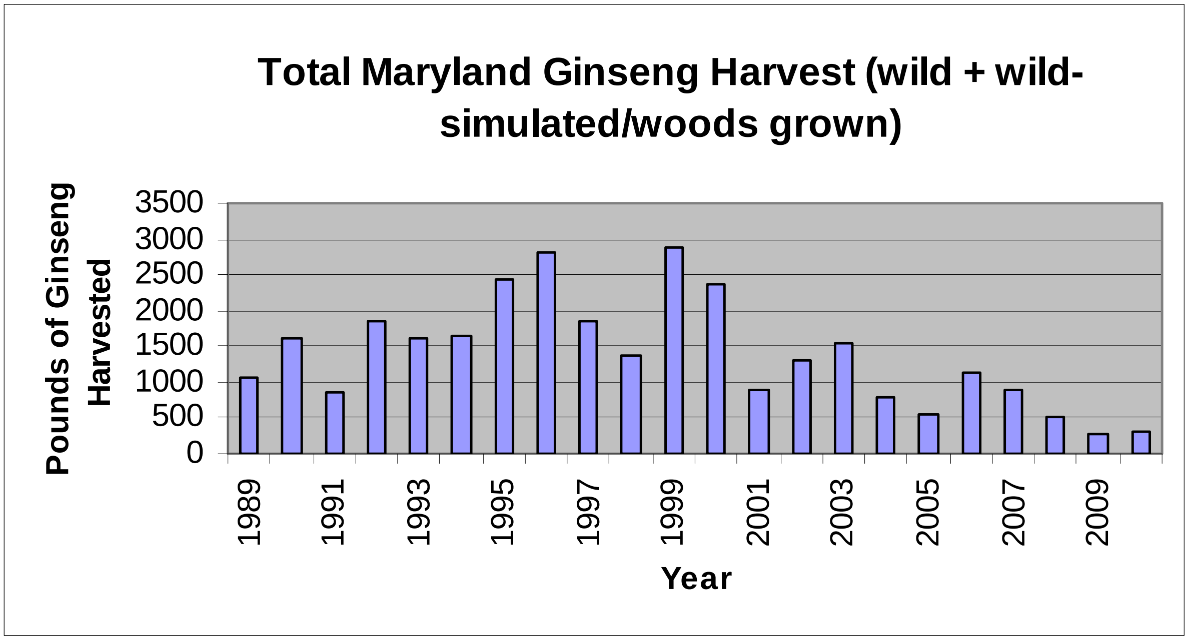

Figure 8. National and Maryland trends in wild ginseng harvest from1992-2010.

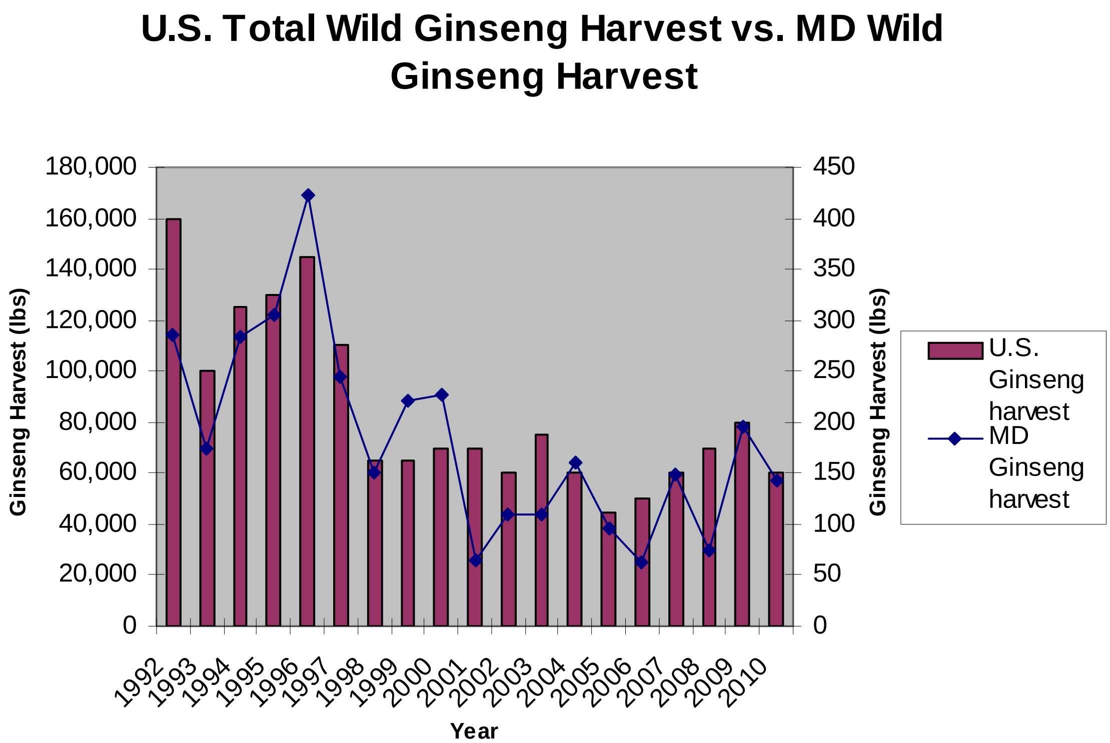

Figure 9. Trends in wild harvest of American ginseng from Allegany and Garrett Counties, Maryland.

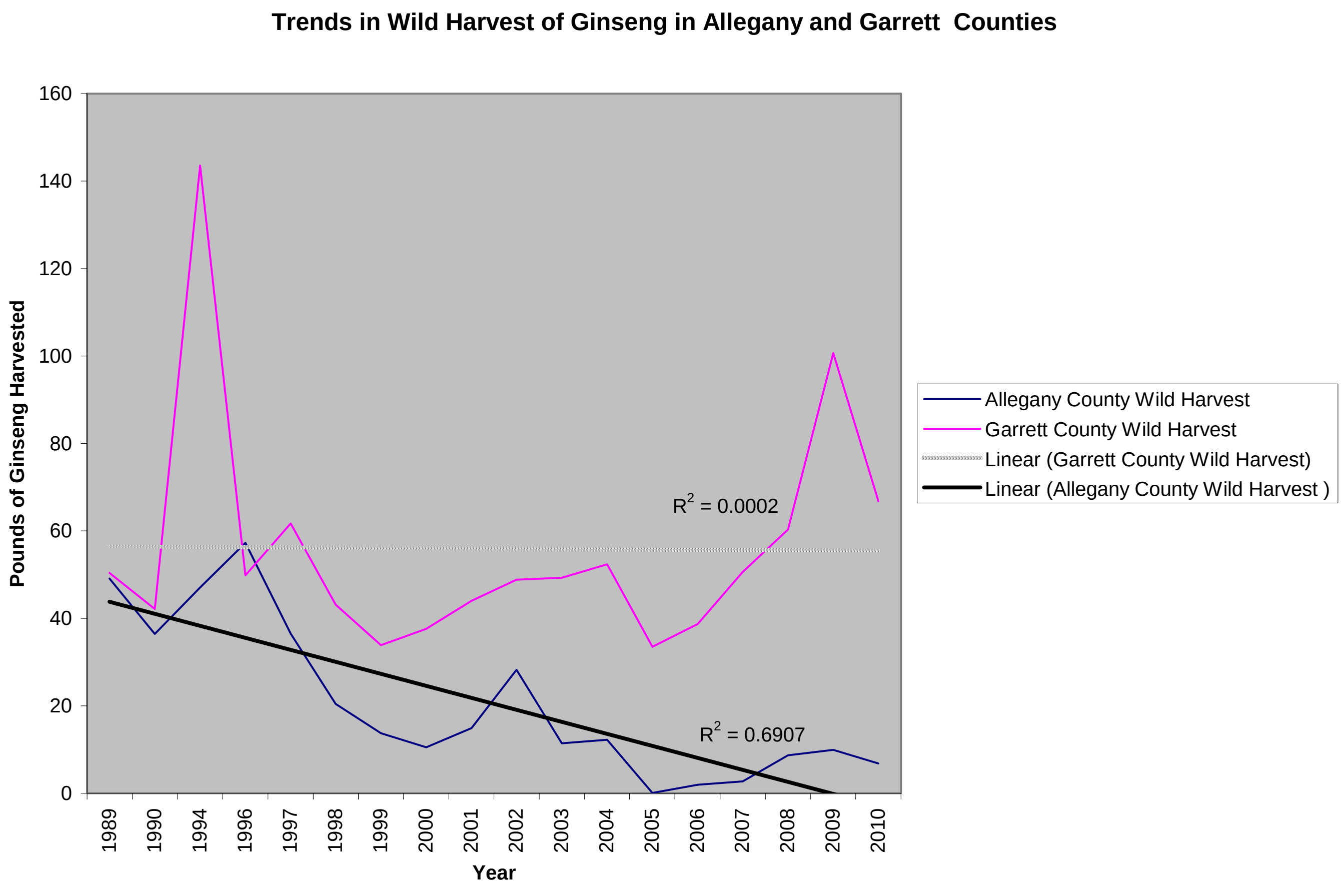

Figure 10. Distributions of size classes at eight Maryland sites surveyed in 2012. (Data from Puttock et al. 2012).

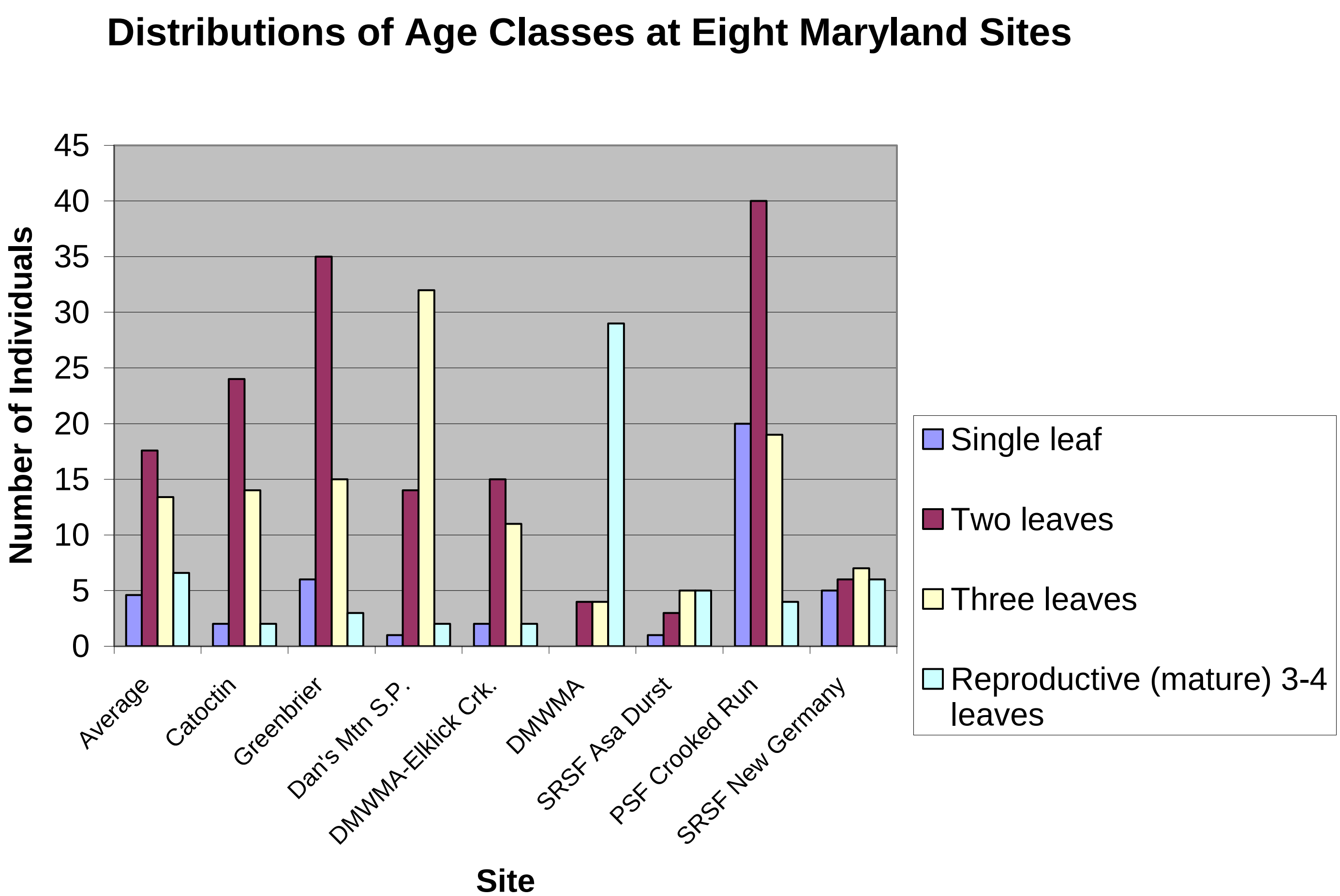

Figure 11. Comparison of age class distributions among studies and sites.