Weed Risk Assessment for *Phyllostachys aureosulcata* McClure (1945) (Poaceae) – Yellow groove bamboo

Maryland Department of Agriculture

August 22, 2016

Version 2

Bamboo Research, Bugwood.org) Right top and bottom: Characteristic yellow sulcis and zigzag lower culms (source: Wayne Longbottom, Maryland Plant Atlas).

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Introduction The Maryland Department of Agriculture regulates terrestrial ornamental invasive plants under the authority of Md. AGRICULTURE Code Ann. § 9.5-101 et seq. Invasive Plant Prevention and Control. An invasive plant is defined as "a terrestrial plant species that a) did not evolve in the State, and b) if introduced within the State, will cause or is likely to cause, as determined by the Secretary: economic harm; ecological harm; environmental harm; or harm to human health."

Maryland's Invasive Plant Advisory Committee (IPAC) was established by legislative mandate in October 2011. The IPAC's primary responsibility is to advise the Secretary of Agriculture on regulating the sale of invasive plants, and on preventing them from entering Maryland or from spreading further in the state. IPAC evaluates the risk potential of plants already present in Maryland, newly detected in the Maryland or the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

The IPAC evaluates the potential invasiveness of plants using the weed risk assessment (WRA) process developed by the Plant Protection and Quarantine (PPQ) Program of the US Department of Agriculture's Animal and Plant Health Inspection Service (Koop et al. 2012). PPQ's risk model uses information about a species' biological traits and behavior to evaluate its risk potential (Koop et al. 2012).

Because the PPQ WRA model is geographically and climatically neutral, it can be used to evaluate the baseline invasive/weed potential of any plant species for the entire United States, or for any specific region in the United States. In the PPQ process, the geographic potential of the species is evaluated separately so that risk managers can make decisions appropriate for their regions. With respect to Maryland's evaluation process, we use PPQ's Geographic Information System overlays of climate to evaluate the potential for a plant to establish and grow in Maryland. The PPQ weed risk assessment also uses a stochastic simulation to evaluate how the uncertainty associated with the assessments affects the model's predictions. Detailed information on the PPQ WRA process is available in the document, *Guidelines for the USDA-APHIS-PPQ Weed Risk Assessment Process* (APHIS PPQ 2015), which is available upon request.

The IPAC uses a second tool, the Maryland Filter, to assign plant species that score as highly invasive either Tier 1 or Tier 2 status. Maryland regulations define Tier 1 plants as "invasive plant species that cause or are likely to cause severe harm within the State" and Tier 2 plants as "invasive plant species that cause or are likely to cause substantial negative impact within the State." The Maryland Filter considers the actual and potential distribution of a species in Maryland, its threat to threatened and endangered ecosystems and species in the state, the difficulty of control of the species, and whether added propagule pressure would be likely to increase its persistence and spread significantly. The IPAC then recommends regulations to reduce the risk of the Tiered invasive plants in Maryland.

***Phyllostachys aureosulcata* McClure – Yellow groove bamboo**

Species Family: Poaceae

Information Synonyms: No recent synonyms are listed for this species (The Plant List 2016).

Common Names: yellow groove bamboo (NRCS 2012).

Botanical description: *Phyllostachys aureosulcata* is a bamboo growing 12-30 feet tall. It has green stems in the spring with a pronounced yellow groove found on the sides of the canes. Strong vertical growth and spreading by underground rhizomes (stems) are a characteristic of yellow groove bamboo (Meredith 2009). *Phyllostachys aureosulcata* is readily confused with *P. aurea* (Carrière ex Rivière & C. Rivière 1878) as well as other members of the genus. Identification is difficult and verification by visual means must take place in the early spring.

Initiation: *Phyllostachys aureosulcata* is easily confused with *P. aurea* and is commonly sold in the nursery trade and naturalized in Maryland. *P. aurea* is listed on the MD Department of Natural Resources (DNR) Do Not Plant List, a policy document available from MD DNR, which lists approximately 90 plant species that may not be planted on DNR land or for DNR projects. Because the two species are often confused in the trade *P. aureosulcata* is also being assessed.

Foreign distribution: *Phyllostachys aureosulcata* is native to China, mainly in the Anhui, Zhejiang, and Jiangsu provinces (Ohmberger 1999).

U.S. distribution and status: *Phyllostachys aureosulcata* has been cultivated for many years in the United States and has only recently been reported as naturalizing. It has naturalized in Illinois (Basinger, 2001), Pennsylvania (DavesGarden 2012, Kartesz 2011), West Virginia, Texas, Georgia, Alabama, Mississippi (Kartesz 2011), and Kentucky (NRCS 2012). It is prohibited for sale in New York state (NYSDEC 2014).

WRA area[1]: Entire United States, including territories

[1] "WRA area" is the area in relation to which the weed risk assessment is conducted [definition modified from that for "PRA area"] (IPPC 2012).

Summary Statement

Phyllostachys aureosulcata received a rating of High Risk in the PPQ Weed Risk Assessment. This species spreads into natural areas from cultivated plantings by extensive rhizomatous growth. Natural area land managers are actively working to manage or control it. The species received a ranking of Tier 2 in the Maryland Filter analysis. Although it is documented as occurring within a population of a State Listed S2 Threatened species in Maryland, it is widely distributed within the state, has been present here for over 20 years and is present in well over 20 sites. Continued sales in Maryland will not add sufficient propagule pressure to significantly increase the species' potential for persistence and spread.

1.*Phyllostachys aureosulcata* analysis

Establishment/ Spread Potential

Where naturalized, *P. aureosulcata*, with few exceptions, appears to have spread from immediately adjacent cultivated sites (Basinger 2001). The exceptions include stands of *P. aureosulcata* in riverine areas along the Susquehanna River in Pennsylvania and next to a bridge abutment in Connecticut, both of which are thought to have originated from rhizomes washed downstream from an upstream source (DavesGarden 2012, Ward 2012a). Other than via rhizomes in water, *P. aureosulcata* lacks long-distance dispersal mechanisms. This running bamboo species primarily spreads via underground rhizomes that emerge each spring (Young and Haun 1961). The American Bamboo Society states that all running bamboos can become pestiferous and recommends either planting these species in containers or installing rhizome barriers around the planting area (ABS 2008). Other characteristics contributing to this species' Establishment and Spread risk score include unintentional dispersal by humans, (e.g. disposal of rhizomes in yard waste), tolerance of above-ground mutilation, and a minimum generation time of one year. Bamboos rarely set seed (Janzen 1974) and seed viability is short (Stapleton 2004).The uncertainty associated with this element was low.
Risk score = 6 Uncertainty index = 0.04

Impact Potential

Phyllostachys aureosulcata primarily affects human-dominated areas (cities, suburbs, home gardens and their surrounding areas). This species damages sidewalks and driveways, destroys swimming pools, invades septic systems, establishes in lawns, and shades out other vegetation (Rickel 2012). Multiple townships have established ordinances restricting the planting and growth of running bamboos; many of those specifically target *Phyllostachys* spp. (Brookhaven NY 2012, West Bradford PA 2011, Cumberland MD 2012). This species forms monocultures (Ward 2011) that change community structure in natural areas. We found no evidence that it is an agricultural weed. A low level of uncertainty was associated with impact potential.
Risk score = 2.9 Uncertainty index = 0.11

Geographic Potential

Based on three climatic variables, we estimated that about 32 percent of the United States is suitable for the establishment of *P. aureosulcata* (Fig. 1). This estimate is based on the species' known distribution (native and naturalized) elsewhere in the world, including both point-referenced localities and general areas of occurrence. The map for *P. aureosulcata* represents the joint distribution of Plant Hardiness Zones 4-10, areas with 30-60 inches of annual precipitation, and the following Köppen-Geiger climate classes: Humid subtropical, Humid continental warm summers, and Humid continental cool summers.

Limited information is available on its full native distribution in China and that hindered our ability to estimate geographic potential. Other environmental variables, such as soil and habitat type, may limit the areas in which this species is likely to establish, but based on the wide cultivation of *P. aureosulcata*, it may establish in areas beyond the predicted range. For example, this bamboo is grown in and sold from nurseries in the Pacific Northwest (Greer Gardens 2012) and can likely establish in that climate. Additionally, the predictive map (Fig. 1) does not include southeastern Louisiana, because we found no reports of *P. aureosulcata* being native or naturalized in areas with an average annual rainfall greater than 60 inches. This prediction likely reflects the lack of data rather than true inability for this bamboo to establish and spread in southeastern Louisiana.

Entry Potential

Because *Phyllostachys aureosulcata* is established in the United States (see U.S. distribution and status, above), we did not assess this risk element.

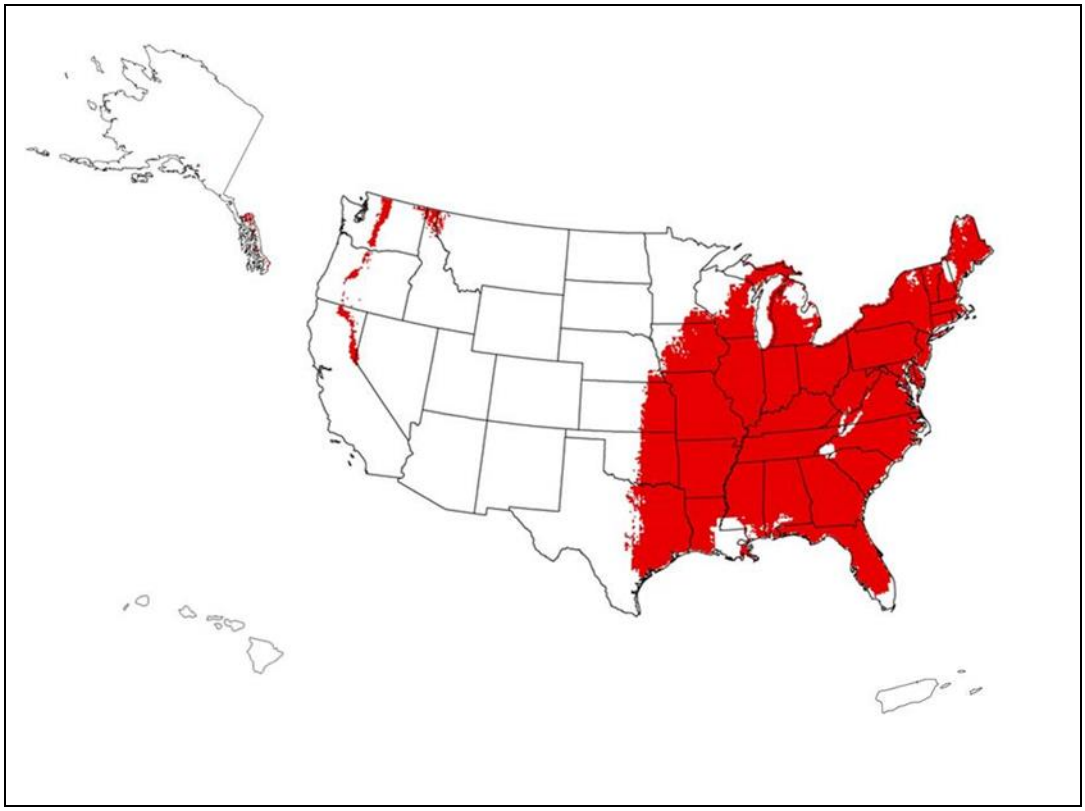

Figure 1. Predicted distribution of *Phyllostachys aureosulcata* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 27.4 %
P(Minor Invader) = 65.2 %
P(Non-Invader) = 7.4 %
Risk Result = Evaluate Further
Secondary Screening = High Risk

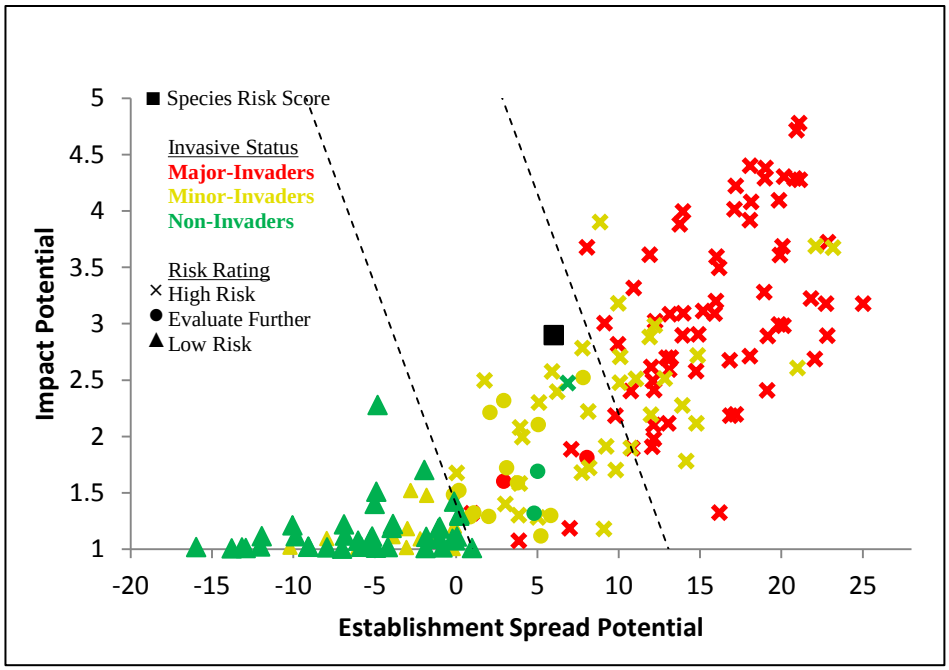

Figure 2. *Phyllostachys aureosulcata* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

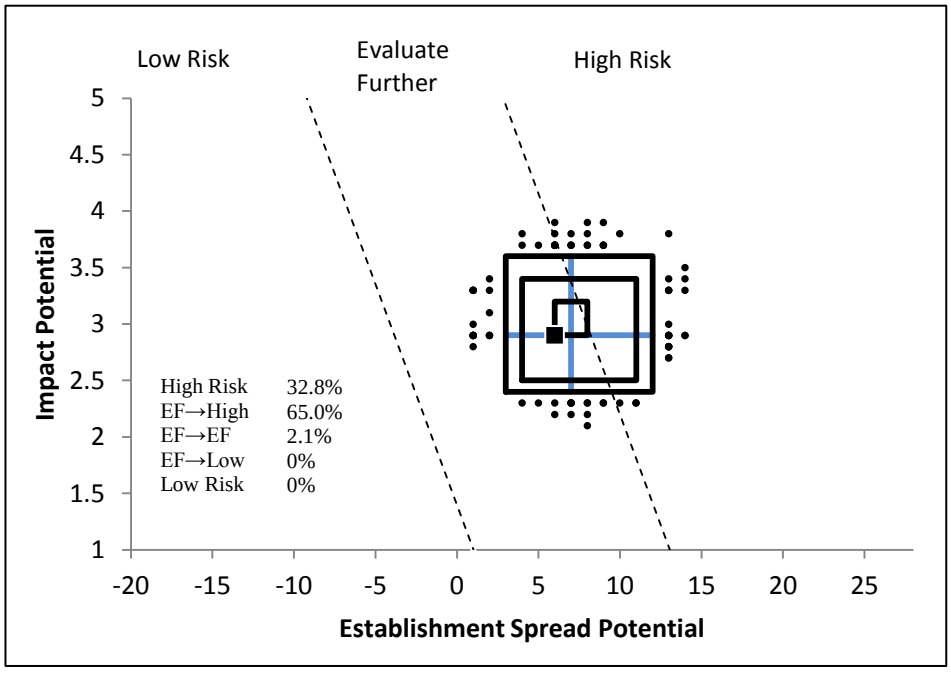

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Phyllostachys aureosulcata*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The risk scores for *Phyllostachys aureosulcata* indicate it has a 65 percent chance of being a minor invader, and the secondary screening tool gave a result of High Risk (Fig. 2). This resulted primarily because the species has demonstrated an ability to spread beyond areas where it is intended to grow. In our uncertainty analysis, 33 percent of the iterations resulted in an outcome of High Risk. In addition, 65 percent of the Evaluate Further analyses were also High Risk (Fig. 3), indicating that the WRA outcome is robust.

Phyllostachys aureosulcata did not obtain a greater proportion of High Risk scores because of relatively low seed production, limited long-distance dispersal mechanisms, and documented impacts that are primarily limited to anthropogenic areas. Because it can spread vegetatively in all directions, if given enough time and space, it will eventually form a forest (Young and Haun 1961). That behavior may impact natural as well as anthropogenic areas. Literature on bamboo cultivation in the United States makes it clear that such species should not be planted near buildings and must be contained (Young and Haun 1961). Maryland, New York and Pennsylvania municipalities have imposed restrictions on planting running bamboos (Cumberland MD 2012, Brookhaven NY 2012, Haverford PA 2011). In 2013, Connecticut adopted a state law restricting running bamboo plantings (Connecticut General Statutes 2014), and the Connecticut Landscape and Nursery Association produced public education flyers and guides for containment for its members to distribute to bamboo purchasers (CTIPC 2016, Musgrave 2010).

The Maryland Filter analysis for this species is Tier 2. *P. aureosulcata* is naturalized and widely distributed within Maryland. It is difficult to control due to its rhizomatous growth and its ability to withstand cutting or mutilation. It has been present in Maryland for sufficient years and in sufficient locations that continued sales are not expected to substantially increase its potential for persistence and spread. It has been documented within a population of swamp oats, *Sphenopholis pensylvanica*, a State Listed S2, Threatened species in a state natural area (Kyde 2016a).

Some confusion exists over the identity of running bamboos, particularly *P. aurea* and *P. aureosulcata*, in northern states and possibly elsewhere. Because these species behave similarly in suitable environments, we expect their invasive and impact potential will be similar. Managing these species similarly may be prudent.

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Appendix A. Weed risk assessment for *Phyllostachys aureosulcata* McClure (Poaceae). The following information came from the original risk assessment, which is available upon request (full responses and all guidance). We modified the information to fit on the page.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	f - low	5	This species is native to China (Ohmberger 1999), and is naturalized in the United States (NRCS 2012). Naturalized in Illinois, it is vegetatively spreading from an old home site into dry-mesic upland forest (Basinger 2001). *Phyllostachys aureosulcata* is also naturalized along logging roads in Alabama (Diamond 2013). It is cultivated as an ornamental in South Carolina, Virginia, West Virginia, and is persistent, or spreading from plantings (Weakley 2015). It has escaped from cultivation in Connecticut and is spreading into yards, roadsides, and natural areas (Rickel 2012). Although most of the plants in natural areas in Connecticut appear to be the result of spread from ornamental plantings, one clump next to a bridge abutment may have dispersed from upstream occurrences (Ward 2012a). *Phyllostachys aureosulcata* plants form large clumps and can be very invasive if not kept in check; "I have personally seen landscapes where this plant has taken over the whole yard" (Lemke 2008). Running bamboos, including *P. aureosulcata*, send out rhizomes in all directions from each culm; rhizomes may extend 15 to 25 feet within a growing season (Young and Haun 1961). Alternate answers for the Monte Carlo simulation are both "e."
ES-2 (Is the species highly domesticated)	n - low	0	There are at least seven cultivars ('Alata', 'Aureocaulis', 'Harbin', 'Harbin Inversa', 'Lama Temple', 'Pekinensis', 'Spectabilis') within the species; they are distinguished primarily by culm and leaf color (Gardeners World.com 2016, Ohmberger 1999, Meredith 2009). Although *P. aureosulcata* is a popular ornamental, there is no evidence that it has been bred in any way to reduce weed potential.
ES-3 (Weedy congeners)	y - negl	1	Running bamboos in general and *Phyllostachys* species in particular have proven themselves to be problematic in both natural and anthropogenic settings. Several towns in northern states have enacted legislation to control the sale and planting of running bamboos, including the genus *Phyllostachys* (Brookhaven NY 2012, West Bradford PA 2011 Cumberland MD 2012). *Phyllostachys pubescens* was introduced from China into Japan in 1746. "It is a clonal grass, growing 25m high, capable of overtopping and killing a big tree; it now dominates hundreds of kilometers of abandoned terrace cultivation that fringe the bases of the mountains and its upward spread is a continuing threat to the ancient woodlands above the terraces" (Rackham 2008). *Phyllostachys pubescens* has invaded forests in Japan, forming uniform monolayers of foliage, and dominating competing vegetation; between 1975 and 1993, this

			bamboo had replaced the trees in a once-mixed forest (Isagi and Torii 1977). *Phyllostachys flexuosa* is reported to form dense stands which prevent native vegetation from growing (GISD 2008).
ES-4 (Shade tolerant at some stage of its life cycle)	n - negl	negl	*P. aureosulcata* requires full sun (Halvorson et al. 2010) or full sun to light shade (Lemke 2008).
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	*P. aureosulcata* is a woody, perennial, reed-like plant, and is neither a vine nor does it have a basal rosette of leaves. It spreads primarily through underground rhizomes which produce culms each spring (Young and Haun 1961, McClure 1957).
ES-6 (Forms dense thickets, patches, or populations)	y - negl	2	Where well-established in full sunlight, *P. aureosulcata* forms dense, nearly impenetrable thickets with no native vegetation (Ward 2012a). The plants form large clumps and can be very invasive if not kept in check (Lemke 2008). All running bamboos, including the genus *Phyllostachys*, spread primarily by rhizomes; new culms usually appear above ground in mid-spring at varying space intervals (rhizomes may extend 15 to 25 feet underground); a more or less open thicket is produced and, with the giant species, which includes *P. aureosulcata*, eventually a forest (Young and Haun 1961).
ES-7 (Aquatic)	n - negl	0	*P. aureosulcata* is a terrestrial plant (Young and Haun 1961, Weakley 2015).
ES-8 (Grass)	y - negl	1	Bamboos constitute the subfamily Bambusoideae of the grass family Poaceae (Young and Haun 1961, Weakley 2015).
ES-9 (Nitrogen-fixing woody plant)	? - max		Studies from China have shown associative N-fixation in two congeners, *Phyllostachys pubescens* and P. *meyeri* (Gu and Wu 1994, 1998). Nitrogen-fixing plants fall into three categories, rhizobial, actinorhizal, and associative (Thompson 2004); associative N-fixation is well-demonstrated in rice and several members of the Poaceae (e.g., sugarcane, forage grasses) (Thompson 2004). Because the N-fixing *Phyllostachys* spp. are reported from only one geographic location, and because these are the only reported cases of N-fixation in bamboo (Thompson 2004), we answered "unknown" with maximum uncertainty.
ES-10 (Does it produce viable seeds or spores)	y - low	1	Delayed seed production has evolved in bamboos to escape seed predation (Janzen 1974). We could not locate information detailing the specific intermast period for *P. aureosulcata*, but other *Phyllostachys* species may experience intermast periods of 13 to over 100 years (Janzen 1974). That *P. aureosulcata* does flower is evident by a photograph obtained from the American Bamboo Society taken by a Michigan bamboo nursery (bambooweb.info 2016). The online database Plants for a Future provides information on the best method for germinating the seeds of P. *aureosulcata* (PFAF 2016). Bamboo seed is available from online vendors (Compilation of Bamboo Seeds 2016; Alibaba 2016).
ES-11 (Self-compatible or apomictic)	n - mod	-1	Evidence suggests that (bamboo) flowers are able to cross-pollinate, suggesting that isolated clones may

			produce few or no seeds (Janzen 1974). In a Brazilian study, Filgueiras and Magno (2007) suggested that the congener P. *aurea* may be an obligate outcrossed species. Studies of the congener *P. nidularia* suggest that honey bee visits to flowering bamboo may assist wind-pollination (Huang et al. 2002).
ES-12 (Requires specialist pollinators)	n - negl	0	Bamboos are wind-pollinated (Gucker 2009). Evidence suggests that flowers are cross-pollinated, suggesting that isolated clones may produce few or no seeds (Gucker 2009, Janzen 1974). Studies of the congener *P. nidularia* suggest that visits of the generalist pollinators honey bees to flowering bamboo may assist wind-pollination (Huang et al. 2002).
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	b - negl	1	*P. aureosulcata* spreads vegetatively via rhizomes, forming large colonies over time (HSU n.d.). New shoots appear early in midspring (Young and Haun 19611). For all species within the genus *Phyllostachys*, the terminal bud of a rhizome usually dies before active growth begins the following spring and this results in the development and growth of several lateral buds behind the terminal bud; by repeated branching the rhizomes grow in all directions if conditions are favorable (Young and Haun 1961). "The new culms produced each successive year emerge from the ground with a greater diameter and reach a greater height before they stop growing, because the plant has extended its underground system of rhizomes and roots during the intervening period" of one year (McClure 1957)."Shoot initiation...begins in early to mid spring...through late spring to early summer" (Meredith 2009). Alternate answers for the Monte Carlo simulation are both "c."
ES-14 (Prolific reproduction)	n - low	-1	Seed production occurs rarely in bamboos (Janzen 1974); this bamboo spreads vegetatively by rhizome growth.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - low	1	This plant can become established by dumping of yard waste containing rhizome fragments (Langeland and Stocker 2001).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - low	-1	There is no evidence that seeds have been dispersed as trade contaminants or hitchhikers. Additionally, plant rhizomes of these large woody species are not likely to disperse as contaminates or hitchhikers.
ES-17 (Number of natural dispersal vectors)	1	-2	Information relevant for ES17a through ES17e: The general opinion about mast-flowering bamboos, which includes the genus *Phyllostachys*,is that they experience infrequent, cyclical flowering with short-lived seed that is not adapted for dispersal by any agent (Stapleton et al. 2004). Most mast-flowering bamboos have passive dispersal, concentrating seedling recruitment near the dead skeleton of the parent plant (Keeley and Bond 1999). Description of flowers and seeds: Flowering branchlets spicate, ca. 8.5 cm, scaly bracts ca. 4, gradually larger; spathes 4 or 5, glabrous or sparsely puberulous; auricles and oral setae absent, blade subulate, small. Pseudospikelets 5-7 per spathe, usually absent from lowest one. Spikelets with 1 or 2 florets.

			Glumes 1 or 2, keeled; rachilla puberulous; lemma 1.5-1.9 cm, distally pubescent; palea slightly shorter than lemma, distally pubescent; lodicules ca. 3.5 mm. (Flora of China 2006).
ES-17a (Wind dispersal)	n - low		Most mast-flowering bamboos have passive dispersal concentrating seedlings recruitment near the parent plant (Keeley and Bond 1999)
ES-17b (Water dispersal)	y - low		The presence of naturalized stands of *P. aureosulcata* beside rivers and streams suggests that culms and rhizomes can be moved by water and washed downstream from upstream sources (EDDMapS 2012, Ward 2012a). Rhizome dispersal by water was photodocumented along Muddy River in Connecticut (Institute of Invasive Bamboo Research 2016).
ES-17c (Bird dispersal)	n - low		No, seeds are passively dispersed (Keeley and Bond 1999).
ES-17d (Animal external dispersal)	n - low		No, seeds are passively dispersed (Keeley and Bond 1999).
ES-17e (Animal internal dispersal)	n - low		No, seeds are passively dispersed (Keeley and Bond 1999).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - low	-1	Seeds are short-lived (Stapleton 2004). Seed viability in the congener *P. pubescens* is completely lost after one year (Guangcho 2002).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - low	1	That *P. aureosulcata* tolerates mutilation is evident by the difficulty people have in controlling the spread of this bamboo. For example: "Even though all canes cut, rhizome web still invades; shoots up daily - cannot kill it; digging rhizomes - all lawn destroyed" (Rickel 2012). "Fully invading State land and running up along Merritt Parkway. DOT not able to kill it (workers mow it and it comes back up fast)" (Rickel 2012). There is evidence that fire can cause flowering to occur (Koller 1989).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	*Phyllostachys aurea, P. aureosulcata,* and *P. bambusoides* can be controlled but it requires one or more years of herbicide treatment (Ward 2012b). Although it takes effort and often multiple applications, running bamboos within the genus *Phyllostachys* can be controlled with glyphosate herbicides (Czarnota and Derr 2007, Smith 2008). There are no *Phyllostachys* species listed by the International Survey of Herbicide Resistant Weeds (Heap 2012).
ES-21 (Number of cold hardiness zones suitable for its survival)	7	0	
ES-22 (Number of climate types suitable for its survival)	3	0	
ES-23 (Number of precipitation bands suitable for its survival)	3	-1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - high	0	Although field observations and subsequent laboratory research in Taiwan of a congener, *P. edulis*, suggest that allelopathy may play an important role in interspecific competition (Chou and Yang 1982), we found no evidence that P. aureosulcata is allelopathic.

Imp-G2 (Parasitic)	n - negl	0	No species within the family Poaceae is known to be parasitic (Nickrent 2012).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - high	0	We found no evidence of this. If *P. aureosulcata* were to become established along a stream, it could alter food webs; its congener; *P. aurea*, is said to have this effect (Gonzalez and Christoffersen 2006, LBJWC 2007).
Imp-N2 (Changes habitat structure)	y - low	0.2	P. *aureosulcata* forms monocultures: "I have never seen a species so thoroughly dominate a site and form a monoculture that completely excludes other species" (Ward 2011). All running bamboos within the genus *Phyllostachys* spread by underground rhizomes, at first forming thickets and, with giant species, including *P. aureosulcata*, eventually a forest (Young and Haun 1961).
Imp-N3 (Changes species diversity)	y - low	0.2	"Where well-established in full sunlight, bamboo forms dense nearly impenetrable thickets with NO native vegetation. In small gaps with some trees (similar to a shelterwood), the bamboo is less dense and lesser vegetation is still present" (Ward 2012a). Bamboos can form very dense single-species thickets that displace native plant species and create dense shade that makes it difficult for seedlings of native seedlings to survive (Swearingen 2011). Running bamboos will take over any sunny or semi-shaded area forming impenetrable thickets and effectively crowding out all native vegetation (Reaves 2011).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	y - low	0.1	We found no explicit examples for *P.aureosulcata*. Several bamboo stands in Maryland occur in close proximity to Federally listed Threatened or Endangered species. Because *P. aureosulcata* occurs in the same habitat type as these listed species, and because it *has* been documented within a population of swamp oats, *Sphenopholis pensylvanica*, a State Listed S2, Threatened species in a state natural area (Kyde 2016a), Maryland's Natural Heritage Program considers the bamboo a threat to them. Because running bamboos spread by rhizomes, form forests, and can outcompete other species fairly easily, it is expected that this bamboo could affect threatened plant species under the right conditions.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	y - mod	0.1	While most of the documented infestations in Maryland occur along roadsides or rights of way, *P. aureosulcata* has invaded secondary forests, forest clearings and forest edges in both Maryland and Virginia (EDDMapS 2016), and is spreading from cultivated planting on the Upper Coastal Plain and the Piedmont into mixed mesophytic forests. As these areas are within the Appalachian and Mixed Mesophytic Forest globally outstanding ecoregion, we answered "yes" with moderate uncertainty.
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed	c - mod	0.6	The species is vegetatively spreading from an old home site into dry-mesic upland forest in Illinois (Basinger 2001). Information provided to the Connecticut General Assembly documents multiple examples of escapes

and evidence of control efforts]			from cultivation in which *P. aureosulcata* is spreading into natural areas (Rickel 2012). National Park Service, Maryland Park Service and the conservation community are actively engaged in removing running bamboos from natural areas (Frey 2016, Palmer 2016, Phillips 2016). Alternate answers for the Monte Carlo simulation are both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	y - negl	0.1	A Connecticut citizen supporting legislation to regulate running bamboo documented various problems with *P. aureosulcata* on private property: rhizomes traveled under the sidewalk and reached central air conditioning units; rhizomes cracked and lifted a new asphalt driveway; rhizomes destroyed an in-ground swimming pool; rhizomes invaded septic and leaching fields; rhizomes grew into power lines (Rickel 2012). "The running bamboos are not suitable for growing near buildings or where space is otherwise limited" (Young and Haun 1961).
Imp-A2 (Changes or limits recreational use of an area)	y - mod	0.1	National and state park land managers report interference with trail use due to running bamboo infestations (Frey 2016, Palmer 2016). The land manager for a large southern Maryland conservancy reported "Areas with bamboo can't be used for hiking, bird watching, hunting, camping, etc. so as it spreads, it makes more land unavailable for recreational activities" (Phillips 2016).
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	y - negl	0.1	The plant is a continual nuisance, invading all landscape and killing peonies, hydrangea, lilac, crabapple, roses all invaded; all lawn destroyed; invading 30 year-old forsythia hedge (Rickel 2012). The majority of neighbor-to-neighbor complaints received by Maryland DNR's invasive plant ecologist concern running bamboo species (Kyde 2016b.).
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - negl	0.4	Towns in New York, Pennsylvania, and Maryland have adopted or are considering ordinances regulating the sale and growth of running bamboos (Brookhaven NY 2012, Haverford PA 2011, West Bradford PA 2011, Cumberland MD 2012). In 2014, Connecticut passed a law restricting planting of running bamboos, specifically mentioning *P.aureosulcata*, within a certain distance of property boundaries or public roadways, and levying a financial penalty for violations. The law lists those state and municipal officials who may enforce the provisions (C.G.S. 2014, Rickel 2012). The Connecticut Nursery and Landscape Association, was required by law to produce, and did, a handout for Connecticut retailers selling *Phyllostachys* species detailing how the plant should be controlled (CTIPC 2016, Musgrave 2010). If grown in landscape, they need some sort of barrier to keep them in bounds; "I have personally seen landscapes where this plant (*P. aureosulcata*) has taken over the whole yard" (Lemke 2008). The running bamboos are not suitable for growing near buildings or where space is otherwise limited; plots are kept within bounds by

			breaking off new shoots in the spring that start outside the set limits (all running bamboos) (Young and Haun 1961). Alternate answers for the Monte Carlo simulation are both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - low	0	*P. aureosulcata* is relatively well known; there is no evidence that it invades agricultural settings or that it is an agricultural weed.
Imp-P2 (Lowers commodity value)	n - low	0	*P. aureosulcata* is relatively well known; there is no evidence that it invades agricultural settings or that it is an agricultural weed.
Imp-P3 (Is it likely to impact trade?)	n - low	0	*P. aureosulcata* is relatively well known; there is no evidence that it invades agricultural settings or that it is an agricultural weed.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	*P. aureosulcata* is relatively well known; there is no evidence that it invades agricultural settings or that it is an agricultural weed.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - negl	0	*Phyllostachys* foliage can meet the maintenance or growth needs of goats and other ruminants (Halvorson et al. 2010).
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - low	0	*P. aureosulcata* is relatively well known; there is no evidence that it invades agricultural settings or that it is an agricultural weed.. Alternate answers for the Monte Carlo simulation are both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points (pts) obtained from the Global Biodiversity Information Facility, accessed in 2012. Non geo-referenced locations from GBIF and other sources are noted as occurrences (occ.) Original search conducted by USDA APHIS.
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that this plant occurs in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that this plant occurs in this zone
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that this plant occurs in this zone
Geo-Z4 (Zone 4)	y - low	N/A	In areas with winter temperatures as low as -34C, the above-ground portions of P.aureosulcata will die but this bamboo will grow back in the summer (Ontario Bamboo n.d.).
Geo-Z5 (Zone 5)	y - low	N/A	Hardy to Zone 5 (zones 5 to 10) DavesGarden 2012). Can tolerate -15C or -20C (Ohmberger 1999).
Geo-Z6 (Zone 6)	y - negl	N/A	Zone 6 (DavesGarden 2012); U.S.: CT, WV (EDDMapS 2012, pts).
Geo-Z7 (Zone 7)	y - negl	N/A	Zone 7 (DavesGarden 2012); Native: China: Anhui, Jiangsu (Ohmberger 1999); U.S.: CT, DC, KY, MD, NY, OH, TN, VA, WV (EDDMapS 2016 pts.); PA (Kartesz 2011 occ.).
Geo-Z8 (Zone 8)	y - negl	N/A	Zone 8 (DavesGarden 2012); Native: China: Anhui, Zhejiang, Jiangsu (Ohmberger 1999); U.S.: MS (Kartesz 2011 occ); AL (GBIF 2012 pts, Kartesz 2011 occ).
Geo-Z9 (Zone 9)	y - negl	N/A	Zone 9 (DavesGarden 2012); U.S.: TX (Kartesz 2011 occ).

Geo-Z10 (Zone 10)	y - mod	N/A	Zone 10 (DavesGarden 2012; Greer Gardens 2012).
Geo-Z11 (Zone 11)	n - low	N/A	We found no evidence that this plant occurs in this zone.
Geo-Z12 (Zone 12)	n - low	N/A	We found no evidence that this plant occurs in this zone.
Geo-Z13 (Zone 13)	n - low	N/A	We found no evidence that this plant occurs in this zone.
Köppen -Geiger climate classes			We found no evidence that this plant occurs in this zone.
Geo-C1 (Tropical rainforest)	n - mod	N/A	We found no evidence that this plant occurs in this class.
Geo-C2 (Tropical savanna)	n - low	N/A	We found no evidence that this plant occurs in this class.
Geo-C3 (Steppe)	n - low	N/A	We found no evidence that this plant occurs in this class.
Geo-C4 (Desert)	n - negl	N/A	We found no evidence that this plant occurs in this class.
Geo-C5 (Mediterranean)	n - negl	N/A	We found no evidence that this plant occurs in this class.
Geo-C6 (Humid subtropical)	y - negl	N/A	Native: China: Anhui, Zhejiang, Jiangsu)(Ohmberger 1999); U.S.: AL, DC, MD, TN (EDDMapS 2012 pts; GBIF 2012); AL, MS, WV (Kartesz 2011 occ).
Geo-C7 (Marine west coast)	n - mod	N/A	We found no evidence that this plant occurs in this class.
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	U.S.: PA (Kartesz 2011 occ); CT (EDDMapS 2012 pts).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	U.S.: CT, NY (EDDMapS 2012 pts); WV (Kartesz 2011 occ).
Geo-C10 (Subarctic)	n - low	N/A	We found no evidence that this plant occurs in this class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that this plant occurs in this class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that this plant occurs in this class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - negl	N/A	We found no evidence that this plant occurs in this band.
Geo-R2 (10-20 inches; 25-51 cm)	n - negl	N/A	We found no evidence that this plant occurs in this band.
Geo-R3 (20-30 inches; 51-76 cm)	n - low	N/A	We found no evidence that this plant occurs in this band.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Native: China: Anhui, Zhejiang, Jiangsu (Ohmberger 1999); U.S.: WV (EDDMapS 2012 pts); (TX) (Kartesz 2011 occ).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Native: China: Anhui, Zhejiang, Jiangsu (Ohmberger 1999); U.S. (CT, DC, MD, NY, VA, WV) (EDDMapS 2012 pts);
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Native: China (Anhui, Zhejiang, Jiangsu) (Ohmberger 1999); U.S.: AL, TN (GBIF 2012 pts); AL, MS (Kartesz 2011 occ).
Geo-R7 (60-70 inches; 152-178 cm)	n - mod	N/A	We found no evidence that this plant occurs in this band.
Geo-R8 (70-80 inches; 178-203 cm)	n - low	N/A	We found no evidence that this plant occurs in this band.
Geo-R9 (80-90 inches; 203-229 cm)	n - low	N/A	We found no evidence that this plant occurs in this band.
Geo-R10 (90-100 inches; 229-254 cm)	n - low	N/A	We found no evidence that this plant occurs in this band.
Geo-R11 (100+ inches; 254+ cm)	n - low	N/A	We found no evidence that this plant occurs in this band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Naturalized in southern Illinois; most of the 13 southernmost counties in IL have P. aureosulcata (Basinger 2001). Growing (and naturalized) in Connecticut (Ward 2012) and Maryland (Longbottom 2016). Naturalized in Arkansas (HSU n.d.).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the	-	N/A	

Caribbean or China)		
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A
Ent-4c (Contaminant of seeds for planting)	-	N/A
Ent-4d (Contaminant of ballast water)	-	N/A
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A
Ent-4f (Contaminant of landscape products)	-	N/A
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A
Ent-4i (Contaminant of some other pathway)	-	N/A
Ent-5 (Likely to enter through natural dispersal)	-	N/A

Appendix B. Maryland Filter assessment for *Phyllostachys aureosulcata* McClure (Poaceae).

Maryland Filter questions	Answer	Instructions /Result	Notes
1. Is the plant currently naturalized in Maryland? Yes OR no	yes	Go to question 2	Documented as present in Baltimore, Caroline, Cecil, Dorchester, Kent, Montgomery, Prince George's, and Worcester Counties (EDDMapS 2016, Longbottom 2016, Maryland Plant Atlas 2016).
2. What is the species' potential distribution in Maryland? wide OR narrow	wide	Go to question 4	Plants could grow in any physiographic province of Maryland (WRA GIS results).
3. Does or could the species harm threatened or endangered Maryland species or community types or CITES listed species occurring in MD? yes OR no			(See Question ImpN4 in Appendix A for complete information.)
4. How feasible is control of the species? easy OR difficult	difficult	Go to Question 5	It is difficult to control due to rhizomatous growth and the ability to withstand cutting or mutilation (Rickel 2012).
5. Is added propagule pressure from sales significantly increasing potential of the species to persist and spread? yes OR no	no	**Tier 2**	*Phyllostachys aureosulcata* has been sold in the United States since at least the 1940s (Fruitland Nurseries 1947) and it is present at more than 20 sites in Maryland (Kyde 2016a).