Weed Risk Assessment for *Oplismenus hirtellus* (L.) P. Beauv. subsp. *undulatifolius* (Ard.) U. Scholz (Poaceae) – Wavyleaf basketgrass

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Oplismenus hirtellus subsp. *undulatifolius* infestation (photo by Kerrie L. Hyde). Insets from left to right show foliage (photo by K.L. Hyde), flower (photo by K.L. Hyde), and seeds (photo by Garrett Waugaman). Source for images : www://invasives.org.

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Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use weed risk assessment (WRA) —specifically, the PPQ WRA model[1]—to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

Because our 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 any area within it. We use a climate matching tool in our WRAs to evaluate those areas of the United States that are suitable for the establishment of the plant. We also use a Monte Carlo simulation to evaluate the consequences of uncertainty on the outcome of the risk assessment. For more information on the PPQ WRA process, please refer to the document, *Introduction to the PPQ Weed Risk Assessment Process*, which is available upon request.

Oplismenus hirtellus (L.) P. Beauv. subsp. _undulatifolius_ (Ard.) U. Scholz – Wavyleaf basketgrass

Species Family: Poaceae

Information Initiation: Al Tasker, APHIS PPQ National Noxious Weed Program Manager, requested that the Plant Epidemiology and Risk Analysis Laboratory (PERAL) Weed Team conduct a weed risk assessment for *Oplismenus hirtellus* subsp. *undulatifolius*, wavyleaf basketgrass. This request was initiated after he was informed of an infestation in Maryland. Although *O. hirtellus* is sold by the nursery industry, molecular work conducted by Sharon Talley, PPQ Center for Plant Health and Science Technology (CPHST), confirmed that this was not the same taxon being sold by the nursery industry (Tasker, 2010).

Foreign distribution: *Oplismenus hirtellus* subsp. *undulatifolius* occurs in temperate, subtropical, and tropical areas of the world (Scholz, 1981). It occurs in many African countries (including Madagascar), temperate and tropical Asia, Australia, and parts of Europe (Scholz, 1981; USDA ARS NGRP, 2009).

U.S. distribution and status: First discovered in the United States in 1996 in a state park in Maryland, *O. hirtellus* subsp. *undulatifolius* has since been found in at least seven locations in Maryland (Westbrooks and Imlay, 2009) and four in Virginia (Akerson, 2010). Maryland and Virginia have not taken regulatory action against this taxon, although considerable effort has been made at state and local levels to combat the organism. Eradication and control efforts include Early Detection Rapid Response (EDRR) strategies (Kyde and Marose, 2008), and ongoing removal by county and volunteer weed crews (MDDNR, n.d.). In pure stands, the herbicide glyphosate is used to kill the plants, while hand-removal is used when plant are growing among native species.

[1] Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294. DOI:10.1007/s10530-011-0061-4

WRA area: The United States, including its territories and possessions.

1. *Oplismenus hirtellus* subsp. *undulatifolius* analysis

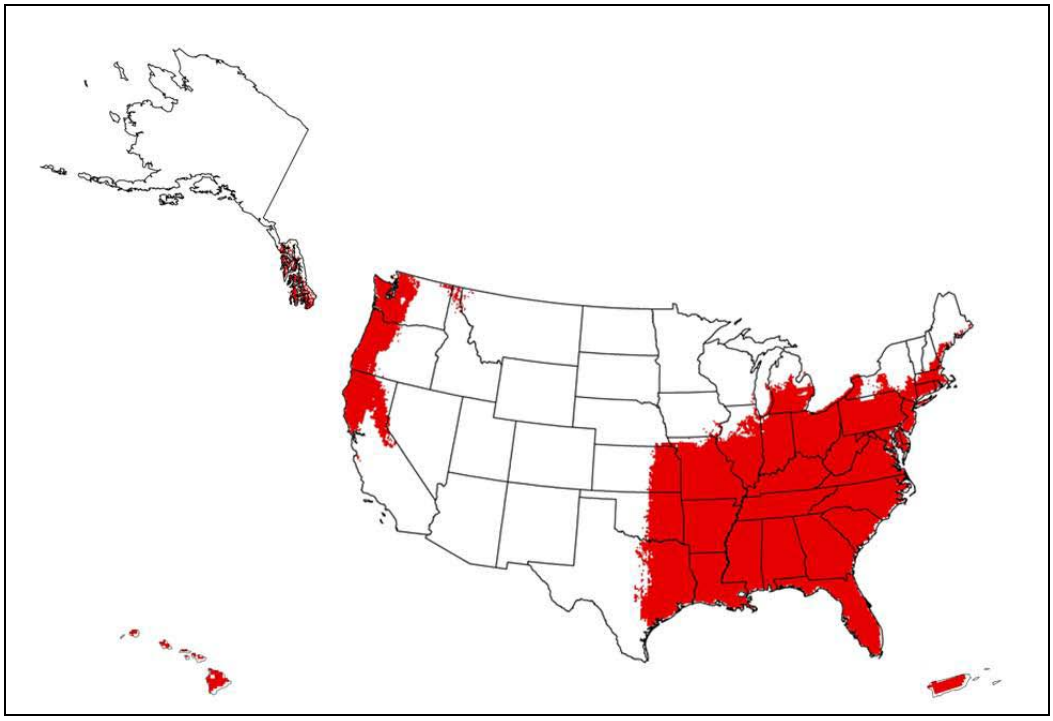
Establishment/Spread Potential In Maryland, *O. hirtellus* subsp. *undulatifolius* has demonstrated a high capacity to establish and spread (Westbrooks and Imlay 2009). Since its initial detection in 1996, it has spread to at least seven locations (Westbrooks and Imlay 2009). The most notable characteristics contributing to its high establishment/spread risk score include the following: self reproduction (Scholz, 1981); a short generation time; and sticky propagules that promote dispersal (Beauchamp, 2010). This taxon's rapid spread in Maryland is likely due to unintentional dispersal by bikers, dog walkers, and hikers who use infested areas. For example, a recent article in the Baltimore Sun reports "After a recent hike through Patapsco Valley State Park, Baltimore teacher Greg Schnitzlein's jaw dropped as he watched his two dogs emerge from the woods looking, as he says, like Chia Pets, every inch of their fur slathered in sproutlike seeds" (Rosen, 2011). Although we found little information about *O. hirtellus* subsp. *undulatifolius*, beyond what is known in the United States, this risk element had a relatively low level of uncertainty due to contributions from an expert in PPQ (Talley, 2010).
Risk score = 15 Uncertainty index = 0.11

Impact Potential Once *O. hirtellus* subsp. *undulatifolius* becomes established, it spreads rapidly through wooded natural areas, crowding out native herbaceous plants and preventing regeneration of native hardwood tree species (Westbrooks and Imlay, 2009). It forms dense carpets in the forest understory (Beauchamp, 2010), at times creating a new layer of plant vegetation in habitats (Kyde, 2010). This taxon affects recreational use of infested areas because people do not want themselves or their pets to get covered in seeds (Kyde, 2010; Rosen, 2011). *Oplismenus hirtellus* subsp. *undulatifolius* has been observed in lawns in Virignia (Hughes, 2010). The U.S. Fish and Wildlife Service helps private landowners control this taxon in suburban areas to maintain suitable wildlife on their property (Kyde, 2010). This risk element had a high level of uncertainty due to a lack of knowledge on what impacts this taxon may have in anthropogenic and production systems.
Risk score = 3.3 Uncertainty index = 0.25

Geographic Potential We estimate that about 30 percent of the United States is suitable for the establishment of *O. hirtellus* subsp. *undulatifolius* (Fig. 1). That predicted distribution is based on the taxon's known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *O. hirtellus* subsp. *undulatifolius* represents the joint distribution of USDA Plant Hardiness Zones 6-13, areas with 30-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savannah, mediterranean, humid subtropical, marine west coast, humid continental warm summers, and humid continental cool summers.

Entry Potential Because *Oplismenus hirtellus* subsp. *undulatifolius* is already established in the United States (Westbrooks and Imlay 2009), assessment of this risk element was not necessary.

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



2. Results and Conclusion

Model Probabilities: P(Major Invader) = 80.0%
P(Minor Invader) = 19.3%
P(Non-Invader) = 8.0%

Risk Result = High Risk

Secondary Screening = Not Applicable

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

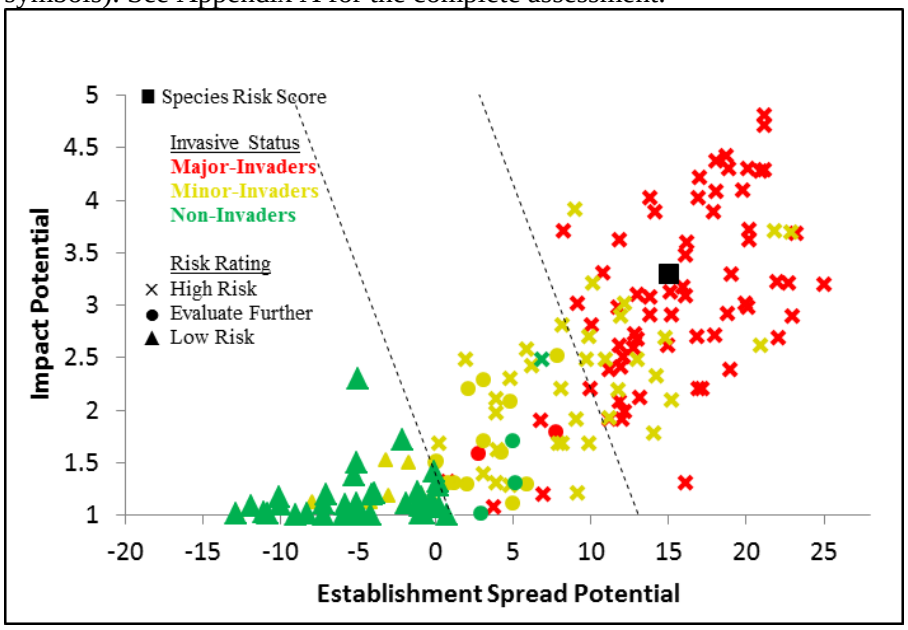
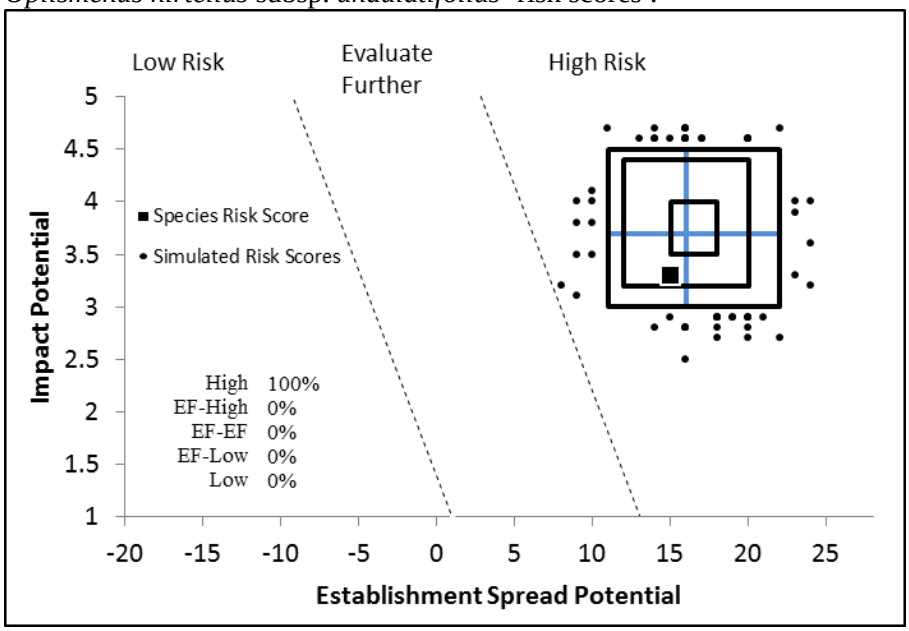


Figure 3. Monte Carlo simulation results (N=5000) for uncertainty around *Oplismenus hirtellus* subsp. *undulatifolius'* risk scores[a].



[a] 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 result of the weed risk assessment for *O. hirtellus* subsp. *undulatifolius* is High Risk with a relatively low level of uncertainty (Figs. 2 and 3). This taxon forms dense mats, which replace native species, prevent regeneration of native hardwood tree species (Westbrooks and Imlay, 2009), and render areas undesirable for recreational use (Kyde, 2010). Efforts are underway to detect and eradicate this taxon from Maryland (Kyde and Marose, 2008) and Virginia (PEC, 2012). A taskforce was established in 2008 to focus on mapping and eradication of known infestations (Westbrooks and Imlay, 2009). They have developed a public awareness campaign to help detect and report infestations before they become widespread. Land managers believe that, if left unchecked, *O. hirtellus* subsp. *undulatifolius* will have a devastating impact on the deciduous forests of eastern North America for many decades (Westbrooks and Imlay, 2009). Plant managers, state and local native plant societies, Native American tribes, and others wrote an open letter to Congress requesting funding to combat *O. hirtellus* subsp. *undulatifolius* in Maryland and Virginia and prevent its spread into other states (Ford and Imlay, 2012).

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Appendix A. Weed risk assessment for *Oplismenus hirtellus* subsp. *undulatifolius* (Poaceae). The following information was obtained from the species' risk assessment, which was conducted on a Microsoft Excel platform. The information shown below was modified to fit on the page. The original Excel file, the full questions, and the guidance to answer the questions are available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Establishment/Spread Potential			
ES-1 (Invasiveness elsewhere)	f - negl	5	*Oplismenus hirtellus* subsp. *undulatifolius* is reported as having naturalized outside its native range in Australia (Randall, 2007).This rapidly spreading understory grass is invading the states of Maryland and Virginia (Kyde, 2010; Westbrooks and Imlay, 2009). Once established, it spreads rapidly through wooded natural areas (Westbrooks and Imlay, 2009). The sticky awns allow the grass seeds to easily spread by adhering to passing animals, people, and vehicles (Westbrooks and Imlay, 2009). By October of 2009, *O. hirtellus* subsp. *undulatifolius* spread to 300 to 400 acres in (Hughes, 2010). Alternate answers for the Monte Carlo simulation are both "e".
ES-2 (Domesticated to reduce weed potential)	n - low	0	*Oplismenus hirtellus* subsp. *undulatifolius* is not known to be cultivated. A closely related taxon, *O. hirtellus* subsp. *varigatus*, is sold as an ornamental grass by the horticulture industry (Dave's Garden, 2008; University of Minnesota, 2008). It is not clear if this cultivar has been bred for reduced weediness potential. From DNA sequence comparisons of variable regions, the horticultural variety appears to be a hybrid and is believed to be sterile (Talley, 2010).
ES-3 (Weedy congeners)	y - mod	1	*Oplismenus compositus* is recorded as a common weed of agriculture in Borneo and Malaysia (Holm et al., 1979) and is listed as a major weed in forest plantations in West Bengal, India (Basnet, 2005).
ES-4 (Shade Tolerance)	y - negl	1	*Oplismenus* species are exclusively grasses of forest understory and are found in areas of moderate to dense shade (Scholz, 1981). *Oplismenus hirtellus* subsp. *undulatifolius* is found in shady forests (Scholz, 1981). Generally *O. hirtellus* subsp. *undulatifolius* does not grow beyond the treeline (Kyde, 2010). *O. hirtellus* subsp. *undulatifolius* grows well under 70% shade in the greenhouse (Talley, 2010).
ES-5 (Climbing or smothering growth form)	n - negl	0	*Oplismenus hirtellus* subsp. *undulatifolius* is a stoloniferous grass (Peterson et al., 1999; Scholz, 1981) and has not been observed to have a climbing or smothering habit (Kyde, 2010; Talley, 2010).
ES-6 (Dense Thickets)	y - negl	2	*Oplismenus hirtellus* subsp. *undulatifolius* forms dense carpets in the forest understory (Beauchamp, 2010; Kyde, 2010). It is further described as "covering all our woodland habitats like astroturf, killing all the other herbaceous plants" (Ford and Imlay, 2012).
ES-7 (Aquatic)	n - negl	0	*Oplismenus hirtellus* subsp. *undulatifolius* is a terrestrial plant (Scholz, 1981) and is not an obligate aquatic plant. *O. hirtellus* subsp. *undulatifolius* has not been observed to grow submerged in water for extended periods of time (Beauchamp, 2010; Kyde, 2010).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-8 (Grass)	y - negl	1	*Oplismenus hirtellus* subsp. *undulatifolius* is a grass and belongs to the Poaceae (Peterson et al., 1999; Scholz, 1981).
ES-9 (N2-fixer)	n - negl	0	There is no evidence that any members of the family Poaceae have nitrogen-fixing capabilities (Martin and Dowd, 1990).
ES-10 (Viable seeds)	y - negl	1	Most species of the genus *Oplismenus* produce fertile caryopses (Scholz, 1981). *O. hirtellus* subsp. *undulatifolius* produces abundant seed; germination rates of *O. hirtellus* subsp. *undulatifolius* seeds from their naturlized range in the U.S. can be as high as 97%, when the caryopsis coat is removed to prevent dormancy (Talley, 2010). Recruitment from seedlings is evident from seedlings appearing in late spring and early summer (Kyde, 2010). Soil collected in the fall produced seedlings the following spring (Beauchamp, 2010).
ES-11 (Self-compatible)	y - mod	1	Reproduction in most *Oplismenus* species is likely apomictic (Scholz, 1981). Florets have both male and female parts (Scholz, 1981). Most grasses are wind or self pollinated. Abundant fertile seeds of *O. hirtellus* subsp. *undulatifolius* are produced from greenhouse grown plants that have little to no exposure to pollinators or wind (Talley, 2010).
ES-12 (Special Pollinators)	n - negl	0	No pollinators for *Oplismenus hirtellus* subsp. *undulatifolius* have been observed in the field (Kyde, 2010). Because abundant fertile seeds were produced in the greenhouse from plants with little to no exposure to pollinators, pollinators do not appear necessary for effective reproduction (Talley, 2010). Reproduction in most *Oplismenus* species is likely apomictic (Scholz, 1981). Most grasses (Poaceae) and sedges (Cyperaceae) are wind pollinated (Culley et al., 2002).
ES-13 (Min generation time)	b - low	1	*Oplismenus hirtellus* subsp. *undulatifolius* is capable of regenerating from seeds and vegatatively through stolons (Kyde, 2010; Scholz, 1981; Talley, 2010). Seeds can germinate in a few days and it takes about 4 months for seedling to mature enough to produce viable seeds (Talley, 2010). Mature plants that are vegetatively propagated can produce seeds within one month or less (Talley, 2010). Under greenhouse conditions healthy mature plants can produce seeds all year (Talley, 2010). In early spring in MD, *O. hirtellus* subsp. *undulatifolius* emerges from overwintering roots. Seed production peaks in August and seedlings emerge the following late spring (Kyde, 2010). Alternate answers for the Monte Carlo simulation are "a" and "c".
ES-14 (Prolific reproduction)	n - mod	-1	Dense stands of *O. hirtellus* subsp. *undulatifolius* might be capable of producing from 1000 to 5000 seeds (Beauchamp, 2010), although Kerry Kyde does not think production is higher than 1000 seeds/ m2/ yr (Kyde, 2010). Greenhouse grown plants have not been estimated to produce more than 5000 seeds/ m2/ yr (Talley, 2010).
ES-15 (Unintentional dispersal)	y - negl	1	Seeds of *O. hirtellus* subsp. *undulatifolius* are wrapped in a visid awn that aids in its epizoochoric dispersal; seeds readily adheres to human hair, skin, and wool (Scholz, 1981). Seeds with awns also stick to clothing, leather, and rubber (Kyde, 2010; Talley, 2010). Mountain bikers have claimed that seeds can spread via mountain biking activities (Kyde, 2010). Seeds readily stick to

Question ID	Answer - Uncertainty	Score	Notes (and references)
			the fur of dogs Rosen, 2011).
ES-16 (Trade contaminant)	y - low	2	*Oplismenus hirtellus* subsp. *undulatifolius* is found in forested areas and can stick to timber and be transported during months when fruit is ripe (Kyde, 2010).
ES-17 (#Natural dispersal vectors)	1	-2	
ES-17a (Wind dispersal)	n - negl		*Oplismenus hirtellus* subsp. *undulatifolius* caryopses do not have wind-specialized awns or other structures that would facilitate wind dispersal; *O. hirtellus* subsp. *undulatifolius* caryopses are an oval shape that is not conducive to wind dispersal (Talley, 2010).
ES-17b (Water dispersal)	n - negl		Viable *O. hirtellus* subsp. *undulatifolius* seeds are not buoyant and therefore are not adapted to dispersal by water (Talley, 2010).
ES-17c (Bird dispersal)	? - max		Unknown. *O. hirtellus* subsp. *undulatifolius* seeds stick to almost anything and can potentially stick to the feet and feathers of ground foraging birds (Beauchamp, 2010; Talley, 2010); however we have no data to support this.
ES-17d (Animal external dispersal)	y - negl		*O. hirtellus* subsp. *undulatifolius* caryopses are spread by animals exterally via a sticky awn (Scholz, 1981).
ES-17e (Animal internal dispersal)	n - high		There is no evidence that *O. hirtellus* subsp. *undulatifolius* is eaten by animals through casual observation , such as deer and birds (Beauchamp, 2010; Kyde, 2010). However, no formal studies have evaluated whether deer use the plant as forage and the caryopsis coat could allow some seeds to pass undigested (Talley, 2010).
ES-18 (Seed bank)	? - max	0	Unknown
ES-19 (Tolerance to loss of biomass)	n - mod	-1	There is no evidence that *O. hirtellus* subsp. *undulatifolius* can withstand mutilation or fire. Hand pulling appears to be an effective form of control (Kyde, 2010).
ES-20 (Herbicide resistance)	n - low	0	*Oplismenus hirtellus* subsp. *undulatifolius* can be killed though herbicide treatments with a 1-2% solution of glyphosate (Westbrooks and Imlay, 2009). Herbicide trials with eight different herbicides demonstrated that each herbicide has some effect on *O. hirtellus* subsp. *undulatifolius* survival (Kyde, 2010).
ES-21 (# Cold hardiness zones)	8	0	
ES-22 (# Climate types)	7	2	
ES-23 (# Precipitation bands)	8	1	
Impact Potential			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	An extensive literature review did not reveal any evidence that any member of the *Oplismenus* genus is allelopathic. Other plants appear to grow well with *O. hirtellus* subsp. *undulatifolius* in soil and in hydroponic solutions (Talley, 2010). Additionally, no evidence has been revealed through field observations (Kyde, 2010).
Imp-G2 (Parasitic)	n - negl	0	An extensive literature review did not reveal any evidence that any member of the *Oplismenus* genus is parasitic. *Oplismenus hirtellus* subsp. *undulatifolius* belongs to the Poaceae, and there are no known grasses that are parasitic. *O. hirtellus* subsp. *undulatifolius* produces chlorophyll and the plant does not

Question ID	Answer - Uncertainty	Score	Notes (and references)
			require nutrients from other plants (Talley, 2010). No evidence through field observations (Kyde, 2010). No evidence after searching the online parasitic plant database (Walker, 2003).
Impacts to Natural Systems			
Imp-N1 (Ecosystem processes)	n - mod	0	No evidence that *O. hirtellus* subsp. *undulatifolius* changes the physical properties of the ecosystem.
Imp-N2 (Community structure)	y - low	0.2	*O. hirtellus* subsp. *undulatifolius* forms a dense carpet layer in the forest understory and has been found to grow underneath Japanese stilt grass (Beauchamp, 2010; Kyde, 2010), thus creating either a new canopy layer where stiltgrass does not occur or an additional layer where stiltgrass does occur. Once it becomes established, WLBG spreads rapidly through wooded natural areas, crowding out native herbaceous plants, and preventing regeneration of native hardwood tree species (Westbrooks and Imlay, 2009).
Imp-N3 (Community composition)	y - low	0.2	Once it becomes established, WLBG spreads rapidly through wooded natural areas – crowding out and preventing regeneration of native species (Westbrooks and Imlay, 2009).
Imp-N4 (T&E species)	y - low	0.1	There are 22 federally threatened or endangered plants in Maryland and Virginia (USFWS, 2010). Jake Hughes, National Park Service, reported to Sharon Talley, PPQ CPHST, that *Isotria medeoloides* (small whorled pogonia) is a federally threatened species occurring in Virginia that could be negatively impacted by *Oplismenus hirtellus* subsp. *undulatifolius* in their state-both occur in the same habitats (Hughes, 2010).
Imp-N5 (Globally outstanding ecoregions)	y - mod	0.1	There are globally-outstanding ecoregions on the east coast of the United States where wavyleaf basketgrass is growing and could spread (Ricketts et al., 1999). Given the impacts described above, it is likely to impact these ecoregions.
Imp-N6 (Natural systems weed)	c - negl	0.6	There are active control programs to manage *O. hirtellus* subsp. *undulatifolius* in Patapsco Valley State Park, Shenandoah National park, Rosaryville State Park, Little Paint Branch Park, and Hernwood Sanitary Landfill (Kyde, 2010). Alternate answers for the Monte Carlo simulation are both "b".
Impact to Anthropogenic areas (cities, suburbs, roadways)			
Imp-A1 (Affects property, civilization, ...)	n - mod	0	No evidence.
Imp-A2 (Recreational use)	y - low	0.1	Hunters do not want to bow hunt in infested areas because *O. hirtellus* subsp. *undulatifolius* seeds sticks to clothing. Some people do not want to walk dogs in infested areas because *O. hirtellus* subsp. *undulatifolius* seeds stick to dog fur (Kyde, 2010; Rosen, 2011).
Imp-A3 (Affects ornamental plants)	? - max		*Oplismenus hirtellus* subsp. *undulatifolius* has been observed in lawns in Virginia (Hughes, 2010) and is controlled there (Kyde, 2010).
Imp-A4 (Anthropogenic weed)	c - low	0.4	MassWildlife Landowner Incentive Program (LIP) funded through the U. S. Fish and Wildlife Service helps private landowners control *O. hirtellus* subsp. *undulatifolius* in suburban areas to maintain suitable wildlife habitat on their property (Kyde, 2010). Alternate answers for the Monte Carlo simulation

Question ID	Answer - Uncertainty	Score	Notes (and references)
			are both "b".
Impact to Production systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Crop yield)	? - max		*Oplismenus undulatifolius* (synonym) is a weed of rice in Japan (Enomoto, 2003) and listed as an agricultural weed (Randall, 2007). Though it occurs in agricultural cropping systems, it is not listed as a Principal or Serious weed by any country; that is, it has not reduced crop yield significantly (Holm et al., 1979).
Imp-P2 (Commodity Value)	? - max		No evidence for a poorly studied taxon. *O. undulatifolius* (synonym) is a weed of rice in Japan (Enomoto, 2003) and listed as an agricultural weed (Randall, 2007).
Imp-P3 (Affects trade)	n - mod	0	There is no evidence that *O. hirtellus* subsp. *undulatifolius* or any of is conspecifics or congeners impacts trade due to regulatory restrictions (USDA APHIS PPQ CPHST, 2007).
Imp-P4 (Irrigation)	? - max		*O. hirtellus* subsp. *undulatifolius* is not well studied and no studies have been found that reports its ability to significantly compete for water.
Imp-P5 (Animal toxicity)	n - mod	0	There is no evidence that *O. hirtellus* subsp. *undulatifolius* or any of its congeners is toxic to animals (Burrows and Tyrl, 2001).
Imp-P6 (Production system weed)	c - low	0.6	*O. hirtellus* subsp. *undulatifolius* impacts forests in the United States and is actively being controlled (Kyde, 2010). *O. hirtellus* subsp. *undulatifolius* may prevent the establishment of tree seedlings (Kyde, 2010). *O. undulatifolius* is a weed of rice in Japan (Enomoto, 2003) and listed as an agrigultural weed (Randall, 2007). Because forests are considered production systems, answering "c". Alternate answers for the Monte Carlo simulation are both "b".
Geographic Potential			
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	No evidence
Geo-Z2 (Zone 2)	n - negl	N/A	No evidence
Geo-Z3 (Zone 3)	n - negl	N/A	No evidence
Geo-Z4 (Zone 4)	n - negl	N/A	No evidence
Geo-Z5 (Zone 5)	n - high	N/A	No evidence, though some point source data came close to occurring in this range.
Geo-Z6 (Zone 6)	y - low	N/A	Italy, Japan (GBIF, 2010 p.s.)
Geo-Z7 (Zone 7)	y - negl	N/A	US-Maryland, Japan-Tohoku (GBIF, 2010 p.s.)
Geo-Z8 (Zone 8)	y - negl	N/A	Japan-Kinki (GBIF, 2010 p.s.)
Geo-Z9 (Zone 9)	y - negl	N/A	China-Yunnan, Taiwan (GBIF, 2010 p.s.)
Geo-Z10 (Zone 10)	y - negl	N/A	China-Taiwan (GBIF, 2010 p.s.)
Geo-Z11 (Zone 11)	y - negl	N/A	Australia-Queensland, Papua New Guinea (GBIF, 2010 p.s.)
Geo-Z12 (Zone 12)	y - negl	N/A	Papua New Guinea, Sri Lanka (GBIF, 2010 p.s.)
Geo-Z13 (Zone 13)	y - negl	N/A	Papua New Guinea, Sri Lanka (GBIF, 2010 p.s.)
Koppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Australia-Queensland, Papua New Guinea (GBIF, 2010 p.s.)
Geo-C2 (Tropical savanna)	y - low	N/A	Africa-Uganda, Australia-Queensland (GBIF, 2010 p.s.)
Geo-C3 (Steppe)	n - low	N/A	No evidence

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C4 (Desert)	n - negl	N/A	No evidence
Geo-C5 (Mediterranean)	y - high	N/A	Spain (GBIF, 2010 p.s.)
Geo-C6 (Humid subtropical)	y - negl	N/A	US-Maryland (GBIF, 2010 p.s.)
Geo-C7 (Marine west coast)	y - negl	N/A	New Zealand, Australia-New South Wales (GBIF, 2010 p.s.)
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	Japan, South Korea (GBIF, 2010 p.s.)
Geo-C9 (Humid cont. cool sum.)	y - low	N/A	Italy, Japan-Shikoku (GBIF, 2010 p.s.)
Geo-C10 (Subarctic)	n - negl	N/A	No evidence
Geo-C11 (Tundra)	n - negl	N/A	No evidence
Geo-C12 (Icecap)	n - negl	N/A	No evidence
10-inch precipitation bands			
Geo-R1 (0-10")	n - negl	N/A	No evidence
Geo-R2 (10-20")	n - low	N/A	No evidence
Geo-R3 (20-30")	n - high	N/A	No evidence
Geo-R4 (30-40")	y - low	N/A	Spain-Cataluna (GBIF, 2010 p.s.); *Oplismenus hirtellus* subsp. *undulatifolius* is native to moist parts of Europe in Northern Italy and Southern Switzerland (and southeast Asia) that receive between 950 mm (`37 in) and 2000 mm (79 in) of rain (Scholz, 1981 occ.).
Geo-R5 (40-50")	y - negl	N/A	US-Maryland (GBIF, 2010 p.s.); *Oplismenus hirtellus* subsp. *undulatifolius* is native to moist parts of Europe in Northern Italy and Southern Switzerland (and southeast Asia) that receive between 950 mm (`37 in) and 2000 mm (79 in) of rain (Scholz, 1981 occ.).
Geo-R6 (50-60")	y - negl	N/A	Japan-Kanto (GBIF, 2010 p.s.); *Oplismenus hirtellus* subsp. *undulatifolius* is native to moist parts of Europe in Northern Italy and Southern Switzerland (and southeast Asia) that receive between 950 mm (37 in) and 2000 mm (79 in) of rain (Scholz, 1981 occ.).
Geo-R7 (60-70")	y - negl	N/A	Japan-Kanto, Italy-Lombardi (GBIF, 2010 p.s.); *Oplismenus hirtellus* subsp. *undulatifolius* is native to moist parts of Europe in Northern Italy and Southern Switzerland (and southeast Asia) that receive between 950 mm (37 in) and 2000 mm (79 in) of rain (Scholz, 1981 occ.).
Geo-R8 (70-80")	y - negl	N/A	Japan-Chubu (GBIF, 2010); *Oplismenus hirtellus* subsp. *undulatifolius* is native to moist parts of Europe in Northern Italy and Southern Switzerland (and southeast Asia) that receive between 950 mm (37 in) and 2000 mm (79 in) of rain (Scholz, 1981 occ.).
Geo-R9 (80-90")	y - negl	N/A	Point source data: Papua New Guinea
Geo-R10 (90-100")	y - negl	N/A	Point source data: Papua New Guinea
Geo-R11 (100"+)	y - negl	N/A	Point source data: Papua New Guinea
Entry Potential			
Ent-1 (Already here)	y - negl	1	*O. hirtellus* subsp. *undulatifolius* is invading the states of Maryland and Virginia (Akerson, 2010; Kyde, 2010; Westbrooks and Imlay, 2009). *O. hirtellus* subsp. *undulatifolius* was discovered in the U.S.A. in 1996 (Peterson et al., 1999).
Ent-2 (Proposed for entry)		N/A	
Ent-3 (Human value & cultivation/trade status)		N/A	

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-4 (Entry as a Contaminant)			
Ent-4a (In MX, CA, Central Amer., Carib., or China)		N/A	
Ent-4b (Propagative material)		N/A	
Ent-4c (Seeds)		N/A	
Ent-4d (Ballast water)		N/A	
Ent-4e (Aquaria)		N/A	
Ent-4f (Landscape products)		N/A	
Ent-4g (Container, packing, trade goods)		N/A	
Ent-4h (Commodities for consumption)		N/A	
Ent-4i (Other pathway)		N/A	
Ent-5 (Natural dispersal)		N/A	