Key Words: High Risk, Naturalized, Environmental Weed, Neotropical tree, Bird-dispersed

Family: ***Moraceae***

Taxon: ***Castilla elastica***

Synonym: *Castilla elastica subsp. costaricana*
Castilla elastica subsp. elastica

Common Name: castilloa rubber
Central American rubbertree
Mexican rubbertree
uletree
Panama rubber tree

Questionaire : current 20090513 **Assessor:** Chuck Chimera **Designation:** H(HPWRA)
Status: Assessor Approved **Data Entry Person:** Chuck Chimera **WRA Score 9**

101	**Is the species highly domesticated?**	**y=-3, n=0**	**n**
102	**Has the species become naturalized where grown?**	**y=1, n=-1**	
103	**Does the species have weedy races?**	**y=1, n=-1**	
201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**(0-low; 1-intermediate; 2-high) (See Appendix 2)**	**High**
202	**Quality of climate match data**	**(0-low; 1-intermediate; 2-high) (See Appendix 2)**	**High**
203	**Broad climate suitability (environmental versatility)**	**y=1, n=0**	**n**
204	**Native or naturalized in regions with tropical or subtropical climates**	**y=1, n=0**	**y**
205	**Does the species have a history of repeated introductions outside its natural range?**	**y=-2, ?=-1, n=0**	**y**
301	**Naturalized beyond native range**	**y = 1*multiplier (see Appendix 2), n= question 205**	**y**
302	**Garden/amenity/disturbance weed**	**n=0, y = 1*multiplier (see Appendix 2)**	**n**
303	**Agricultural/forestry/horticultural weed**	**n=0, y = 2*multiplier (see Appendix 2)**	**n**
304	**Environmental weed**	**n=0, y = 2*multiplier (see Appendix 2)**	**y**
305	**Congeneric weed**	**n=0, y = 1*multiplier (see Appendix 2)**	**n**
401	**Produces spines, thorns or burrs**	**y=1, n=0**	**n**
402	**Allelopathic**	**y=1, n=0**	**n**
403	**Parasitic**	**y=1, n=0**	**n**
404	**Unpalatable to grazing animals**	**y=1, n=-1**	
405	**Toxic to animals**	**y=1, n=0**	**n**
406	**Host for recognized pests and pathogens**	**y=1, n=0**	
407	**Causes allergies or is otherwise toxic to humans**	**y=1, n=0**	**n**
408	**Creates a fire hazard in natural ecosystems**	**y=1, n=0**	**n**
409	**Is a shade tolerant plant at some stage of its life cycle**	**y=1, n=0**	**n**

410	**Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)**	**y=1, n=0**	**y**
411	**Climbing or smothering growth habit**	**y=1, n=0**	**n**
412	**Forms dense thickets**	**y=1, n=0**	**n**
501	**Aquatic**	**y=5, n=0**	**n**
502	**Grass**	**y=1, n=0**	**n**
503	**Nitrogen fixing woody plant**	**y=1, n=0**	**n**
504	**Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)**	**y=1, n=0**	**n**
601	**Evidence of substantial reproductive failure in native habitat**	**y=1, n=0**	**n**
602	**Produces viable seed**	**y=1, n=-1**	**y**
603	**Hybridizes naturally**	**y=1, n=-1**	**n**
604	**Self-compatible or apomictic**	**y=1, n=-1**	**y**
605	**Requires specialist pollinators**	**y=-1, n=0**	
606	**Reproduction by vegetative fragmentation**	**y=1, n=-1**	**n**
607	**Minimum generative time (years)**	**1 year = 1, 2 or 3 years = 0, 4+ years = -1**	**>3**
701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	**y=1, n=-1**	
702	**Propagules dispersed intentionally by people**	**y=1, n=-1**	**y**
703	**Propagules likely to disperse as a produce contaminant**	**y=1, n=-1**	**n**
704	**Propagules adapted to wind dispersal**	**y=1, n=-1**	**n**
705	**Propagules water dispersed**	**y=1, n=-1**	**n**
706	**Propagules bird dispersed**	**y=1, n=-1**	**y**
707	**Propagules dispersed by other animals (externally)**	**y=1, n=-1**	**y**
708	**Propagules survive passage through the gut**	**y=1, n=-1**	**y**
801	**Prolific seed production (>1000/m2)**	**y=1, n=-1**	**y**
802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y=1, n=-1**	
803	**Well controlled by herbicides**	**y=-1, n=1**	
804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	**y=1, n=-1**	
805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	**y=-1, n=1**	

Designation: H(HPWRA) **WRA Score** **9**

Supporting Data:

101	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Is the species highly domesticated? No evidence]
102	2012. WRA Specialist. Personal Communication.	NA
103	2012. WRA Specialist. Personal Communication.	NA
201	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Species suited to tropical or subtropical climate(s) 2-High] "Southern Mexico to Colombia and perhaps southward; in moist forests at low elevations."
202	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Quality of climate match data 2-High]
203	2008. Gargiullo, M.B./Magnuson, B.L/Kimball, L.D.. A Field Guide to Plants of Costa Rica. Oxford University Press US, New York, NY	[Broad climate suitability (environmental versatility)? No] "Habitat: Wet to seasonally dry lowland forests, second growth. Altitude: Sea level to 850 m, mostly below 400 m."
204	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Native or naturalized in regions with tropical or subtropical climates? Yes] "Southern Mexico to Colombia and perhaps southward; in moist forests at low elevations."
205	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Does the species have a history of repeated introductions outside its natural range? Yes] "When introduced to the Kew Gardens for growth and propagation, the plant was called Darien Castilla. The records of Kew show that the plants introduced into Ceylon, Singapore, Mauritius and Africa grew rapidly and produced seeds within 10 years. A single plant was sent to the West Indies from Kew in 1876, another in 1879, and 12 in 1880 (3)."
301	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Naturalized beyond native range? Yes] "Trees of Castilla persist in the local vegetation, however, for the fruits are attractive to birds and are easily distributed by this means."
301	1991. Francis, J.K./Liogier, H.A.. Naturalized Exotic Tree Species in Puerto Rico. General Technical Report SO-82. United States Department of Agriculture Forest Service, New Orleans, LA	[Naturalized beyond native range? Yes] "Table 1 -Naturalized and escaped exotic trees in Puerto Rico" … "Castilla elastica … Several sites near Utuado; less than 100 hectares"
301	1994. Whistler, W.A.. Botanical Inventory of the Proposed Tutuila and Ofu Units of the National Park of American Samoa. Technical Report 87. Cooperative National Park Resources Studies Unit UH Manoa, Honolulu, HI	[Naturalized beyond native range? Yes] "Another potentially harmful species, Castilla elastica (pulu mamoe) is an invasive species in Western Samoa, and was recently recorded from Tutuila (near Fagamalo) and Ta'u (personal observation, 1993). It should be eliminated before it becomes further established." … "Large tree with milky sap, large, oblong, alternate leaves, and inconspicuous flowers forming a sessile, cauliflorus aggregate fruit. Uncommon in disturbed forest, noted so far only on the western portion of the island (where it is locally common at Maloata) and 'Ili'ili (where it is rare), reported from ca. 100 to 700 m elevation (in Western Samoa). A modem introduction, native to tropical America."
301	1998. Csurhes, S./Edwards, R.. Potential environmental weeds in Australia: Candidate species for preventative control. Biodiversity Group, Environment Australia, Canberra, Australia	[Naturalized beyond native range? Yes] "Castilla elastica is native to tropical America (southern Mexico to northern South America). It is reported to be invading rainforest in the Kamerunga area near Cairns. Naturalised specimens may have originated from the horticultural station nearby (Stanton, pers. comm.). It has also been recorded from Lake Placcid (near Cairns) where it is numerous in small areas of edges and clearings on red soil (Queensland Herbarium)."
301	2002. Space, J.C./Flynn, T.. Report to the Government of the Cook Islands on invasive plant species of environmental concern. U.S.D.A. Forest Service, Honolulu, HI	[Naturalized beyond native range? Yes] "Two rubber trees, Castilla elastica (Panama rubber tree) and Funtumia elastica (African rubber tree), are very invasive in Samoa. Birds spread the seeds of Castilla while those of Funtumia are wind-borne "parachute" seeds."
301	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Naturalized beyond native range? Yes] "Introduced range: Invasive in Tanzania, American Samoa, Hawaii, Samoa, French Polynesia and Australia. Introduced but not invasive in Puerto Rico."

301	2006. Webb, E.L./van de Bult, M./Chutipong, W./Kabir, M.E.. Composition and Structure of Lowland Rain-Forest Tree Communities on Ta'u, American Samoa. Pacific Science. 60(3): 333-354.	[Naturalized beyond native range? Yes] "Other tree species in American Samoa have been introduced only to naturalize and become aggressive invasives, notably Adenanthera pavonina, Castilla elastica Cerv., and Paraserianthes falcataria (L.) I. Neilsen, the latter of which has been the focus of an intensive eradication program within the National Park of American Samoa. As of yet, there have been no reports of P. falcataria on Ta'u, but C. elastica has already arrived (E.L.W., pers. obs.)."
301	2010. CSIRO. Australian Tropical Rainforest Plants Edition 6 - Castilla elastica. http://keys.trin.org.au/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Castilla_elastica.htm [Accessed 30 Oct 2012]	[Naturalized beyond native range? Yes] "An introduced species originally from Mexico, Central America, Colombia and Ecuador, now naturalized in NEQ in the Cairns region. Altitudinal range from near sea level to 100 m. Grows in well developed but disturbed gallery forest, rain forest regrowth and on old farmland."
301	2010. Nghiem, T.P.L. The Ecology of Invasive Tree Species in Singapore. MSc Thesis. National University of Singapore, Singapore	[Naturalized beyond native range? Singapore] "Possible candidates for this include the globally widespread tropical invasive trees, Castilla elastica, Miconia calvescens, Psidium cattleianum, and Syzygium jambos, which have all been cultivated in Singapore, but only C. elastica and S. jambos have been recorded as producing the occasional self-sown sapling."
301	2012. Frohlich, D./Lau, A.. Oahu Early Detection Botanists. Pers. Comm. 29 Oct 2012.	[Naturalized beyond native range?] "Castilla elastica: this was the tall, fuzzy Moraceae species we encountered sporadically spread within the collection and a bit up Haleiwa Gulch." … "Castilla elastica is accessioned under numbers 87C47 and 77P617."
302	2012. WRA Specialist. Personal Communication.	[Garden/amenity/disturbance weed? A pioneer or early successional tree with negative environmental impacts]
303	2012. Randall, R.P.. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	[Agricultural/forestry/horticultural weed? Listed as an environmental weed]
304	2001. Werren, G.. Environmental Weeds of the Wet Tropics Bioregion: Risk Assessment & Priority Ranking. Rainforest CRC, Cairns, Australia	[Environmental weed] "It is instructive to consider management action directed towards species naturalising in the region considered by Csurhes & Edwards (1998) to be 'potential' (if not actual) environmental weeds. Six taxa have been identified that are in the initial phase of invasion and are considered, at this stage, to be amenable to eradication (Table 13)." … "The effective control of Panama Rubber (Castilla elastica) by the Cairns City Council's Pest Management Unit and the Wet Tropics Tree Planting Scheme team is a case in point. In 1998, incipient infestations of this tree that was originally imported and maintained at the former Tropical Horticultural Collection of DPI at Kamerunga, as a producer of a rubber substitute, were noted establishing under the closed canopies of nearby riparian and adjacent rainforest. Although mainly confined to Kamerunga Environment Park, the management of which is a joint Cairns City Council and QPWS responsibility, and on private freehold land, some infestations were also flourishing in the Barron Gorge National Park section of the World Heritage Area. This species was afforded highest priority in the Council's Pest Management Plan and infestations, including 25m tall mature trees, were treated. Currently, follow-up control is being undertaken by the Pest Management Unit, including searches for additional seedlings and ongoing monitoring of treated sites, to ensure no resurgence. The prospects of eradicating this highly invasive alien species from the region are now very good. This is due to the foresight of the Pest Management Working Group and the diligence of the Pest Management Unit, the personnel of which understand that weeds do not respect property lines and do not remain confined awaiting cumbersome bureaucratic determinations, including resource allocations. They also recognise that weed control must be timely, transcend tenure boundaries and that effort will be wasted entirely if there is no follow-up activity."
304	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Environmental weed? Yes] "Ecosystem: C. elastica can become established in undisturbed rainforest. It is one of the first plants to become established if there is a gap in the canopy, it is an aggressive pioneer plant and produces huge quantities of seed. However, the natural succession process may eventually shade the plant out, as the development of brushy areas around the trees seems to hinder seed germination."
304	2007. Poon, E./Westcott, D.A./Burrows, D./Webb, A.. Assessment of research needs for the management of invasive species in the terrestrial and aquatic ecosystems of the Wet Tropics. Reef & Rainforest Research Centre Ltd, Cairns	[Environmental weed?] "Table 5. High priority newly emerging environmental weeds, recommended by the WT Conservation Strategy to be eradicated completely in the WTR (WTMA 2004). (*) = WoNS" [Includes Castilla elastica]

304	2009. Craig, P. (ed.). Natural History Guide to American Samoa. 3rd Edition. National Park of American Samoa, Pago Pago, American Samoa	[Environmental weed?] "Used to make kirikiti (cricket) balls, this tree spreads fast and out-competes native trees.
304	2009. LaRosa, A.M.. Forest Health Highlights - Pacific Islands. USDA Forest Service Institute of Pacific Islands Forestry, Hilo, HI	[Environmental weed? Yes] "Early detection and eradication of weeds includes such target species as African tulip (Spathodea campanulata) in Palau and Panama rubber tree (Castilla elastica) in American Samoa." … "The National Park of American Samoa estimates 1030 acres of native forest infested in American Samoa, where it is a target for control and possible eradication."
304	2011. Dawson, W./Burslem, D.F.R.P./Hulme, P.E.. The comparative importance of species traits and introduction characteristics in tropical plant invasions. Diversity and Distributions. 17: 1111-1121.	[Environmental weed?] "Table 1 The 39 species used in this study, including life-forms and whether or not each species was found establishing in disturbed or intact forest. Also shown are WRA outcomes (from Dawson et al., 2009b), with species judged as having a high or low invasion risk." [Castilla elastica = High Risk]
304	2012. Queensland Government. Weeds of Australia - Panama rubber tree - Castilla elastica. http://keyserver.lucidcentral.org/weeds/data/03030800-0b07-490a-8d04-0605030c0f01/media/Html/Castilla_elastica.htm [Accessed 31 Oct 2012]	[Environmental weed?] "In mainland Australia, Panama rubber tree (Castilla elastica) is only known to be naturalised within the boundaries of the Cairns City Council. Isolated infestations have been located in the Kamerunga and Lake Placid areas, where it is invading rainforest gaps and margins. This species is listed as a priority weed in far northern Queensland and has been targeted for eradication. Panama rubber tree (Castilla elastica) is also regarded as a potentially significant environmental weed on Christmas Island, where it has spread from remnant plantations and become naturalised in nearby intact rainforest vegetation."
305	2012. Randall, R.P.. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	[Congeneric weed? No evidence]
401	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Produces spines, thorns or burrs? No] "Trees 5-10 m. tall, the young branches densely hirsute with spreading (less frequently appressed) golden hairs, eventually glabrate. Leaves oblong-obovate, more or less cordate and usually not strongly inequilateral at the base, subcuspidate- acuminate at the tip, 20-30 cm. long, 10-14 cm. broad, membranaceous, minutely and closely ciliate denticulate, both surfaces golden spreading hirsute but particularly beneath, the petioles about 1 cm. long; stipules 3-6 cm. long"
402	2001. Hanelt, P. (ed.). Mansfeld's encyclopedia of agricultural and horticultural crops: (except ornamentals). Angiospermae - monocotyledones: orchidaceae - pandanaceae, Volume 5. Springer-Verlag, Berlin, Heidelberg, New York	[Allelopathic? No] "In Africa cultivated as a shade tree in coffee and cola plantations."
403	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Parasitic? No evidence]
404	2003. Williams-Guillén, K.. The Behavioral Ecology of Mantled Howling Monkeys (Alouatta palliata) Living in a Nicaraguan Shade Coffee Plantation. PhD Dissertation. New York University, NY	[Unpalatable to grazing animals? Palatable to howler monkeys] Table 3.3. Composition of each group's annual diet by species" [Castilla elastica - Parts Eaten = `ML = mature leaves, YL = young leaves, FR = fruit, FL = flowers]
405	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Toxic to animals? No evidence]
406	1995. Gilbert, G.S.. Rain Forest Plant Diseases: The Canopy - Understory Connection. Selbyana. 15: 75-77.	[Host for recognized pests and pathogens?] "Abstract: Plant diseases are diverse and common in the canopy of tropical rain forests. Many diseases in the canopy are shared by juveniles in the understory, but their relative abundance in the different strata may vary. Ecological effects of the disease may be greater among juveniles than adults. Adult trees may serve as disease incubators, increasing both the amount of pathogen inoculum available and, potentially, the virulence of pathogens." … "The number of recognizable kinds of disease symptoms ranged from none on Antirrhoea trichantha to five on Anacardium excelsum. Luehea and Annona each had one type, and Castilla two."
407	1912. Standley, P.C.. Trees and Shrubs of Mexico, Volume 2. Smithsonian Institution, Washington, D.C.	[Causes allergies or is otherwise toxic to humans? No evidence] "The wood Is white and moderately heavy. The bark is beaten out by some of the Indians of tropical America, and the fabric thus obtained Is used for clothing and blankets. In Mexico the bark Is said to have been one of the sources of paper." … "When cut It yields a gum, called Holu by the Indians, which Is at first milky, but soon yellow, and finally black, If It Is smeared on the bodies of those who gather It."
407	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Causes allergies or is otherwise toxic to humans? No evidence]

408	1978. Croat, T.B.. Flora of Barro Colorado Island. Stanford University Press, Stanford, CA	[Creates a fire hazard in natural ecosystems? No evidence. Unlikely given habitat] "In Panama, known from tropical moist forest in the Canal Zone … from premontane moist forest in the Canal Zone and Panama, from premontane wet forest in Cocle (El Valle) and from tropical wet forest in Colon (Guasimo)."
408	2001. Enquist, B.J./Sullivan, J.J.. Vegetative key & descriptions of tree species of the tropical dry forests of upland Sector Santa Rosa, Area de Conservación Guanacaste, Costa Rica. Univ. of Arizona & Univ. of Pennsylvania, Tucson, AZ & Philadelphia, PA	[Creates a fire hazard in natural ecosystems? No evidence] "Appears to grow in moister and more mature forest."
409	1999. Kobe, R.K.. Light Gradient Partitioning among Tropical Tree Species through Differential Seedling Mortality and Growth. Ecology. 80(1): 187-201.	[Is a shade tolerant plant at some stage of its life cycle? No, but may be irrelevant in Hawaiian forests with relatively high light levels compared to neotropical forest understory] "For the other species, the lowest light levels at which seedlings survive and the highest levels at which they die provide a measure of shade tolerance consistent with the mortality models: Trophis > Castilla > Cecropia." … "While Castilla's low-light mortality was slightly higher than that of Trophis (Fig. 4), the expected low-light (<2% full sun) lifetime for Castilla was 1 yr vs. 3.5 yr for Trophis." … "The highest relative radial growth among survivors gave Pourouma dominance at 12-40% full sun, Castilla at 40-70% full sun, and Cecropia at ?70% full."
410	1991. Francis, J.K./Liogier, H.A.. Naturalized Exotic Tree Species in Puerto Rico. General Technical Report SO-82. United States Department of Agriculture Forest Service, New Orleans, LA	[Tolerates a wide range of soil conditions?] "Table 1" … "Castilla elastica … Soil properties* … NO = adapted to medium fertility soils; does not tolerate nutrient-poor sites. Third line: tolerance of soil internal drainage :.. M = soil profile well drained but moist"
410	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Tolerates a wide range of soil conditions?] "Medium fertility soils with pH of 5.5 to 7. Well drained but moist soil."
410	2008. Viera Martinez, C.A./Abelleira, O./Lugo, A.E.. Estructura y química del suelo en un bosque de Castilla elastica en el carso del norte de Puerto Rico: resultados de una calicata. Acta Científica. 22(1-3): 29-35.	[Tolerates a wide range of soil conditions?] "We dug a soil pit of 1m x 1m x 1m in a forest dominated by Castilla elastica, a tree for shade coffee introduced in the karst of northern Puerto Rico. We found four soil horizons (designation notes in parenthesis) (A) organic soil matter (E) mineral soil leachate (B) aerobic mineral soil, and © saturated soil. The total storage of soil organic matter was 143 Mg/ha. Apparent soil density increased with depth, the ground water level was between 65 and 80 cm deep, and there were no roots >55 cm deep. This suggests that most of the C. elastica roots are superficial and unlikely to tolerate permanent waterlogging in the soil. Despite the limitation in the amount of soil available to the roots of the forest, the pit stores large amounts of chemical elements necessary to sustain primary productivity. Storages were (Mg/ha): N-13.9, P-4.0 K-1.8, Ca-19.4, Mg 3.6, Mn-15.9, Al-168, Fe-645, Na-1.1 and C-71.7. The soil was rich in N and P and low in K, Ca and Mg compared to other forests in Puerto Rico."
411	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Climbing or smothering growth habit? No] "Trees 5-10 m. tall…"
412	1978. Croat, T.B.. Flora of Barro Colorado Island. Stanford University Press, Stanford, CA	[Forms dense thickets? No evidence] "Widespread on both coasts from Mexico to Panama and along the western coasts of Colombia and Ecuador."
412	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Forms dense thickets? No evidence] "Ecosystem: C. elastica can become established in undisturbed rainforest. It is one of the first plants to become established if there is a gap in the canopy, it is an aggressive pioneer plant and produces huge quantities of seed. However, the natural succession process may eventually shade the plant out, as the development of brushy areas around the trees seems to hinder seed germination."
412	2010. Condit, R./Pérez, R./Daguerre, N.. Trees of Panama and Costa Rica. Princeton University Press, Princeton, NJ	[Forms dense thickets? No evidence] "Abundant along roads near Panama City. Otherwise, widely but sparsely known."
501	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Aquatic? No] Terrestrial
502	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Grass? No] Moraceae

503	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Nitrogen fixing woody plant? No] Moraceae
504	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "Trees 5-10 m. tall, the young branches densely hirsute with spreading (less frequently appressed) golden hairs, eventually glabrate."
601	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Evidence of substantial reproductive failure in native habitat? No evidence]
601	2008. Gargiullo, M.B./Magnuson, B.L/Kimball, L.D.. A Field Guide to Plants of Costa Rica. Oxford University Press US, New York, NY	[Evidence of substantial reproductive failure in native habitat? No evidence]
602	2006. Sautu, A./Baskin, J.M./Baskin, C.C./Condit, R.. Studies on the seed biology of 100 native species of trees in a seasonal moist tropical forest, Panama, Central America. Forest Ecology and Management. 234: 245–263.	[Produces viable seed? Yes] "This study quantified various aspects of the seed biology of 100 tree species native to the seasonal moist tropical forest in the Panama Canal Watershed." … "Germination of nontreated seeds ranged from 0% (6 species) to 99% and was 50% for 46 species. Seeds of Beilschmiedia pendula, Castilla elastica, Diphysa robinioides, Genipa americana, Hura crepitans, Inga spectabilis, Jacaranda copaia, Protium tenuifolium, Pseudobambox septenatum, and Trattinnickia aspera germinated >85%...."
603	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Hybridizes naturally? No evidence after long history of cultivation]
604	2001. Sakai, S.. Thrips pollination of androdioecious Castilla elastica (Moraceae) in a seasonal tropical forest. American Journal of Botany. 88(9): 1527-1534.	[Self-compatible or apomictic? Yes] "Sexual system—Castilla elastica is androdioecious with cosexes and male plants within a population. Pollen grains were not different between male and cosexual plants, and existence of cytoplasm was confirmed in pollen grains from both primary and complemental staminate inflorescences." … A distinctive characteristic of androdioecy in C. elastica is that male and female flowers are produced on different inflorescences. Thus male and female functions do not share any structure. Additionally, the shape of staminate inflorescences on male and cosexual plants is quite different. Androdioecy in C. elastica might have evolved from dioecy." … "Outstanding colonizing ability of C. elastica is evidenced by trees growing in the wild out of its original distribution dispersed by cultivated mother trees (Berg, 1972). Producing seeds through self pollination must be essential when they invade a new habitat without conspecific trees. In addition, for C. elastica it may be important to assure a high level of pollination, because selective abscission of unfertilized ovaries (i.e., sterile fruits) is impossible due to fusion of all pistillate flowers on a discoid inflorescence. All flowers on a developing infructescence were observed to grow into fruits, some of which were without a seed. It may be advantageous to maintain high fruit set through self-pollination rather than to produce many seedless fruits as a part of an infructescence." … "For male trees, it is essential to attract and release as many thrips as possible, while smaller complemental staminate inflorescences may function primarily to ensure self pollination if outcross pollen is unavailable. The closed structure of a complemental inflorescence may protect pollinators as well as pollen. When there is no male tree nearby, density of pollintor thrips may be low. Therefore, a cosexual tree should increase and maintain a thrips population on its own staminate inflorescences throughout the flowering period to successfully produce seeds through self-pollination mediated by thrips."

605	2001. Sakai, S.. Thrips pollination of androdioecious Castilla elastica (Moraceae) in a seasonal tropical forest. American Journal of Botany. 88(9): 1527-1534.	[Requires specialist pollinators? Possibly Yes] "This study reports thrips pollination of C. elastica, demonstrated by a pollinator introduction experiment. Thrips pollination of the species may be an example of mutualism originating from plant– herbivore interactions. In the Moraceae, shifts from simple herbivores on flowers to pollinators might have occurred many times, evolving into diverse pollination systems including the fig–fig wasp mutualism. The family, of which little is known about pollination systems, provides interesting and unique opportunities to study evolution of pollination systems and roles of nonpollinating associates of inflorescences." … "Pistillate inflorescences or complemental staminate inflorescences closed by imbricate bracts may not be attractive for them due to absence or inaccessibility of pollen. In addition to thrips, ants and parasitoids of thrips visited both pistillate and staminate inflorescences. Although these insects might pollinate C. elastica accidentally in rare cases, they are unlikely to visit C. elastica flowers that lack their prey, thrips, and they could not be the principal pollinators, considering their low visit frequencies. I conclude that Castilla elastica is pollinated by thrips for the following reasons. First, thrips were observed and collected on all the three types of inflorescences, primary and complemental staminate inflorescences and pistillate inflorescences, and accounted for 96.9–99.8% of the flower visitors. Presence of thrips both in staminate and in pistillate inflorescences was also observed by Pittier (1910). Second, a high proportion of the thrips carried pollen on the body. All the thrips collected on male trees, and two-thirds of thrips on pistillate inflorescences had pollen loads. Third, the results of the pollination experiment 1 suggest that pollen vectors included very small insects, because some flowers bagged with mesh developed into fruits. Finally, in experiment 2, thrips introduced inflorescences enclosed in a bag of fine cloth showed fruit set as high as hand-pollinated ones and the open pollinated control. High fruit set (80.2%) cannot be explained if thrips did not pollinate, although small numbers (1.1%) of insects other than thrips were accidentally introduced together."
606	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Reproduction by vegetative fragmentation? No. Spreads by seeds] "Trees of Castilla persist in the local vegetation, however, for the fruits are attractive to birds and are easily distributed by this means."
606	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Reproduction by vegetative fragmentation? No evidence] "Ecosystem: C. elastica can become established in undisturbed rainforest. It is one of the first plants to become established if there is a gap in the canopy, it is an aggressive pioneer plant and produces huge quantities of seed. However, the natural succession process may eventually shade the plant out, as the development of brushy areas around the trees seems to hinder seed germination."
607	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Minimum generative time (years)? 10+] "The records of Kew show that the plants introduced into Ceylon, Singapore, Mauritius and Africa grew rapidly and produced seeds within 10 years."
701	2010. Condit, R./Pérez, R./Daguerre, N.. Trees of Panama and Costa Rica. Princeton University Press, Princeton, NJ	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Possibly] "Abundant along roads near Panama City." [Distribution along roadside could allow for inadvertent dispersal of seeds, although fruits & seeds lack means of external attachment]
702	2010. CSIRO. Australian Tropical Rainforest Plants Edition 6 - Castilla elastica. http://keys.trin.org.au/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Castilla_elastica.htm [Accessed 30 Oct 2012]	[Propagules dispersed intentionally by people? Yes] "This species was probably deliberately introduced to the Kamerunga Research Station. It was used at one time as a source of rubber before Hevea braziliensis became the preferred source. C. elastica has become naturalized along the Barron River at Kamerunga and has spread into neighbouring areas."
703	2012. WRA Specialist. Personal Communication.	[Propagules likely to disperse as a produce contaminant? No evidence] Adapted for consumption and dispersal by frugivorous birds and mammals
704	1960. Nevling, Jr., L.I.. Flora of Panama. Part IV. Fascicle II. Annals of the Missouri Botanical Garden. 47(2): 81-203.	[Propagules adapted to wind dispersal? No] "Fruit a more or less fleshy syncarp." … "Fruiting heads thickly discoid, 4-5 cm. in diameter, about 1.5 cm. thick, sessile or subsessile, the component flowers half or more coherent, developing an orange or reddish pulp at maturity."
705	2012. WRA Specialist. Personal Communication.	[Propagules water dispersed? No evidence] Distribution and habitat of plant, as well as fleshy-fruit adapted for bird and mammal dispersal, suggest that this plant is not dispersed by water.
706	1963. Howard, R.A./Powell, D.A.. The Introduction of Rubber-Producing Species in the West Indies. Economic Botany. 17(4): 337-349.	[Propagules bird dispersed? Yes] "Castilla elastica, easily recognized by its characteristic shape and branching habit, is widely spread by birds, and unmarked trees are found along fence rows or in remote woodlands." … "Trees of Castilla persist in the local vegetation, however, for the fruits are attractive to birds and are easily distributed by this means."

706	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Propagules bird dispersed? Yes] "Dispersal: Seeds spread by birds, monkeys and other mammals, as well as ants. Seeds are dispersed by animals feeding on the fruit."
706	2009. Craig, P. (ed.). Natural History Guide to American Samoa. 3rd Edition. National Park of American Samoa, Pago Pago, American Samoa	[Propagules bird dispersed? Yes] "Birds and bats eat the fruits and spread its plentiful seeds."
706	2010. CSIRO. Australian Tropical Rainforest Plants Edition 6 - Castilla elastica. http://keys.trin.org.au/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Castilla_elastica.htm [Accessed 30 Oct 2012]	[Propagules bird dispersed? Yes. Fleshy-fruited] "Fruit is a flat disk of numerous green bracts with about 20-30 individual, orange-red, fleshy, 1-seeded fruits. Seeds about 8-10 x 6-8 mm."
707	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Propagules dispersed by other animals (externally)? Yes. Ant dispersed] "Dispersal: Seeds spread by birds, monkeys and other mammals, as well as ants. Seeds are dispersed by animals feeding on the fruit."
708	1998. Banack, S.A.. Diet Selection and Resource Use by Flying Foxes (Genus Pteropus). Ecology. 79(6): 1949-1967.	[Propagules survive passage through the gut? Presumably Yes. Fruit consumed] "Plant species eaten by Pteropus tonganus and Pteropus samoensis in the Samoan archipelago; x = author's personal observations, + recorded in the literature. Families follow Mabberley 1993."
708	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Propagules survive passage through the gut? Presumably Yes] "Dispersal: Seeds spread by birds, monkeys and other mammals, as well as ants."
708	2011. Chaves, Ó.M./Stoner, K.E./Arroyo-Rodríguez, V./Estrada, A.. Effectiveness of Spider Monkeys (Ateles geoffroyi vellerosus) as Seed Dispersers in Continuous and Fragmented Rain Forests in Southern Mexico. International Journal of Primatology. 32: 177-	[Propagules survive passage through the gut? Yes] "Table II Top defecated seed species in communities of Ateles geoffroyi inhabiting continuous forest and forest fragments in Lacandona, Chiapas" [Castilla elastica - % Undamaged seeds = 100%]
801	1964. Little, Jr. E.L./Wadsworth , F.H.. Common trees of Puerto Rico and the Virgin Islands. Agriculture Handbook No. 249. USDA Forest Service, Washington, D.C	[Prolific seed production (>1000/m2)? Yes] "Each individual fruit is ½-¾ inch long and ¼-⅜ inch across, blunt pointed and half within the disk, composed of the fleshy, finely hairy calyx, changing color from yellow to green, orange, and red, very juicy, almost tasteless but slightly sour, soon fermenting and molding, and containing 1 white oblong seed ⅜-½ inch long. Seeds 800 to a pound."
801	2006. Darwin Initiative Project. Usambara Invasive Plants - Castilla elastica. http://www.tropical-biology.org/research/dip/species/Castilla%20elastica.htm [Accessed 30 Oct 2012]	[Prolific seed production (>1000/m2)? Yes] "It is one of the first plants to become established if there is a gap in the canopy, it is an aggressive pioneer plant and produces huge quantities of seed."
802	2008. Royal Botanic Gardens Kew. Seed Information Database (SID). Version 7.1. http://data.kew.org/sid/	[Evidence that a persistent propagule bank is formed (>1 yr)? Probably Not] "Storage Behaviour: Recalcitrant? Storage Conditions: Short-lived (Mensa & Acosta, 1990)"
803	1997. Swarbrick, J.T.. Environmental Weeds and Exotic Plants on Christmas Island, Indian Ocean: A Report to Parks Australia. J.T. Swarbrick, Weed Science Consultancy,	[Well controlled by herbicides? Presumably Efficacy unknown] "Pending the results of field trials seedlings and young trees should be basal bark sprayed with 10% Garlon 600 in diesel oil"
803	2012. Pacific Invasives Learning Network. Soundbites - August 2012. Secretariat of the Pacific Regional Environment Programme, Apia Samoa	[Well controlled by herbicides? Presumably Efficacy unknown] "Control work on the invasive pulu mamoe tree (Castilla elastica) on Ta'u Island has started with the National Park's crew removing 742 mature trees by drilling the bark of the tree and applying the 'Imitator Plus' herbicide. The crew recorded the DBH (diameter breast height) in cm and the GPS location for future surveys and removal of seeds."
804	2012. WRA Specialist. Personal Communication.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Unknown]
805	2012. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown]

Summary of Risk Traits

High Risk / Undesirable Traits

- Naturalized in Samoa, Puerto Rico, Australia, Tanzania, French Polynesia, Singapore
- Thrives in tropical climates
- Environmental weed in American Samoa, invading intact rainforest & competing with native plants. Regarded as a potential environmental weed in other locations.
- Tolerates many soil conditions
- Self-compatible
- Seeds are bird and mammal dispersed
- Prolific seed production

Low Risk / Desirable Traits

- May be limited to lower elevations
- Unarmed (no spines, thorns or burrs)
- Non-toxic
- Prefers full sun & more open habitats
- May require thrips for pollination
- Landscaping and ornamental value
- Reaches reproductive maturity in >4 years
- No evidence of vegetative spread