	Kauai Status	KISC Status	HPWRA	Invasive Impacts Score	Feasibility Score	Combined Score
<p><b><i>Paulownia tomentosa</i></b> (Princess tree)</p>	ADVENTIVE	EARLY DETECTION	HIGH RISK (9)	6.5	7.5	14

Initial Prioritization Report completed: January 2018

Report updated as of: N/A

Current Recommendation for KISC: pending scoring rank and committee review

Knowledge Gaps and Contingencies:

- 1) Delimiting surveys surrounding the one known location is required to gain knowledge of the extent of population.
- 2) Outreach efforts are required to increase the likelihood of detection on private land

## Background

*Paulownia tomentosa* (Paulowniaceae), or “princess tree” is a tree cultivated for timber, medicinal properties, cultural traditions, and as an ornamental (Wysokińska and Rózga 1998, Staples and Herbst 2005, Remaley 2006, Roman 2016). *P. tomentosa* has never been a target for control by KISC. Thus, this prioritization report is intended to assess whether KISC should attempt eradication (i.e. accept “Target” status). This will be evaluated by scoring and comparing *P. tomentosa* to other “Early Detection” species known to Kauai (See Table 5 in KISC Plant Early Detection Report for status terminology).

## Detection and Distribution

2015-2017 surveys recorded the first observations of *P. tomentosa* on Kauai with the discovery of 10-15 seedlings in a nursery in Moloaa (Figure C35- 1). The nursery manager did not know the plant, but mentioned that he has been seeing seedling pop up for a while, which suggests that a mature tree had been previously removed from the immediate area. The Bishop Museum’s vascular plant checklist shows Hawaii Island as the only location of naturalization for this species in the Hawaiian archipelago (Imada 2012). By 2010, however, BIISC eradicated this outbreak population and there are no other known naturalized populations on Hawaii Island (BIISC 2010, Parker and Parsons 2012) or elsewhere in the state. So far, *P. tomentosa* is only known from one judiciary district (Kawaihau) and one watershed (Papaa) on Kauai.

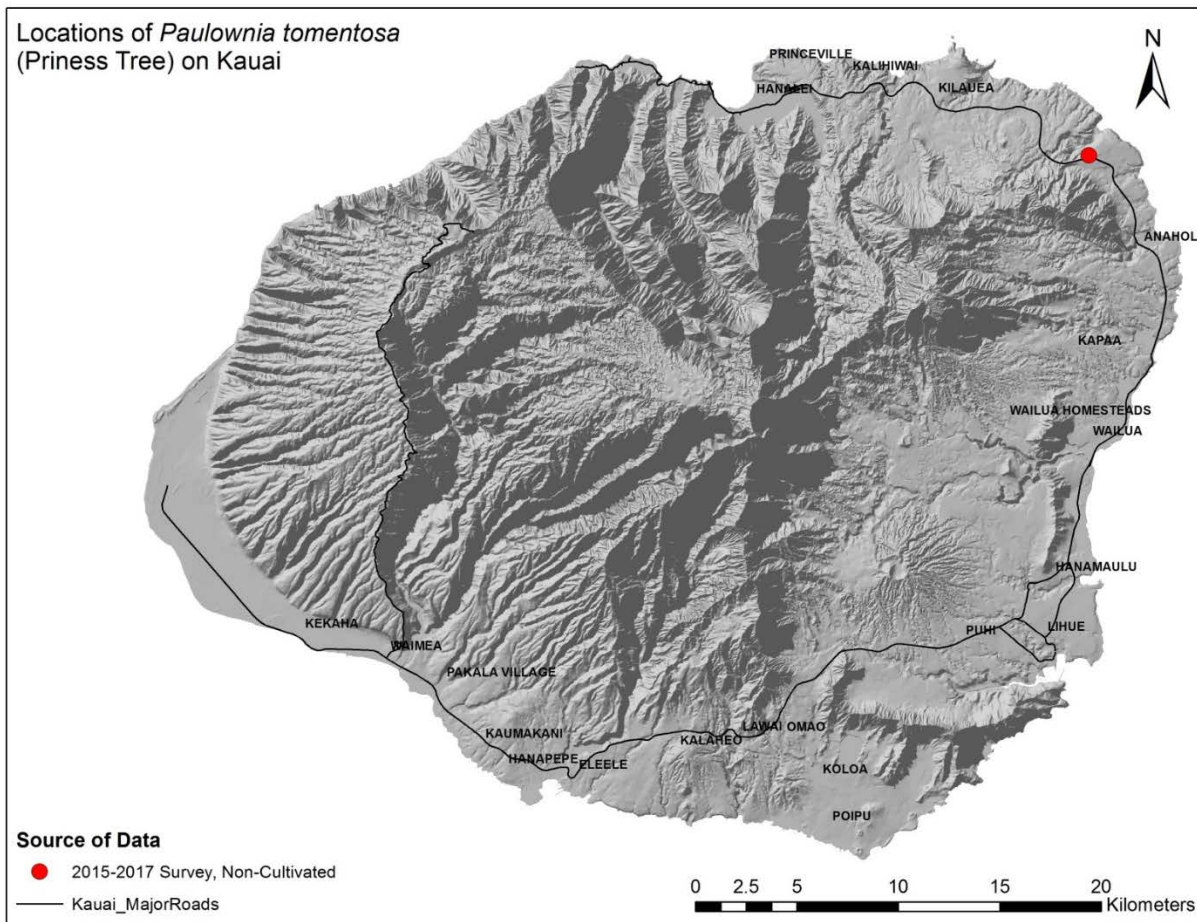


Figure C35- 1. Location of *P. tomentosa* on Kauai.

### Hawaii Pacific Weed Risk Assessment (HPWRA) Score

*P. tomentosa* is designated as “High Risk”, receiving a score of 9 (Daehler et al. 2004, HPWRA 2012). Traits contributing to this status are listed below according to whether they pertain to the likelihood a plant will invade vs. the consequences of the invasion, according to Daehler and Virtue (2010). Categorization of traits in this manner more accurately informs invasive impact potential scoring and prioritization of species that are already established on Kauai.

<i>Likelihood of Invasion</i>	<i>Consequences of Invasion</i>
<ul style="list-style-type: none"> <li>• Suited to climates in Hawaii (intermediate climate match)</li> <li>• Broad climate suitability</li> <li>• Naturalized outside of its native range</li> <li>• Tolerate a wide range of soil conditions</li> <li>• Produces viable seed</li> <li>• Reproduces by vegetative fragmentation</li> <li>• Propagules dispersed intentionally by people</li> <li>• Propagules wind and water dispersed</li> <li>• Prolific seed production</li> <li>• Forms a persistent seed bank</li> <li>• Benefits from disturbance</li> </ul>	<ul style="list-style-type: none"> <li>• Garden/Amenity/Disturbance weed</li> <li>• Environmental weed</li> </ul>

Refer to the full Weed Risk Assessment for *P. tomentosa* at <https://sites.google.com/site/weedriskassessment/assessments/Download-Assessments>.

## Invasive Impacts Score

### 1. Impact on natural community structure and/or composition

**Score: 2** = Moderate impacts

*P. tomentosa* was assigned a score of 2 because this tree is known to invade disturbed sites such as cliffs and eroding hillsides, especially in areas susceptible to drought or those that have recently burned (Remaley 2006, Kuppinger and Jenkins 2010, HPWRA 2012, Neel 2012, DNR 2017, NRCS 2018). It is a well-known invader across the eastern United States from Texas to Florida, north to Wisconsin and across the Midwest to Massachusetts, and also on the west coast in Washington and Oregon (Remaley 2006, Kuppinger and Jenkins 2010, DNR 2017, NRCS 2018). However, these areas are temperate, like its native range in China. The population that BIISC eradicated in Waimea on Hawaii Island was at ~850 m elevation (Parker and Parsons 2012), which is cooler than the lowlands. *P. tomentosa* is known to grow rapidly to form a co-dominant canopy in its invaded range and produces a large amount of very light seed (2.8 million seeds per pound) that can disperse by wind across large distances. However, it also spreads quickly by vegetative reproduction (Hyatt and Casper 2000, Remaley 2006, NRCS 2018). Additionally seedling recruitment is high (Remaley 2006, NRCS 2018), so there is a possibility that a population on one side of Kauai can lead to distant outbreaks in more ideal habitats. It has large leaves that may shade native plants that grow in open areas or forest edges (Neel 2012), and it may alter growing conditions of nearby plants (Zhao et al. 2010, Singh et al. 2012). Therefore, *P. tomentosa* is most likely to invade and impact high elevation open areas that are prone to disturbance such as the nearby Anahola mountains, upper Waimea Canyon and Na Pali habitats on the west side of the island. However, plants found during KISC's 2015-2017 survey indicate that germination and seed set are possible at ~80 m elevation.

However, it is not known to form monotypic stands, is less likely to encroach on stable ecosystems, and may not remain established in post-disturbance areas as they recover (Kuppinger and Jenkins 2010, Neel 2012). Nevertheless, this species has the potential to alter the species composition in early successional stages. This score may increase if future Kauai-specific data indicates that it can invade low-mid elevations. The known site of *P. tomentosa* on Kauai overlaps with one POPREF polygon also containing PEP plants (Papaa-PAP).

### 2. Impacts to Agriculture, Culture and other Human Systems

**Score: 2** = Moderate Impacts

*P. tomentosa* received a score of 2 because its affinity for disturbed sites and wind-dispersed seeds could lead it to spread into areas of human habitation (Remaley 2006, BIISC 2010, HPWRA 2012, DNR 2017). Seedlings are able to grow on houses, buildings, road sides, and construction sites (Remaley 2006, BIISC 2010). By vegetative growth, it is able to spread as much as 5 meters per season (Remaley 2006). Five years after germination, *P. tomentosa* trees have a trunk diameter at breast height of 30-40 cm and can grow over 30 m tall (Ye et al. 2016). Due to this rapid growth, the wood is fragile (Remaley 2006) and thus poses a hazard to houses, buildings, or roadways from falling branches.

Furthermore, this species tends to grow in open areas such as pastures (Kuppinger and Jenkins 2010, Parker and Parsons 2012), and may become a problem for ranchers. Evidence also shows that *Paulownia* inhibits nearby soybean, wheat, and corn germination and production (Zhao et al. 2010, Singh et al. 2012), so it could also affect cropland on Kauai. However, as its invasive impacts are known from temperate areas, it is difficult to determine whether it would impact most of Kauai's population, which is predominately situated in lowland areas. However, some pastureland on Kauai exists over 400m above sea level. This score may increase if future Kauai-specific data indicates that it can invade low-mid elevations.

### 3. Impacts to biotic and abiotic processes

**Score: 2.5** = Moderate - High Impacts

*P. tomentosa* was assigned a score of 2.5 because it produces chemical compounds that can alter soil structure. *Paulownia* produces allelopathic chemicals, including phenolic compounds, which leach into the soil and impair the growth of nearby plants (Wysokińska and Rózga 1998, Li et al. 2010, Zhao et al. 2010, Singh et al. 2012). This species also produces verbascoside, a compound which has antifungal and antibacterial properties (Wysokińska and Rózga 1998) and therefore may impede soil mycorrhizal fungi. However, a score of 2.5 was assigned rather than a 3 as this plant may be unlikely to invade lowland or well-established ecosystems.

**TOTAL INVASIVE IMPACTS SCORE: 6.5**

#### Feasibility of Control Score

Feasibility of Control Scoring and rationale for *P. tomentosa* is presented below. Refer to Appendix A for details regarding the Invasive Impact Score.

#### Delimiting Survey:

**Score: 2** = Moderate Effort

This plant was assigned a score of 2 because it is currently known from only one location on Kauai. However, a large delimiting survey buffer is necessary due to the ability of its seeds to disperse long distances by wind. Additionally, this plant is rumored to have been cultivated on the north shore of Kauai (Parker and Parsons 2012), although the original source of this information cannot be tracked down and no other plants were detected during 2010 or 2015-2017 surveys. Nonetheless, its presence in a nursery indicates that it may have been sold to private residences and thus, outreach efforts are necessary to increase detection on private land.



Figure C35- 2. *P. tomentosa* near Moloaa.



Figure C35- 3. A *P. tomentosa* sapling near Moloaa on Kauai.

**Initial control:**

**Score: 3 = Minimal Effort**

Several treatment methods are effective for *P. tomentosa*, giving this species a feasibility score of 3 for initial control. A 2% glyphosate herbicide is effective for seedlings and smaller trees when combined with 0.5% surfactant (Remaley 2006). However, this score will decrease if additional plants are detected in private residences, which may be likely (see Delimiting Survey section above). People who cultivate this tree may be unlikely to remove it. The Chinese have traditionally used it as a homeopathic medicine (Kang et al. 1994, Wysokińska and Rózga 1998) and it has been exported to the Korean peninsula and Japan extensively since the 3<sup>rd</sup> century BCE, where the custom is to use it as dowries for weddings (Kang et al. 1994, Wysokińska and Rózga 1998, Remaley 2006, Roman 2016).

**Monitoring:**

**Score: 2.5 = Minimal Effort**

This species received a score of 2.5 in this section because although it is known to grow quickly and flower after 3 years, seed set apparently does not occur until the 8<sup>th</sup> year in ideal conditions. However, this species produces millions of seeds per year, which forms relatively persistent seed bank; one study revealed that after 2 years, ~30% of the *P. tomentosa*

seeds remain viable in the soil (Hyatt and Casper 2000). Thus, monitoring of the known site should continue for a minimum of 5 years, but it may be done infrequently owing to its slow maturation rate. Although, detailed field notes during control efforts are necessary to determine if this temperate weed may reach maturity more quickly in tropical environments. This score may decrease rapidly if additional plants are detected.

**FEASIBILITY OF CONTROL SCORE: 7.5**

**COMBINED SCORE: 6.5 + 7.5 = 14**

## Literature Cited

- Adriani, C., C. Bonini, C. Iavarone, and C. Trogolo. 1981. Isolation and characterization of paulownioside, a new highly oxygenated iridoid glucoside from *Paulownia tomentosa*. *The Journal of Natural Products* **44**:739–744.
- BIISC. 2010. Empress tree (*Paulownia tomentosa*). Early Detection Notice. Big Island Invasive Species Committee, [http://www.biisc.org/wp-content/uploads/Paulownia\\_Tomentosa\\_brochure\\_JLP.pdf](http://www.biisc.org/wp-content/uploads/Paulownia_Tomentosa_brochure_JLP.pdf).
- Daehler, C. C., J. S. Denslow, S. Ansari, and H. C. Kuo. 2004. A risk-assessment system for screening out invasive pest plants from Hawaii and other Pacific Islands. *Conservation Biology* **18**:360-368.
- Daehler, C. C., and J. G. Virtue. 2010. Likelihood and consequences: reframing the Australian weed risk assessment to reflect a standard model of risk. *Plant Protection Quarterly* **25**:52-55.
- DNR, W. 2017. Princess tree (*Paulownia tomentosa*). Wisconsin DNR, <http://dnr.wi.gov/topic/invasives/fact/princesstree.html>.
- HPWRA. 2012. *Paulownia tomentosa*. Hawaii Pacific Weed Risk Assessment.
- Hyatt, L. A., and B. B. Casper. 2000. Seed bank formation during early secondary succession in a temperate deciduous forest. *Journal of Ecology* **88**:516-527.
- Imada, C. T. 2012. Hawaiian native and naturalized vascular plant checklist (December 2012 update). , . Bishop Museum Technical Report 60/ Hawaii Biological Survey Contrib. 2012-021: 29 pp. + 27 appendices.
- Kang, K. H., S. K. Jang, B.-K. Kim, and M. K. Park. 1994. Antibacterial phenylpropanoid glycosides from *Paulownia tomentosa* Steud. *Archives of Pharmacal Research* **17**:470-475.
- Kuppinger, D. M., and M. Jenkins. 2010. Predicting the post-fire establishment and persistence of an invasive tree species across a complex landscape. *Biological Invasions* **12**:3473-3484.
- Li, D. H., Q. Wang, X. Ruan, C. D. Pan, and D. A. Jiang. 2010. Phenolics and plant allelopathy. *Molecules* **15**:8933-8952.
- Neel, A. 2012. Effects of fire and invasive *Paulownia tomentosa* on native tree regeneration in southern Ohio after two years. Ohio State University, Columbus, Ohio.
- NRCS. 2018. *Paulownia tomentosa* (Thunb.) Siebold & Zucc. ex Steud. in USDA-NRCS-NGCE, editor., <https://plants.usda.gov/core/profile?symbol=PATO2>.
- Parker, J. L., and B. Parsons. 2012. New plant records from the Big Island for 2009. Bishop Museum Occasional Papers **113**:55-63.
- Remaley, T. 2006. Princess tree. in P. C. Alliance, editor. Alien Working Group, <https://www.invasive.org/weedcd/pdfs/wgw/princesstree.pdf>.
- Roman, M. 2016. The princess tree: stories of paulownia. Rikumo Journal, <http://journal.rikumo.com/journal/2016/5/22/pewlonia-and-boxwood-materials-with-identity>.
- Singh, C., K. S. Dhadwal, R. Kumar, and R. K. Avasthe. 2012. Allelopathic effects of *Paulownia* and poplar on wheat and maize crops under agro forestry systems in Doon valley. *Indian Forester* **138**:981-985.
- Staples, G., and D. Herbst. 2005. A tropical garden flora: plants cultivated in the Hawaiian Islands and other tropical places. Bishop Museum Press., Honolulu, HI.
- Wysokińska, H., and M. Różga. 1998. Establishment of transformed root cultures of *Paulownia tomentosa* for verbascoside production. *Journal of Plant Physiology* **152**:78–83.
- Ye, X., Z. Zhang, Y. Chen, J. Cheng, Z. Tang, and Y. Hu. 2016. Physico-chemical pretreatment technologies of bioconversion efficiency of *Paulownia tomentosa* (Thunb.) Steud. *Industrial Crops and Products* **87**:280-286.
- Zhao, Y., Z. Chen, K. Wang, and W. Fan. 2010. Allelopathy of *Paulownia* and poplar leaves aqueous extracts on crop seed germination. *Transactions of the Chinese Society of Agricultural Engineering* **26**:400-405.