| KISC — Kauai Invasive Species Committee | Kauai Status | KISC Status | HPWRA | Invasive Impacts Score | Feasibility Score | Combined Score |
|---|---|---|---|---|---|---|
| ***Acacia auriculiformis*** (Darwin black wattle) | **PRESENT** | **EARLY DETECTION** | **HIGH RISK (13)** | **8** | **8** | **16** |

**Initial PFC report completed:** October 2017
**PFC report updated as of:** N/A
**Current Recommendation for KISC:** Consider eradication pending scoring rank and committee review
**Knowledge Gaps and Contingencies:**

1) Land access to a cultivated patch on a private residence is required before proceeding.
2) Delimiting surveys surrounding the one known location is required to gain knowledge of the extent of population.
3) A herbarium voucher location needs to be surveyed to determine whether the plant is still cultivated and whether an escaped population has established.

## Background

*Acacia auriculiformis,* or "Darwin black wattle", is a tree most often used as a forestry species for paper pulp and is occasionally cultivated as a hardy ornamental (Orwa et al. 2009). It is also occasionally used as a nitrogen-fixing tree to improve soil condition. *A. auriculiformis* has not been considered for control by KISC in the past. Thus, the purpose of this prioritization assessment report is to evaluate whether KISC should attempt eradication (i.e. accept "Target" status). This will be informed by scoring and comparing *A. auriculiformis* to other "Early Detection" species known to Kauai (See Table 5 in KISC Plant Early Detection Report for status terminology).

## Detection and Distribution

Herbarium records reveal only one location of *A. auriculiformis* on Kauai prior to this survey: a cultivated individual at National Tropical Botanical Garden (NTBG) in 1975 (J.J. Fay 301, PTBG). It is unclear whether this plant is still cultivated there. Statewide, it is known to have been present on Oahu since 1924 ( J.A. Harris C242262, BISH) and other vouchers indicate that it has been cultivated in other botanical gardens (J. Lau 3036, BISH) and experimental research stations (A. Lau/ D. Frohlich 0611292, BISH). Its current naturalization status indicates that it is not yet considered naturalized on any of the Hawaiian islands but is known as "adventive" on Oahu (Imada 2012). However, recent vouchers indicate that it should now be considered naturalized on Oahu (USARMY 329, BISH). 2015-2017 surveys located one main cultivated patch of approximately 10 trees in Moloaa with at least 2 trees spreading up to 300 meters from the planting (Figure C1-1*)*. Together, these sites are distributed across 2 districts (Kawaihau, Koloa) and 2 watersheds (Aliomanu, Lawai). No other sites have been detected.

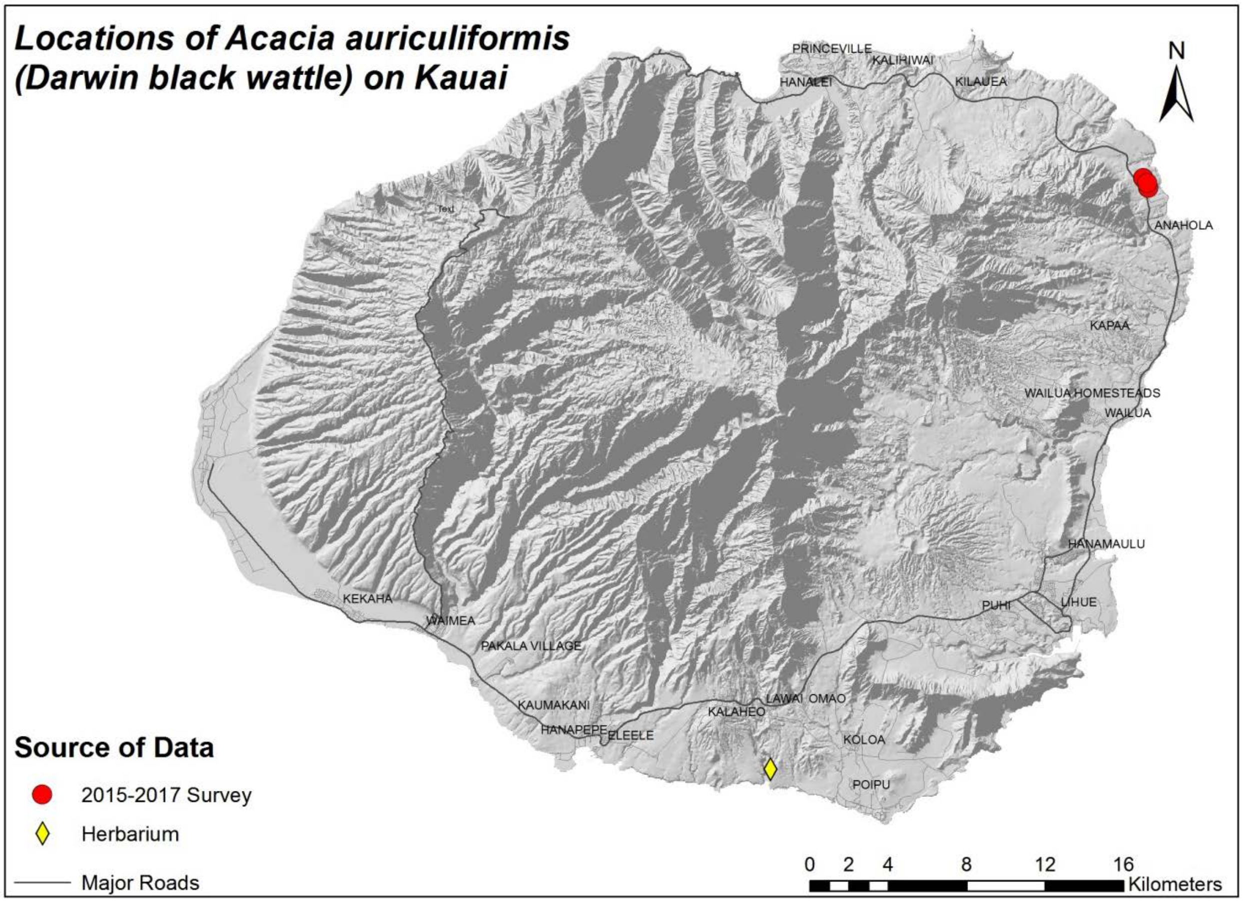


**Figure C1- 1. Locations of *A. auriculiformis* on Kauai. Sites where presence of the plant was confirmed during 2015-2017 surveys are denoted by red circles (north of Anahola).**

## Hawaii Pacific Weed Risk Assessment (HPWRA) Score

*A. auriculiformis* is designated as "High Risk", receiving a score of 13 (HPWRA 2014). 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.

| *Likelihood of Invasion* | *Consequences of Invasion* |
|---|---|
| • Well suited to climates in Hawaii<br>• Repeatedly introduced and naturalized in areas with comparable climates<br>• Tolerate a wide range of soil conditions<br>• Produces viable seed<br>• Hybridizes naturally<br>• Propagules dispersed intentionally by people<br>• Propagules bird dispersed<br>• Forms a persistent seed bank<br>• Benefits from disturbance | • A weed of native ecosystems<br>• A congeneric weed, sharing a genus other invasive *Acacia* (i.e. implies inheritance of tendencies to inflict invasive impacts)<br>• Nitrogen fixer |

Refer to the full Weed Risk Assessment for *A. auriculiformis 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

*A. auriculiformis* was assigned a score of 2 because this species is known to escape forestry plantations and form monotypic, invasive stands in a variety of habitats (Kotiluoto et al. 2009, Nghiem et al. 2015). A study of behavior, distribution and life history traits of acacias commonly used and distributed by humans placed *A. auriculiformis* in the "Extremely High" invasive potential category alongside other acacias known as invasive in Hawaii, including *A. mearnsii*, *A. mangium* and *A*. *melanoxylon* (Wilson et al. 2011). The authors recommend that populations in climatically suitable areas are removed. Infestation of this species is likely rapid, with naturalization occurring in less than 20 years aided by bird dispersal (Nghiem et al. 2015). However, *A. auriculiformis* received a score of 2 instead of 3 because although it is a known invader of disturbed habitats, it appears less likely to invade stable native climax communities (Kotiluoto et al. 2009). This is apparently due to its inability to establish in understory low light conditions. However, many disturbances including invasive animals, human impacts and climate change impact Kauai's native habitats, so this score may change in the future based on field observations. Nonetheless, it is likely to out-compete both alien and native plant species in moist, lowland environments. Sites of *A. auriculiformis* are present in one POPREF polygon also known to contain endangered plants (Aliomanu – ALI).

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

**Score: 3** = Major Impacts

*A. auriculiformis* received a score of 3 because this plant is known to rapidly colonize disturbed areas and spread rapidly via bird dispersal (Kotiluoto et al. 2009, Nghiem et al. 2015). These traits may allow it to colonize human-controlled systems including residential areas, gardens/landscapes, forestry plantations and any agricultural crops that have multi-year turn overs (Kull and Rangan 2008). Additionally, *A. auriculiformis* can become 30 meters tall and grows rapidly; one study found that the growth rate for *A. auriculiformis* (4.8 cm/week) in an open canopy site was comparable to *Falcataria moluccana* "albezia" (4.1 cm/week), a well-known problematic weed in Hawaii (Nghiem et al. 2015). Thus, trees may become problematic or hazardous and expensive to remove if growing under utility lines and next to buildings or highways. It is often regarded as invasive in countries that have cultivated it in forestry plantings (Wilson et al. 2011), and has the potential to become a very common alien plant in lowland areas of Kauai. At least two adventive trees were seen spreading from the cultivated site in Molaa, further suggesting that it has the ability to naturalize on Kauai in the near future.

### 3. Impacts to biotic and abiotic processes

**Score: 3** = Major Impacts

*A. auriculiformis* was assigned a score of 3 because this plant is likely to influence soil nutrient cycling via nitrogen fixation, and release allelopathic chemicals. *A. auriculiformis* is often used in multi-species forestry crops because of its nitrogen fixing capability, and numerous studies have demonstrated its ability to change soil structure and nutrient cycling (Ohta 1990, Goi et al. 1993, Masutha et al. 1997, Nguyen et al. 2006). Although it's not exactly clear how increased soil nitrogen will affect nutrient cycling and plant growth on Kauai, it is possible that nitrogen fixation will facilitate invasions by other quick-growing alien species that can take advantage of high soil nitrogen stores. Furthermore, studies have shown that the fallen leaves of *A. auriculiformis* release chemicals that significantly affect root and shoot growth of other plants, including crop plants (Rafiqul Hoque et al. 2003).

**TOTAL INVASIVE IMPACTS SCORE: 8**

## Feasibility of Control Score

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

**Delimiting Survey:**

**Score: 3** = Minimal Effort

Feasibility of a delimiting survey for *A. auriculiformis* was given a score of 3 because at present, there are only 2 known sites on Kauai that would require delimiting surveys: around the cultivated patch in Moloaa (Figure C1- 2) and around the perimeter of NTBG. Surveys or communication with NTBG are required to see if the tree has been removed, and a survey around the garden's perimeter is required to ensure a population has not established there. Although birds can disperse seeds long distances, much of the land surrounding the known site at Moloaa is treeless, and therefore should be easy to survey (Figure C1- 3). However, this score may be downgraded if mature individuals are found west of Highway 56, which is well within a 1000m buffer easily dispersed by birds. The habitat west of Highway 56 is likely more ideal and surveying efficiency would be hindered by dense shrubs and more difficult terrain. Because the tree matures and spreads very quickly, a careful initial delimiting survey is necessary to ensure all individuals are accounted for because an established population of this species could quickly become (or could already be) beyond KISC's means for eradication.

**Figure C1- 2. A cultivated windrow/privacy barrier of *A. auriculiformis* near Moloaa on Kauai.**

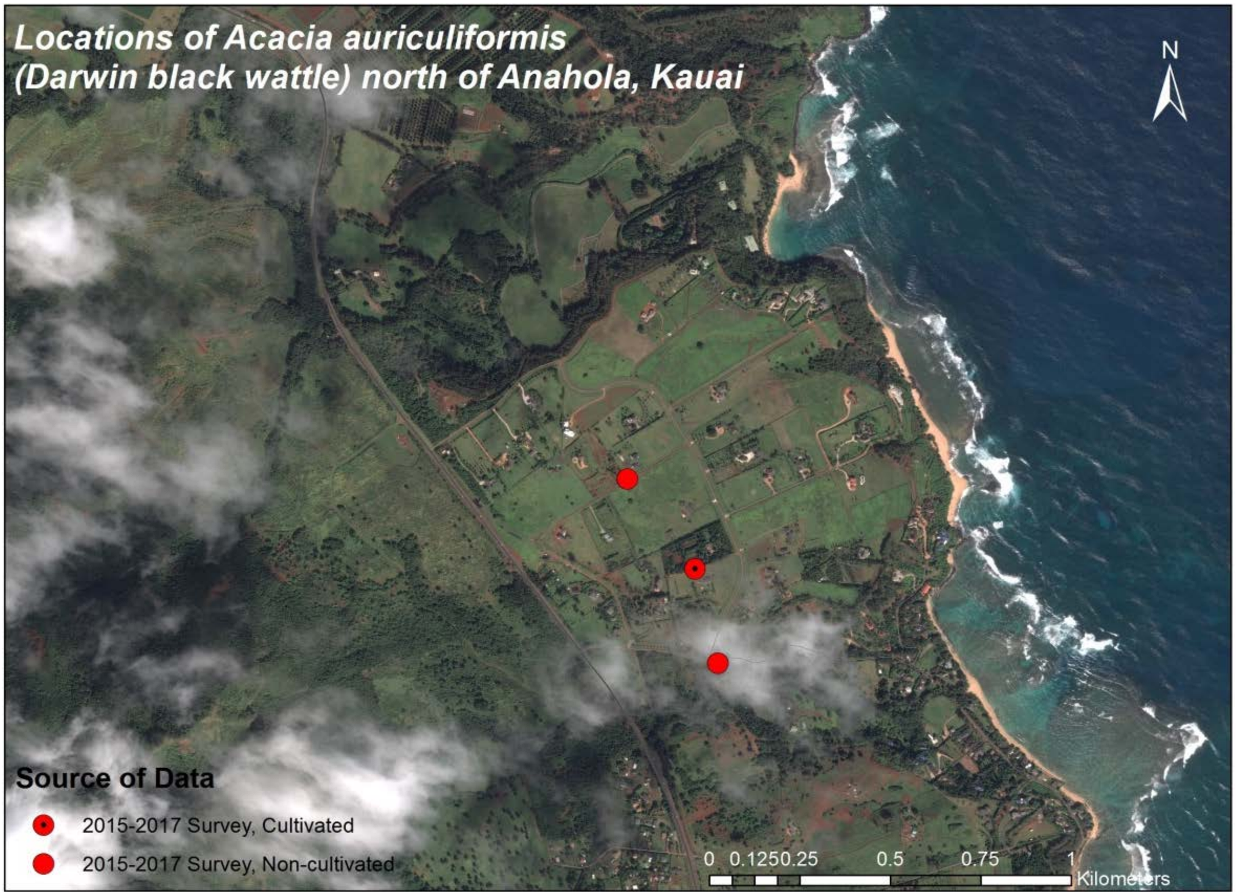


**Figure C1- 3. Map of *A. auriculiformis* locations north of Anahola.**

**Initial control:**

**Score: 2** = Moderate Effort

Feasibility of initial control for *A. auriculiformis* was given a score of 2 because control by herbicide is known to be very effective for most acacias (Kull and Rangan 2008). However, the bulk of the known trees are cultivated as a windrow/ privacy barrier at a private residence in Moloaa. The trees make up a large portion of their landscaping, and are obviously planted intentionally. Furthermore, the trees are large and line a private driveway leading to multiple residences. Arrangements would be needed to fell the trees safely without blocking access to homes. Additional equipment may be necessary to haul away the wood and debris, but because the trees are multi-branched near the base, most (if not all) bolts of wood should be less than 0.5 m in diameter. Although this plant is only present on 3 TMKs, initial control scoring of this plant may be downgraded, potentially to a 0 (impossible), if landowners are unwilling to collaborate.

**Monitoring:**

**Score: 3** = Minimal Effort

Feasibility of monitoring for *A. auriculiformis* was given a score of 3 because although acacias are known to form persistent seed banks (Marchante et al. 2011, Erkovan et al. 2013, Aran et al. 2017, Liyanage and Ooi 2017, Strydom et al. 2017), the Moloaa site is small and extensively cultivated. Thus, long-term visits are necessary but can be conducted by driving by when control crews are in the area after the majority of the seed bank has germinated, which usually declines by about 80% in less than 10 years (Milton and Hall 1981). Within the first 10 years, data on closely related acacias hint that visitation intervals of less than 1 year are required to account for rapid growth and maturity in this species (Krisnawati et al. 2011). Afterwards, acacia seeds are known to persist for up to 50 years (Milton and Hall 1981), so monitoring must continue, but can be done opportunistically between larger time intervals.

**FEASIBILTY OF CONTROL SCORE: 8**

**COMBINED SCORE= 8 + 8 = 16**

## Literature Cited


Aran, D., J. Garcia-Duro, O. Cruz, M. Casal, and O. Reyes. 2017. Understanding biological characteristics of Acacia melanoxylon in relation to fire to implement control measurements. Annals of Forest Science **74**:10.

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.

Erkovan, H. I., P. J. Clarke, and R. D. B. Whalley. 2013. Seed bank dynamics of Acacia farnesiana (L.) Willd. and its encroachment potential in sub-humid grasslands of eastern Australia. Rangeland Journal **35**:427-433.

Goi, S. R., J. I. Sprent, E. K. James, and J. Jacobneto. 1993. INFLUENCE OF NITROGEN FORM AND CONCENTRATION ON THE NITROGEN-FIXATION OF ACACIA-AURICULIFORMIS. Symbiosis **14**:115-122.

HPWRA. 2002. Ac*acia auriculiformis.* Hawaii Pacific Weed Risk Assessment.

Imada, C. T. 2012. Hawaiian native and naturalized vascular pland checklist (December 2012 update). , . Bishop Museum Technical Report 60/ Hawaii Biological Survey Contrib. 2012-021: 29 pp. + 27 appendices.

Kotiluoto, R., K. Ruokolainen, and M. Kettunen. 2009. Invasive Acacia auriculiformis Benth. in different habitats in Unguja, Zanzibar. African Journal of Ecology **47**:77-86.

Krisnawati, H., M. Kallio, and M. Kanninen. 2011. A*cacia mangium W*illd.: ecology, silviculture and productivity. CIFOR.

Kull, C. A., and H. Rangan. 2008. Acacia exchanges: Wattles, thorn trees, and the study of plant movements. Geoforum **39**:1258-1272.

Liyanage, G. S., and M. K. J. Ooi. 2017. Do dormancy-breaking temperature thresholds change as seeds age in the soil seed bank? Seed Science Research **27**:1-11.

Marchante, H., H. Freitas, and J. H. Hoffmann. 2011. The potential role of seed banks in the recovery of dune ecosystems after removal of invasive plant species. Applied Vegetation Science **14**:107-119.

Masutha, T. H., M. L. Muofhe, and F. D. Dakora. 1997. Evaluation of N-2 fixation and agroforestry potential in selected tree legumes for sustainable use in South Africa. Soil Biology & Biochemistry **29**:993-998.

Milton, S. J., and A. V. Hall. 1981. REPRODUCTIVE-BIOLOGY OF AUSTRALIAN ACACIAS IN THE SOUTHWESTERN CAPE-PROVINCE, SOUTH-AFRICA. Transactions of the Royal Society of South Africa **44**:465-485.

Nghiem, L. T. P., H. T. W. Tan, and R. T. Corlett. 2015. Invasive trees in Singapore: are they a threat to native forests? Tropical Conservation Science **8**:201-214.

Nguyen, N. T., P. K. Mohapatra, and K. Fujita. 2006. Elevated CO2 alleviates the effects of low P on the growth of N-2-fixing Acacia auriculiformis and Acacia mangium. Plant and Soil **285**:369-379.

Ohta, S. 1990. INITIAL SOIL CHANGES ASSOCIATED WITH AFFORESTATION WITH ACACIA-AURICULIFORMIS AND PINUS-KESIYA ON DENUDED GRASSLANDS OF THE PANTABANGAN AREA, CENTRAL LUZON, THE PHILIPPINES. Soil Science and Plant Nutrition **36**:633-643.

Orwa, C., A. Mutua, R. Kindt, R. Jamnadass, and A. Simons. 2009. Agroforestree Database: a tree reference and selection guide version 4.0. World Agroforestry Centre, Kenya.

Rafiqul Hoque, A. T. M., R. Ahmed, M. B. Uddin, and M. K. Hossain. 2003. Allelopathic Effect of Different Concentration of Water Extracts of Acacia auriculiformis Leaf on Some Initial Growth Parameters of Five Common Agricultural Crops. Pakistan Journal of Agronomy **2**:92-100.

Strydom, M., R. Veldtman, M. Z. Ngwenya, and K. J. Esler. 2017. Invasive Australian Acacia seed banks: Size and relationship with stem diameter in the presence of gall-forming biological control agents. Plos One **12**:16.

Wilson, J. R. U., C. Gairifo, M. R. Gibson, M. Arianoutsou, B. B. Bakar, S. Baret, L. Celesti-Grapow, J. M. DiTomaso, J. M. Dufour-Dror, C. Kueffer, C. A. Kull, J. H. Hoffmann, F. A. C. Impson, L. L. Loope, E. Marchante, H. Marchante, J. L. Moore, D. J. Murphy, J. Tassin, A. Witt, R. D. Zenni, and D. M. Richardson. 2011. Risk assessment, eradication, and biological control: global efforts to limit Australian acacia invasions. Diversity and Distributions **17**:1030-1046.