KISC KAUAI INVASIVE SPECIES COMMITTEE	*Kauai Status*	*KISC Status*	*HPWRA*	*Invasive Impacts Score*	*Feasibility Score*	*Combined Score*
Buddleja madagascariensis (smoke bush)	**NATURALIZED**	**EARLY DETECTION**	**HIGH RISK (21)**	**8**	**4**	**12**

Initial Prioritization Report completed: December 2017
Report updated as of: N/A
Current Recommendation for KISC: pending scoring rank and committee review.
Knowledge Gaps and Contingencies:

1) Delimiting surveys surrounding known locations are required to gain knowledge of the extent of populations.
2) An understanding of partnership roles may increase the likelihood/rate of success.

Background

Buddleja madagascariensis, or "smoke bush" (Buddlejaceae), is a large, woody vining shrub that is cultivated in warm temperate areas worldwide as an ornamental (Staples and Herbst 2005). *B. madagascariensis* is not currently considered a "Target" (i.e. controlled for island-wide eradication) by KISC, but the staff has assisted Kokee Resource Conservation Program (KRCP) with the control of this plant in Kokee. *B. madagascariensis* is included in the 2016 Kauai Pono Endorsement program to limit its dispersal through the nursery trade. The purpose of this prioritization assessment report is to consider the potential invasive impacts of *B. madagascariensis* and evaluate whether KISC should attempt whole-island eradication in cooperation with partnering agencies (i.e. accept as "Partnership" species status). This will be informed by scoring and comparing *B. madagascariensis* to other "Early Detection" species known to Kauai (See Table 5 in KISC Plant Early Detection Report for status terminology).

Detection and Distribution

B. madagascariensis was first vouchered on Kauai at a private residence in Kalaheo in 1987 (D.H. Lorence 5342, PTBG), and later deemed naturalized in Kokee (D. Lorence and F. Kraus 8147, PTBG) (Lorence and Flynn 1999). Statewide it is considered naturalized on Kauai, Maui, and Hawaii island (Imada 2012) and is targeted for eradication on Hawaii Island by Big Island Invasive Species Committee (BIISC 2017). Excluding a single herbarium voucher from 1987, *B. madagascariensis* has naturalized throughout Kokee, especially along roadsides and on cabin sites. The size of the infestation is thought to be between 250 and 400 ha in area (600-1000 acres). The current naturalized distribution of *B. madagascariensis* on in Kokee includes 1 judicial district (Waimea) and 1 watershed (Waimea); an additional herbarium voucher indicates its cultivation in Kalaheo in 1987 in 1 judicial districts (Koloa) and 1 watershed (Lawai; Figure C6- 1). The spread of this plant appears to be attributable to both rapid vegetative proliferation as well as long distance dispersal, perhaps by birds or pigs.

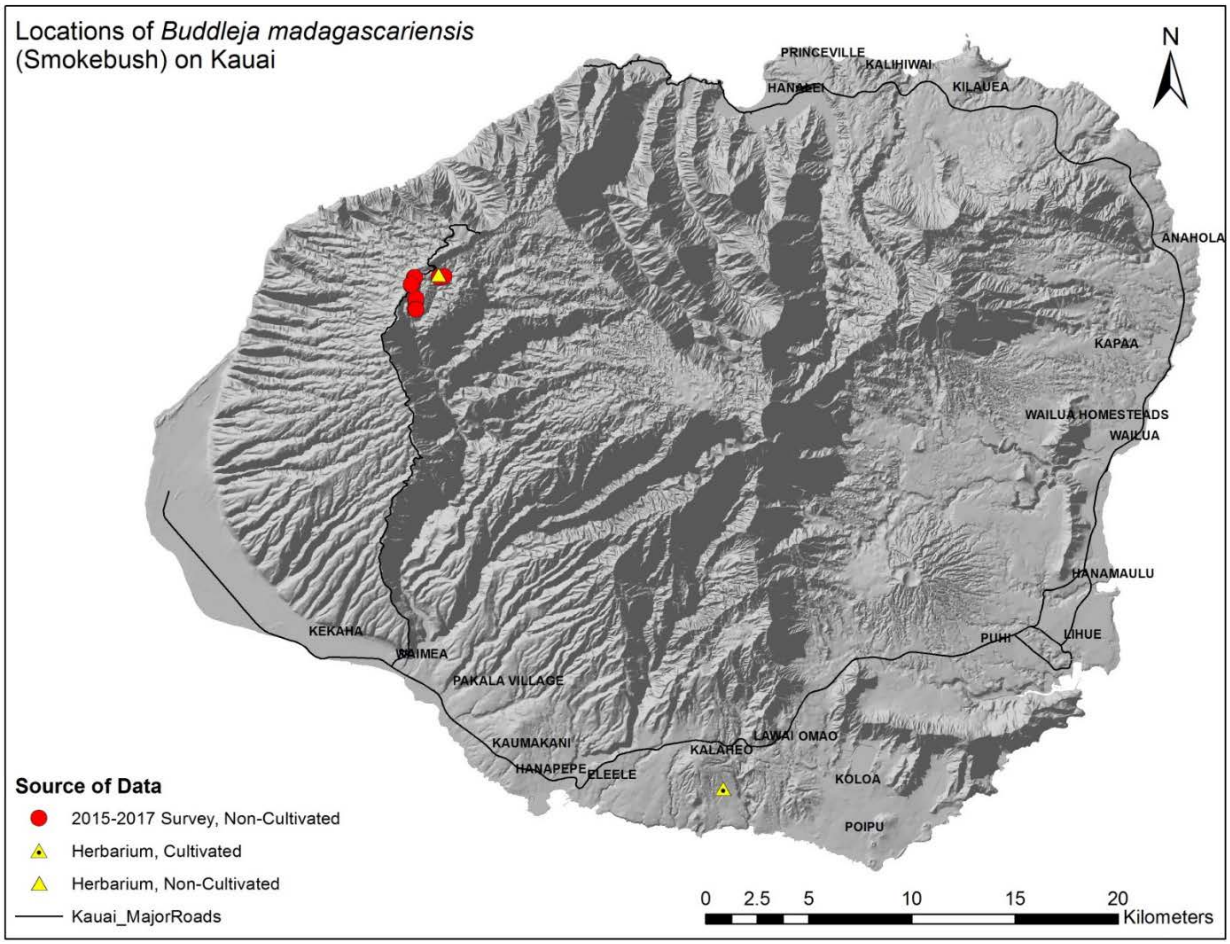

Figure C6- 1. Locations of *B. madagascariensis* on Kauai. Locations where presence of the plant was confirmed during 2015-2017 surveys are denoted by red circles.

Hawaii Pacific Weed Risk Assessment (HPWRA) Score

B. madagascariensis is designated as "High Risk", receiving a score of 21 (Daehler et al. 2004, HPWRA 2011). 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 • Naturalized outside of its native range in tropical/subtropical climates • Shade tolerant during some phase of its life cycle • Tolerate a wide range of soil conditions • Produces viable seed • Reproduction by vegetative fragmentation • Propagules dispersed intentionally and unintentionally by people • Propagules dispersed by water, birds and stick to animal fur • Propagules survive passage through the gut • Tolerates or benefits from mutilation	• An environmental weed • A congeneric weed, sharing a genus with other known invasive vines (i.e. implies inheritance of tendencies to inflict invasive impacts) • A known host of pests and pathogens • Climbing and smothering growth habit that forms dense thickets

Refer to the full Weed Risk Assessment for *B. madagascariensis*, including how these traits and characteristics traits affect HPWRA scoring, at https://sites.google.com/site/weedriskassessment/assessments/Download-Assessments.

Invasive Impacts Score

1. Impact on natural community structure and/or composition

Score: 3 = Major impacts

B. madagascariensis was assigned a score of 3 because observations from Kauai indicate that this plant is already impacting native forests on Kauai. On Kauai, it forms large vining masses that climb into tree canopies, dominating both the understory and overstory. 2015-2017 field surveys have noted this plant establishing in mesic, native-dominated habitat on Kauai and climbing into the canopies of koa trees (*Acacia koa*). Moreover, these observations were recorded far away from large, disturbance-associated "parent" infestations (Figure C6- 2). The temperate climate in its native range (Madagascar >600m above sea level) may indicate that high elevations on Kauai may be more susceptible to invasion (Staples and Herbst 2005); however, its ability to invade tropical forest stands in Australia suggest it may invade lower elevation forests as well (WSVI 2008). *B. madagascariensis* is invading national parks in Australia, where land managers predict damages to native forests (HPWRA 2011).

Figure C6- 2. *B. madagascariensis* growing on a koa tree in native-dominated mesic forest in Kokee.

2. Impacts to Agriculture, Culture and other Human Systems

Score: 3 = Major impacts

B. madagascariensis received a score of 3 in this category because it grows very rapidly in disturbed areas in Kokee, Kauai and has the ability to grow over cultivated trees and infrastructure such as powerlines and buildings. Because of

its woody growth habit and heavy vining masses, death or de-limbing of trees infested with *B. madagascariensis* has been noted on Kauai (Figure C6- 3). Additionally, these woody vines regularly connect multiple trees in a stand; thus, if one tree falls, multiple trees could be damaged. This phenomenon is especially damaging to forestry operations, as it precludes selective logging practices unless vines are manually cut and treated months before harvest (Vidal et al. 1997). The sap of this plant is also known to be poisonous (HPWRA 2011). Importantly, multiple people on Kauai have reported respiratory issues when working with this plant, ranging from a dry, scratchy feeling in the throat to triggering an asthmatic attack in one individual (Katie Cassel pers. comm). Programs attempting to control this plant in South Africa remark that dried sap can become suspended in air to cause coughing, allergies, as well as nasal swelling and eyelid blisters (ISSA 2017).

Figure C6- 3. Photo of *B. madagascariensis* in Kokee climbing *Eucalypus* species often cultivated for forestry purposes.

3. Impacts to biotic and abiotic processes

Score: 2 = Moderate Impacts

B. madagascariensis was assigned a score of 2 because although little is known about how its invasion affects abiotic factors, the incredibly dense thickets formed by this plant are likely to cause at least moderate impact to soil nutrients and moisture. Additionally, *B. madagascariensis* infestations tend to grow overtop their own woody stems, forming a thick layer of dry woody debris (Figure C6- 4). It is possible that accumulation of this debris may increase the likelihood and severity of forest fires in infested areas, although this has not been studied.

Figure C6- 4. Photo of *B. madagascariensis* in Kokee showing accumulation of woody debris in densely infested areas.

TOTAL INVASIVE IMPACTS SCORE: 8

Feasibility of Control Score

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

Delimiting Survey:

Score: 2 = Moderate Effort

Feasibility of a delimiting survey for *B. madagascariensis* was given a score of 2 because much work has already been done by KRCP, and the opportunity to carefully delimit the infestation with the help of KRCP's data and staff may be possible. However, this score should be reassessed after discussions with KRCP. Based on aerial imagery of ideal habitat and estimates of seed dispersal distances, approximately 800 hectares (~2000 acres) would need to be at least roughly surveyed to establish the extent of the population for eradication goals. Use of aerial technology (e.g. drone) may be used to obtain an idea of extent, as canopy-covering vines can be identified aerially by their distinctive blue-gray leaves. This score is likely to decrease to 0 (impossible) if KISC is unable to partner with another conservation agency (although KRCP is already treating this plant when funding and scheduling allow), if aerial technology cannot be used or if the population proves to be much larger than estimated.

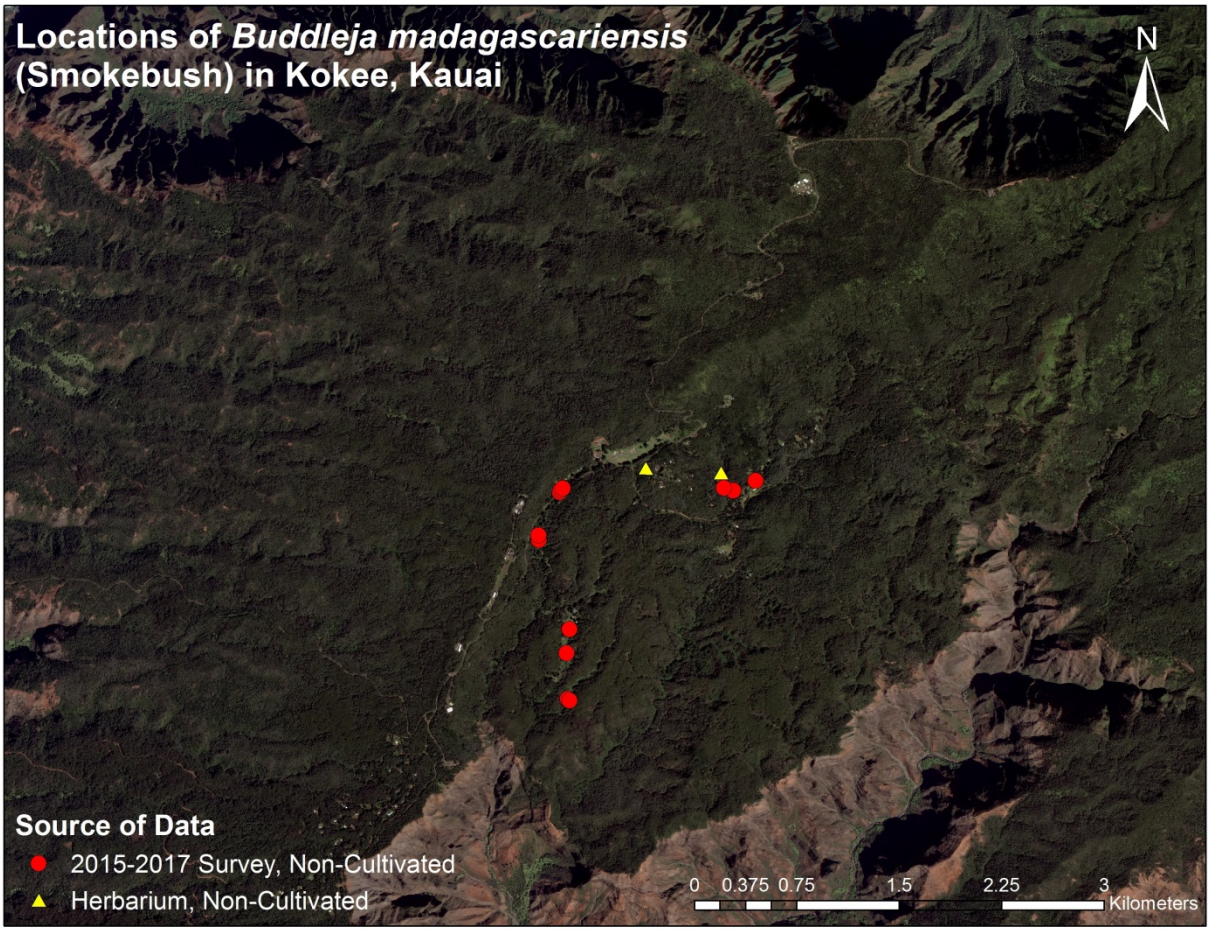

Figure C6- 5. Map of *B. madagascariensis* infestation in Kokee, with red circles denoting locations found during 2015-2017 surveys.

Initial control:

Score: 1 = Significant Effort

Feasibility of initial control for *B. madagascariensis* was given a score of 1 because the infestation of this plant is large (spread over 250-400 ha) and forms dense, impenetrable thickets. However, this score should be revisited after discussions with KRCP to compare area infestation estimates. KRCP notes that control of this plant requires multiple herbicide applications. A challenging aspect of controlling this plant is its growth form, where plants arise from a main stalk and re-root where stems spread along the ground. Herbicide application to main stalks using "hack-and-squirt" or "frill" methods is effective if the main stalks of an infestation can be located (Figure C6- 6). However, main stalks may rot and be replaced by multiple stems as infestations grow and dense patches often prevent access. Thus, multiple foliar herbicide applications may be necessary, working from the outside-in, to kill large patches. The known infestation includes approximately 6 TMKS (land parcels), although KRCP has made great gains in working with land owners in the area.

Figure C6- 6. Photo of large, central *B. madagascariensis* trunk after being treated with herbicide.

Figure C6- 7. Photo of KRCP applying a second round of foliar herbicide to *B. madagascariensis.*

Monitoring:

Score: 1 = Major Effort

Feasibility of monitoring for *B. madagascariensis* was given a score of 1 because although there are no studies on how long *B. madagascariensis* seeds persists, a study including the closely related *B. davidii* suggest that seeds may persist in the soil for multiple years. Thus, intensive monitoring after all initial plants have been controlled likely requires for more than 5 years.

FEASIBILTY OF CONTROL SCORE: 4

COMBINED SCORE= 8 + 4 = 12

Literature Cited

BIISC. 2017. Active Eradication Targets - Smoke Bush.

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.

HPWRA. 2011. Buddleja madagascariensis. 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.

ISSA. 2017. Invasive Plants. Madagascar sagewood- Buddleja madagascariensis. Invasive Species South Africa.

Lorence, D., and T. Flynn. 1999. New naturalized plant records for the Hawaiian Islands. Pages 3-9. Bishop Museum Occasional Papers.

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.

Vidal, E., J. Johns, J. J. Gerwing, P. Barreto, and C. Uhl. 1997. Vine management for reduced-impact logging in eastern Amazonia. Forest Ecology and Management **98**:105-114.

Vitelli, J. S., B. A. Madigan, P. E. Van Haaren, S. Setter, and P. Logan. 2009. Control of the invasive liana, Hiptage benghalensis. Weed Biology and Management **9**:54-62.

WSVI. 2008. Victorian Alert Weed: Smoke bush (Buddleja madagascariensis). Page 7. Weed Society of Victoria Inc. Weedscene.