	Kauai Status	KISC Status	HPWRA	Invasive Impacts Score	Feasibility Score	Combined Score
<i>Flindersia brayleyana</i> (Queensland maple)	NATURALIZED	EARLY DETECTION	EVALUATE (2)	6.5	4.5	11

Initial Prioritization Assessment completed: January 2018

Report updated as of: N/A

Current Recommendation for KISC: Pending Ranking and Committee approval

Knowledge Gaps and Contingencies:

- 1) Delimiting surveys surrounding known locations are required to determine the extent of the population
- 2) Collaboration with landowners of forestry plantings is required
- 3) Partnership with other agencies may increase chances of success
- 4) Arborists are necessary to fell trees in human-trafficked areas

Background

Flindersia brayleyana (Rutaceae), or “Queensland maple”, is a large tree growing to 45 m tall that is cultivated in the tropics as a source of high-value timber (Staples and Herbst 2005). Although *F. brayleyana* was observed naturalizing in 2010, it 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) or joint control with partnering agencies (i.e. accept as “Partnership” species status). This will be informed by scoring and comparing *F. brayleyana* to other “Early Detection” species known to Kauai (See Table 5 in KISC Plant Early Detection Report for status terminology).

Detection and Distribution

F. brayleyana was first vouchered on Kauai in 1990 from a cultivated tree in Lihue (D.H. Lorence 6584, BISH). Statewide, *F. brayleyana* is known as naturalized on Maui and Hawaii Island (Imada 2012), and surveys done in 2010 and 2015-2017 suggest that it should also be considered naturalized on Kauai. Records of forestry species planted on forest reserves statewide between 1910-1960 indicate that although *F. brayleyana* was planted on Oahu and Hawaii island, no planting was recorded on Kauai during this time (Skolmen 1980). There are roughly three locations of *F. brayleyana* known on Kauai, including one naturalized population adjacent to a few cultivated specimens and 2 additional cultivated sites (Figure C21- 1). Additionally, one report that was not verified during 2015-2017 surveys indicates that some cultivated trees are present at a private residence in Kalaheo (UTM approx. 4Q 446862 E x 2425072 N; not represented in Figure C21- 1). The cultivated sites include one tree located in a city park in Lihue near Pua Loke Street and a forestry planting near halfway bridge, west of Puhi, where approximately 30 mature trees can be seen from Highway 50. The population of *F. brayleyana* naturalizing from cultivated plantings in Keahua Arboretum was confirmed during 2015-2017 surveys when more than 70 trees of varying age classes were observed plus numerous saplings (Figure C21- 2). The majority of the trees were detected immediately surrounding the arboretum and along Keahua stream, although approximately 5 additional trees were recorded during roadside surveys about 2km southwest of the arboretum. These trees appeared much younger than those planted in the arboretum and were growing in the midstory of alien forest adjacent to the roadside. However, analysis of aerial imagery after surveys detected forested patches with linear edges in the surrounding area, which may indicate forestry plantings that were not noticed in the field (Figure C21- 3). Seeds are winged for wind-adapted dispersal (Wagner et al. 1999) and thus, three scenarios describing this population are possible:

1. Southwest field points represent trees that have established 2 kms away via long distance wind dispersal from Keahua Arboretum trees,
2. Southwest field points represent trees that are regenerating from other mature, naturalized individuals nearby, and more detailed delimiting surveys will detect a continuous naturalizing population between two points distanced 2km apart, or
3. Southwest field points represent trees planted or naturalizing from a second, undetected forestry planting nearby.

Combined, these data suggest that *F. brayleyana* has so far naturalized in the Kawaihau judiciary district within the Wailua watershed and is cultivated in the Lihue district within two watersheds (Huleia, Nawiliwili).

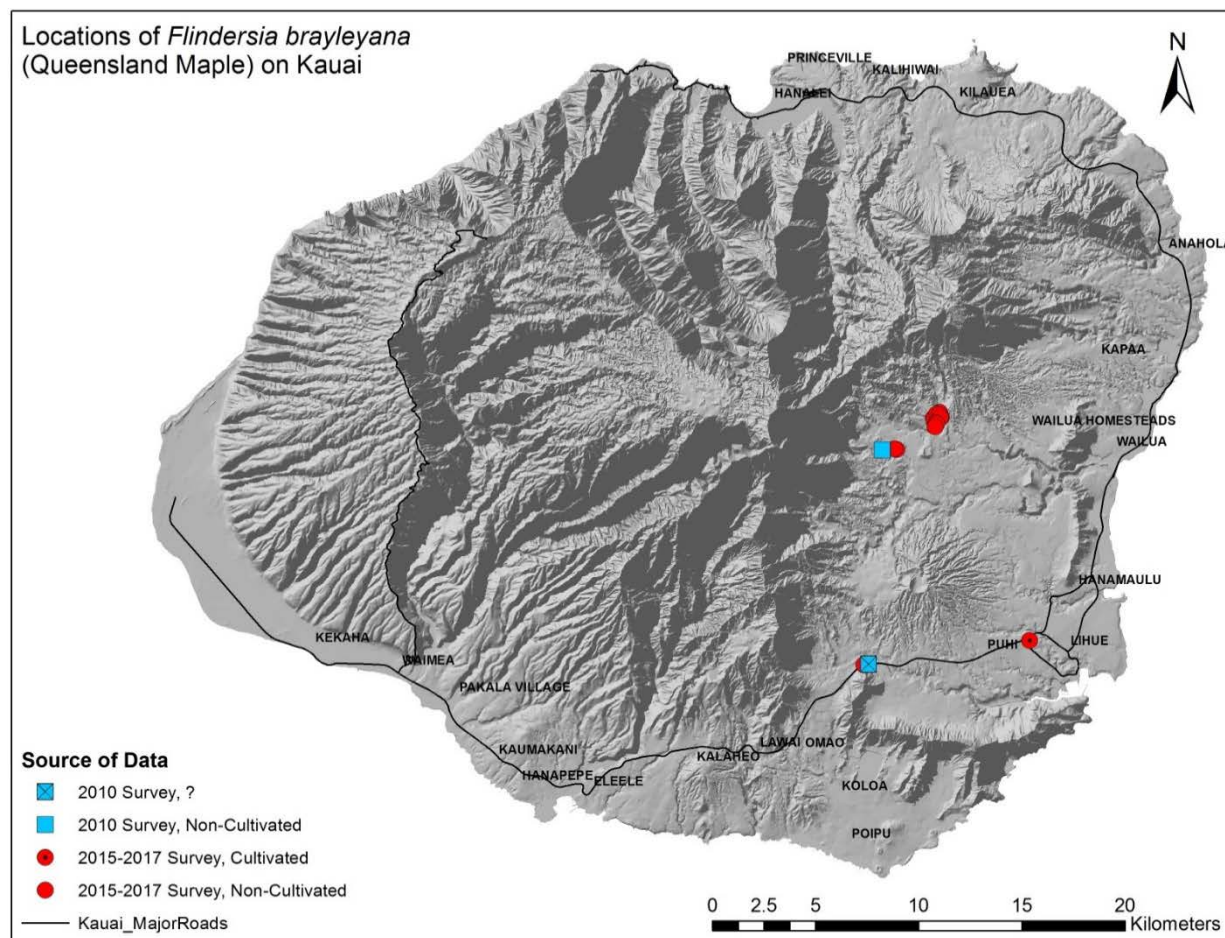


Figure C21- 1. Locations of *F. brayleyana* on Kauai.

Hawaii Pacific Weed Risk Assessment (HPWRA) Score

F. brayleyana is designated as “Evaluate”, receiving a score of 2 (Daehler et al. 2004, HPWRA 2013). 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). As this particular assessment resulted in a “Evaluate” score, traits resulting in a low score are also listed alongside asterisks (*). Categorization of traits in this manner more accurately informs invasive impact potential scoring and prioritization of species that are already established on Kauai. Refer to the full Weed Risk Assessment for *F. brayleyana* at <https://sites.google.com/site/weedriskassessment/assessments/Download-Assessments>.

<i>Likelihood of Invasion</i>	<i>Consequences of Invasion</i>
<ul style="list-style-type: none"> • Well suited to climates in Hawaii • Naturalized outside of its native range • Shade tolerant during some phase of its life cycle • Tolerant of a wide range of soil conditions • Produces viable seed • Propagules dispersed intentionally by people • Propagules dispersed by wind • Does not reproduce by vegetative fragmentation * • Takes more than 4 years to mature * • Propagules not dispersed unintentionally by people* • Propagules unlikely to be dispersed as a contaminant* • Propagules not dispersed by animals or birds* • Does not produce a persistent seed bank * • Does not tolerate mutilation and/or fire * 	<ul style="list-style-type: none"> • Garden/Amenity/Disturbance weed • Host for recognized pests and/or pathogens



Figure C21- 2. Naturalized *F. brayleyana* (red arrows) adjacent to Keahua Arboretum, Kauai.

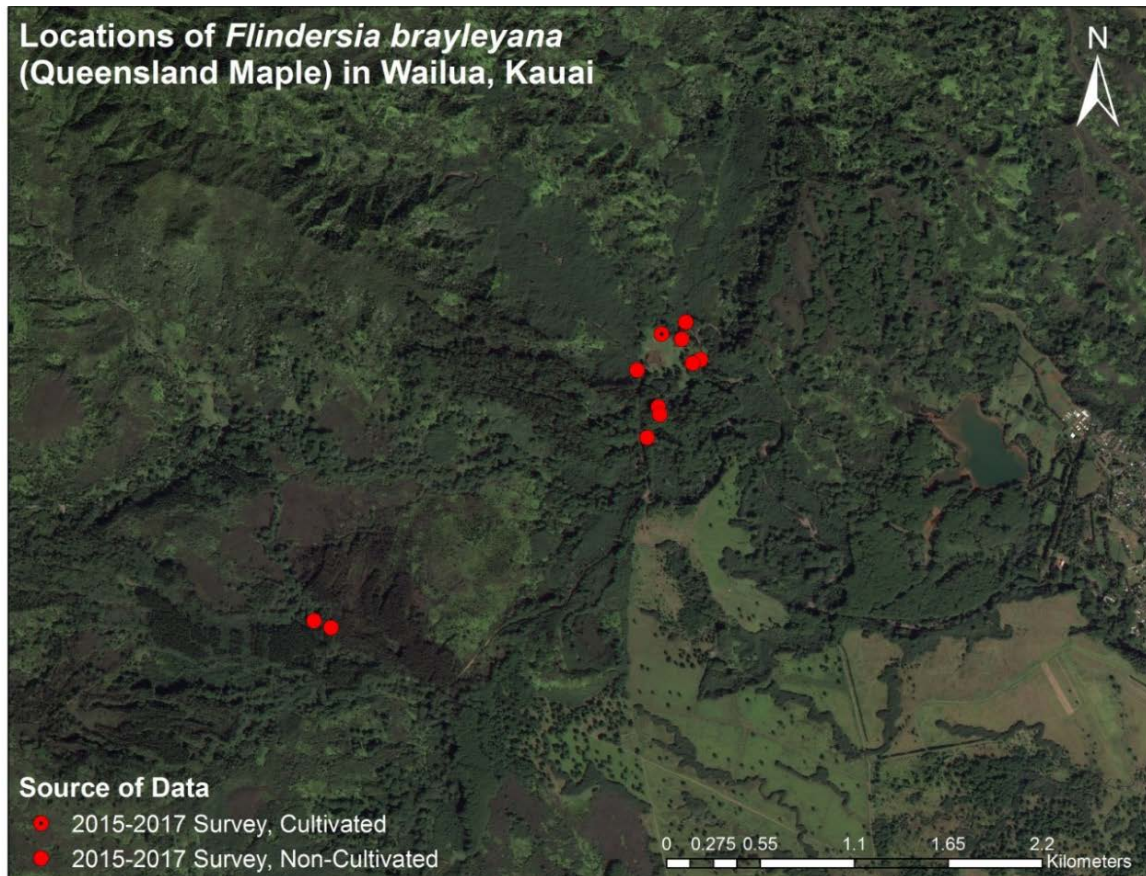


Figure C21- 3. Location of *F. brayleyana* naturalizing near Keahua Arboretum. Note the dark brown/green forested patches surrounding the points to the southwest with linear edges, potentially representing forestry plantings.

Invasive Impacts Score

1. Impact on natural community structure and/or composition

Score: 2.5 = Moderate-Major impacts

F. brayleyana was assigned a score of 2.5; however, a lack of research on its invasive impacts makes prediction of invasive impact difficult. Although it has been cultivated in many tropical areas as a forestry tree, reports of its naturalization are restricted to Hawaii, and thus the scoring of this section is based mostly on observations from Hawaii. In its native habitat in tropical Australia, *F. brayleyana* is considered a quick growing, early and mid-successional species with a preference for moist sites (Herwitz 1993, Kelly et al. 2009). Despite its reputation as a pioneer species, it is favored in forestry plantations for its ability to regenerate in both very shaded understories and open areas (Thompson et al. 1988, Simpson and Osborne 2006, Kelly et al. 2009). Saplings beneath mature trees can form a dense understory that excludes other vegetation, which has been noted in forestry plantations in Hawaii (Figure C21- 4) as well as globally (Harrington and Ewel 1997, Keenan et al. 1997, HPWRA 2013). The fate of these dense sapling stands has not been studied, and it is currently not known whether these densities persist to form monocultures of adult trees. However, observations of naturalizing trees immediately near plantations on Maui suggest that dense, mature stands in native-dominated ecosystems may be possible, at least in moist areas (Figure C21- 5). The new naturalization record for *F. brayleyana* in Maui states “spreading from forestry plantings into native uluhe (*Dicranopteris linearis*) dominated areas, 925 ft [280 m]” (Starr et al. 2004). Other field observations from Maui confirm that *F. brayleyana* disperses long distances and has been found in moist *Metrosideros* (ohia) - *Dicranopteris* (uluhe) dominated lowlands, although it is not yet forming dominant stands (H. Oppenheimer pers. comm.).

On Kauai, young (but mature) naturalized trees approximately 500 m from cultivated sites have been observed forming 40% cover of the mid-canopy in localized areas, implying that it could become a significant component of moist forests. Although the forest directly adjacent to the naturalized population on Kauai is heavily invaded, remnant native *Metrosideros* (ohia) - *Dicranopteris* (uluhe) forest patches with occasional *Pisonia sandwicensis* trees can be found in the immediate area. Additionally, *F. brayleyana* are naturalizing within one POPREF polygon also containing PEP plants (Upper Wailua River –UPP; it is also cultivated in Huleia-HUL popref polygon). The height of this tree along with its ability to form a broad crown may enable it to form a new canopy layer in moist-mesic forests that does not currently exist (Figure C21- 6). Additionally, viability testing of forestry species in their native range (from 0-1200 m above sea level) indicates that *F. brayleyana* is resilient to temperature fluctuations and may naturalize at higher elevations on Kauai with sufficient moisture (Swanborough et al. 1998, HPWRA 2013). The ability of this tree to grow rapidly as an early successional species and disperse via wind-adapted seeds suggests that *F. brayleyana* may become common in moist forests on Kauai. However, additional monitoring of Hawaii populations is necessary to determine whether *F. brayleyana* can dominate natural habitats and exclude native species, as this species is especially notable for being a potentially Hawaii-specific invader, despite cultivation elsewhere in the tropics.

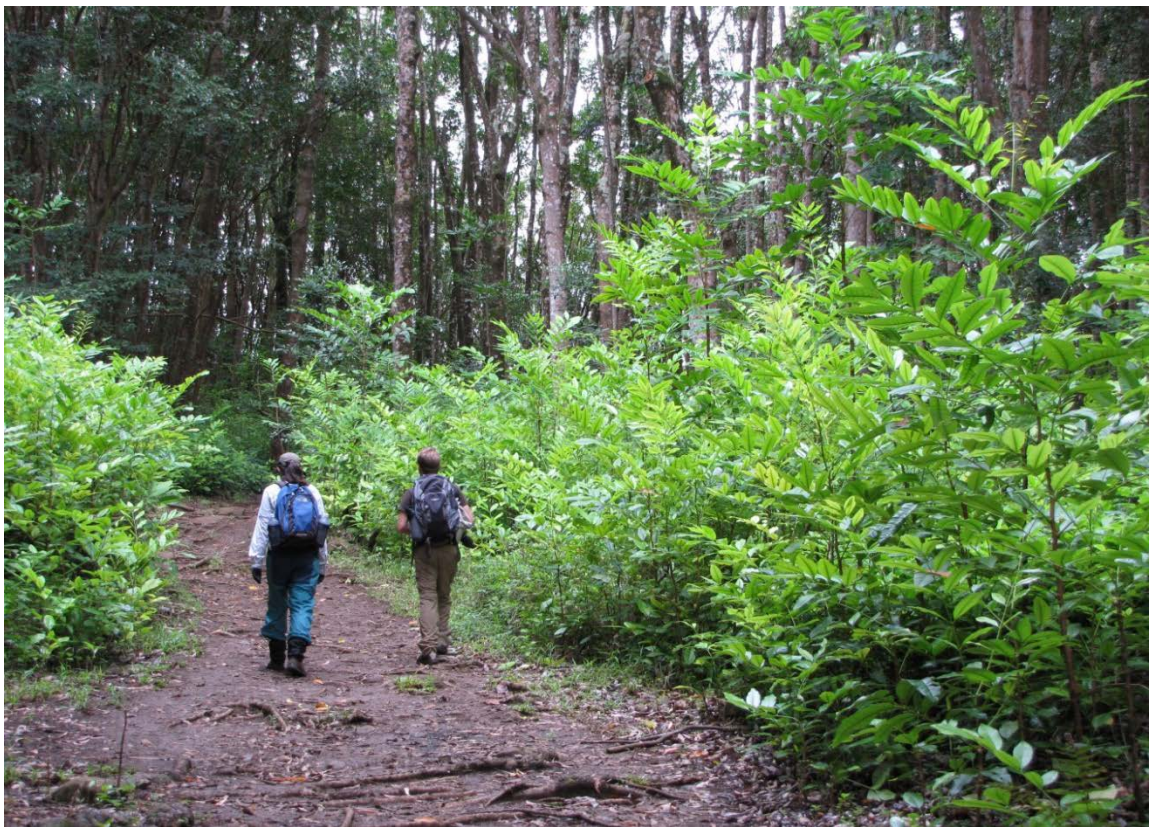


Figure C21- 4. A dense understory of *F. brayleyana* saplings regenerating under a forestry plantation on Waihee ridge, Maui (Photo credit F & K Starr).



Figure C21- 5. A mature stand of *F. brayleyana* escaping from a forestry planting along Hana highway on Maui, showing its characteristic dark green leaves with bright green new growth (Photo credit F & K Starr).

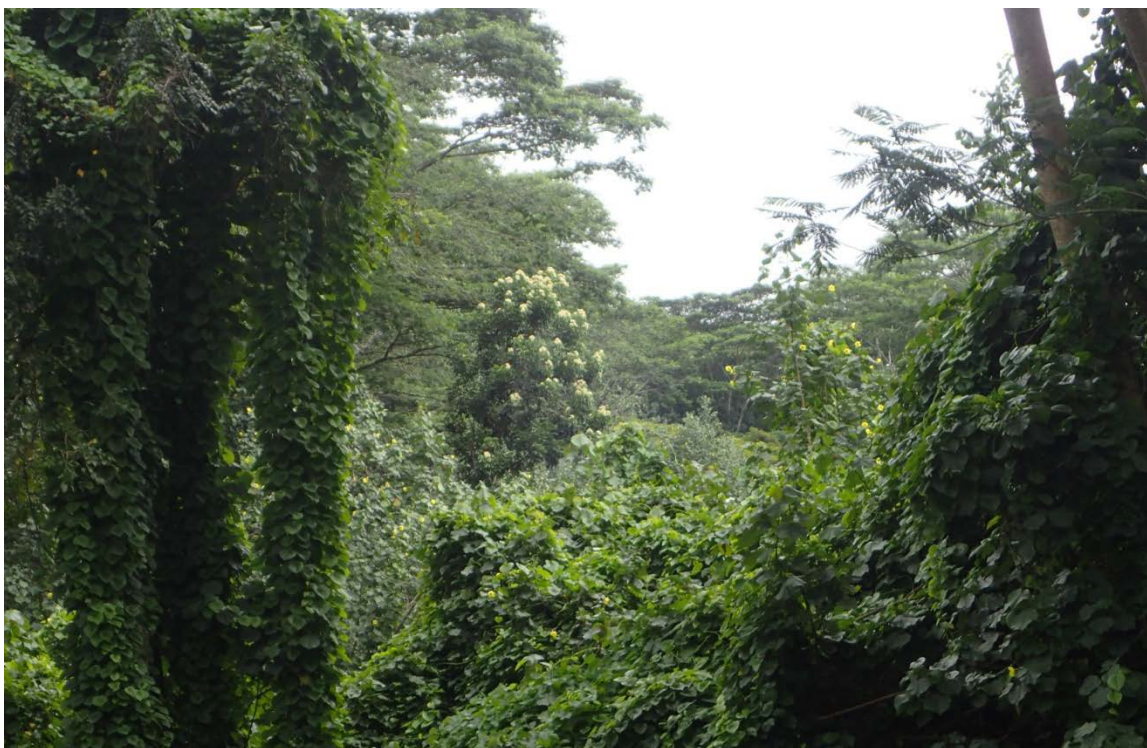


Figure C21- 6. A mature, naturalized *F. brayleyana* along Keahau stream, below albezia (*Falcataria moluccana*) but above hau (*Hibiscus tileaceus*) showing its potential ability to form a new mid-canopy layer in alien or native forests if population densities increase in the future.

2. Impacts to Agriculture, Culture and other Human Systems

Score: 2 = Moderate impacts

F. brayleyana received a score of 2 because this plant is known to rapidly colonize disturbed areas and spread rapidly via wind-dispersed seeds (Wagner et al. 1999, Kelly et al. 2009). These traits may allow it to naturalize in human-controlled systems including along roadsides, residential areas, gardens/landscapes and within forestry plantations. Additionally, *F. brayleyana* can become 45m tall and grow rapidly (Thompson et al. 1988, Herwitz 1993, Staples and Herbst 2005, Kelly et al. 2009). Thus, trees may become hazardous and expensive to remove if growing under utility lines and next to buildings or highways. However, its preference for moist habitats may exclude it from colonizing dry sites throughout Kauai.

3. Impacts to biotic and abiotic processes

Score: 2 = Moderate Impacts

F. brayleyana was given a score of 2 in this category because although no impacts to biotic or abiotic processes have been recorded, a few sources suggest that native plant regeneration under *F. brayleyana* is significantly less than for other forestry species in Hawaii, suggesting that this species has at least some ability to affect conditions favorable to native ecosystem regeneration (Harrington and Ewel 1997, Keenan et al. 1997). However, it is unclear whether changes to abiotic factors are underlying this cause, or if native recruitment is lessened by intense competition with *F. brayleyana* saplings. Nonetheless, the rapid growth, large canopy and root system and its ability to produce a thicket of saplings is likely to cause at least moderate impacts to soil and nutrient cycling in infested areas.

TOTAL INVASIVE IMPACTS SCORE: 6.5

Feasibility of Control Score

Feasibility of Control Scoring and rationale for *F. brayleyana* 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 *F. brayleyana* was given a score of 2 because there are only 3 known sites on Kauai, and part of the naturalizing site near Keahua Arboretum is also within the miconia search buffer, and thus efforts could possibly be included with miconia surveys. However, this score will be lowered if significantly more trees are found naturalizing near Keahua stream, or if the cultivated sites are found to be naturalizing during delimiting surveys. Plants are easiest to detect when flowering, which has been observed in July in 2016 and 2017 Keahua Arboretum.

Initial control:

Score: 0.5 = Impossible – Major Effort

Feasibility of initial control for *F. brayleyana* was given a score of 0.5, which reflects the likely difficulty that will be faced when convincing landowners to remove/harvest cultivated trees as well as potential control issues. As *F. brayleyana* is a high-value timber species, loss of it as a forestry tree may affect future income plans. The Division of Forestry & Wildlife (DOFAW), which manages the Keahua Arboretum, has previously indicated that they do not wish to remove the trees during meetings regarding the Keahua Stream Bridge. Additionally, trees are very large and the felling of cultivated and naturalized plants is outside the scope of KISC control and will require certified arborists. The terrain along Keahua stream is densely vegetated and quite steep, so control of trees will be slow and difficult in these areas. However, a “hack and squirt” method may be applied to trees not adjacent to human accessed areas. This score may increase if KISC is able to recruit a conservation partner or ascertain an affordable method to remove trees. Due to its high value to woodworkers, a few people have expressed interest in using the wood, including the nearby Hindu monastery.

Monitoring:

Score: 2 = Moderate Effort

Feasibility of monitoring for *F. brayleyana* was given a score of 2 because it is known to be incapable of forming a persistent seed bank. Studies attempting to prolong the viability of seeds in ideal, moisture-controlled lab conditions found that seed viability declined rapidly in less than one year (HPWRA 2013). However, a score of three is not warranted because searching for regenerating saplings from controlled trees will likely require several visits.

FEASIBILITY OF CONTROL SCORE: 4.5

COMBINED SCORE: 6.5 + 4.5 = 11

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