KISC KAUAI INVASIVE SPECIES COMMITTEE	Kauai Status	KISC Status	HPWRA	Invasive Impacts Score	Feasibility Score	Combined Score
Juncus effusus (common mat rush)	**Naturalized**	**TARGET**	**HIGH RISK (21)**	**7**	**6**	**13**

Initial Prioritization Assessment Report completed: November 2015
Report updated as of: N/A
Current Recommendation for KISC: Consider adjusting status to PARTNERSHIP Species
Knowledge Gaps and Contingencies:

1) Additional surveys are needed along trails within the area to assess the full extent of the infestation.
2) Island-wide nursery surveys need to be completed to illuminate if *J. effuses* is currently in the horticultural trade on Kauai.
3) Need to investigate partnership project management options with Kokee conservation entities, monitoring would require significant effort, partnering to treat and monitor occurrences will make eradication of known occurrences a feasible goal.

Background

Juncus effusus (Juncaceae) is a perennial rush that has a minimum maturity time of approximately 2 years (Bakker et al. 1996). It is spread by numerous, small (0.5mm) viable seeds that can remain dormant in the seed bank for over 10 years (Amanda Hardman, Division of Forestry and Wildlife, Oahu, pers. com.) and forms dense thickets by vegetative reproduction by rhizomes. The seeds are covered with a mucilaginous coating that allows them to easily adhere to boots or the coats of animals. An initial report summarizing the threat and known distribution of this plant was prepared by Adam Williams and Kelsey Brock on September 8th, 2015 to alert other conservation groups travelling through the infested area to reduce spread, increase reporting of occurrences and instigate control efforts (Williams and Brock 2015); this report is appended below and describes *J. effusus* morphology and life history traits in greater detail.

Detection and Distribution

To date, *J. effusus* has only been found in the Pihea and Alakai Swamp Trails in Koke'e State Park and Na Pali Kona Forest Reserve on Kauai. It is considered naturalized on Kauai by the Bishop Museum based on a first island record collected in 2008 (T. Flynn 7395) on the Pihea trail (Frohlich and Lau 2012). However, a recent review of the National Tropical Botanical Garden herbarium *Juncus* collections (PTBG) revealed a slightly earlier 2006 record (N. Tangalin 671) from the same area. Further queries of the Bishop Museum (BISH) and PTBG collections revealed no other occurrences from Kauai.

The method of introduction for this plant to Kauai is unknown, although it has naturalized along hiking trails on other Hawaiian Islands and seeds may have accidentally been brought here in contaminated hiking boots. Additionally, *J. effusus* is occasionally marketed in the nursery industry for landscaping around water features (Staples and Herbst 2005). Both straight stemmed and curly ('spiralis') varieties exist, although we are only aware of a straight stemmed variety in Hawaii from Home Depot and Ace Hardware nurseries on Maui. An informal survey of the Home Depot nursery on Kauai was recently conducted without sighting *J. effusus*. Island-wide nursery surveys will take place in 2016 and will illuminate whether purposeful introductions of this plant to Kauai are taking place.

Early Detection Surveys in the proximity of the infestation were conducted in areas that receive high amounts of foot traffic, as hikers appear to be the primary vector facilitating spread. This included the entirety of the Pihea, Alakai Swamp and Kawaikoi Stream hiking trails, the southern and eastern borders of the Hono O Na pali Natural Area Reserve (NAR) fence line, a trail used by the Kauai Forest Bird Recovery Program, and a very short portion of trail within the NAR near Pihea Peak (Figure C28- 1). Additional surveys are needed along trails in the NAR to assess the extent of this infestation and reports of *J. effusus* in North Bog from Koke'e Conservation Resource Program (KRCP), and Kanaele Bog from The Nature Conservancy (TNC) still need to be investigated.

There are a total of 25 currently known occurrences of *J. effusus* comprising 250-300* plants on the Pihea and Alakai Swamp trails and adjacent NAR fence line. An occurrence is hereby defined as a somewhat distinct patch containing one or more plants. Currently, *J. effusus* exists sporadically along 2.8km in moist areas with open to partially open canopy. Large patches with mature plants are noticeably associated with more open canopy, likely reflecting quicker maturation when exposed to sufficient sunlight. The majority of occurrences are on the Pihea trail (17 occurrences) with the densest infestation (~45 m^2, 175* plants) on the trail about 250 meters SW of Pihea peak. A map of occurrences is presented in Figure C28- 1, and a summary is presented in Table C28- 1.

Table C28- 1. Summary of *J. effusus* occurrences according to survey area and habitat type.

Infested Area	Number of Occurrences	Approximate Number of Individual Plants	Proportion of Mature Plants
Pihea trail (*Metrosideros* Dominated Native Forest)	17	250*	80%
Alakai Swamp trail (*Metrosideros* Dominated Native Forest)	1	2	0%
Alakai Swamp trail (Native Sedge Dominated Bog)	1	5	100%
NAR fence line (*Metrosideros* Dominated Native Forest)	4	5	20%
NAR trail portion (*Metrosideros* Dominated Native Forest)	2	4	25%

* Estimates of number of individual plants may be inaccurate in densely infested areas due to the rhizomatous habit of *J. effusus.*

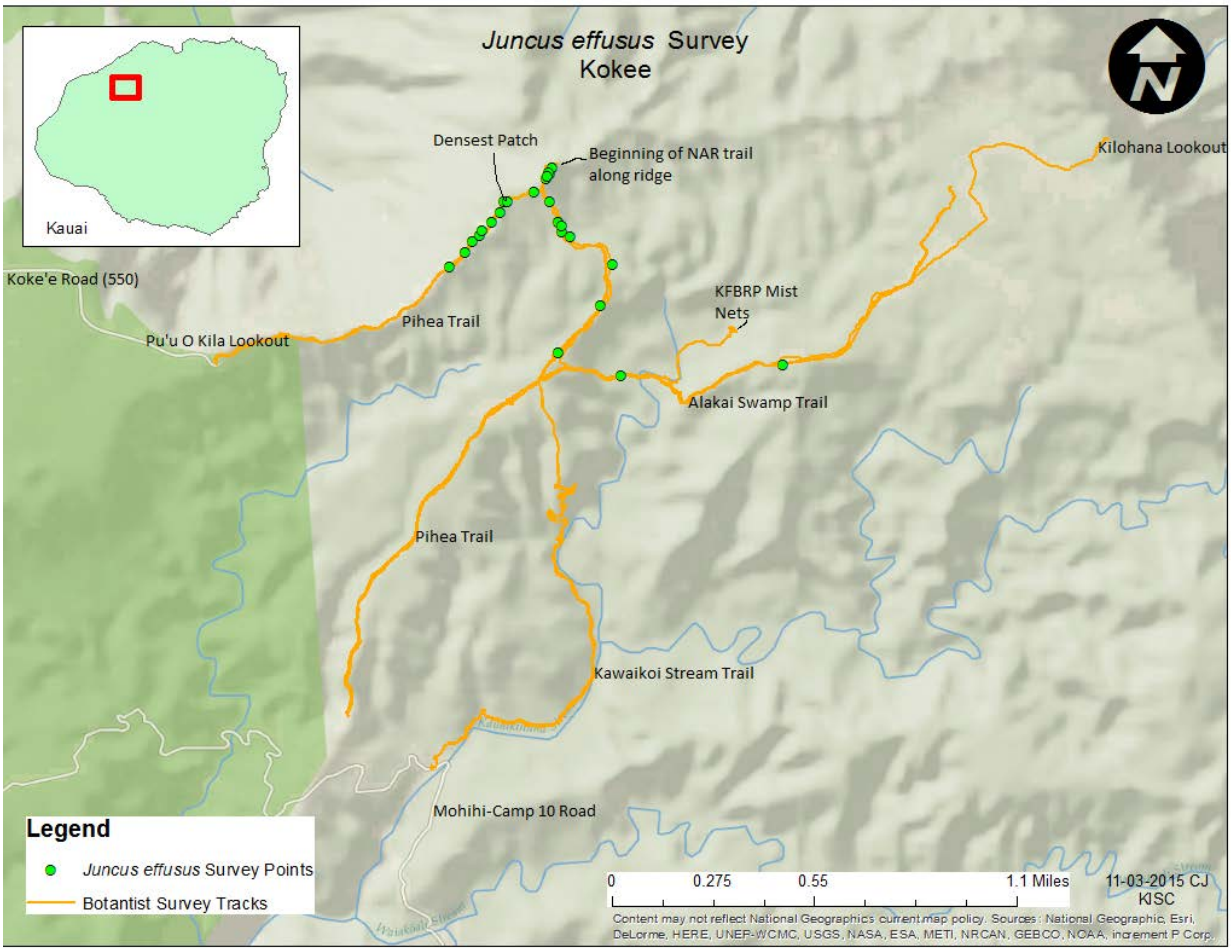

Figure C28- 1. Early Detection Survey effort near known *Juncus effusus* infestation. Green circles indicate patches of *J. effusus* comprised of one or more species. Orange lines indicate the path of the surveyor recorded by handheld GPS.

Hawaii Pacific Weed Risk Assessment (HPWRA) Score

J. effusus is designated as "High Risk" (HPWRA 2013), listing the following biological traits as contributors to its high risk status:

Likelihood and Consequences of Invasion

- Widely naturalized around the world and within Hawaii
- Thrives in temperate and higher elevation tropical climates
- Environmental weed, competing with native vegetation
- Possibly allelopathic
- Forms dense thickets
- Shade tolerant
- Tolerates many soil conditions (and potentially able to exploit many different habitat types)
- Spreads vegetatively by rhizomes
- Reaches maturity in 2 years
- Produced large numbers of seeds
- Seeds easily dispersed by wind, water, and adhering to animals, and machinery
- Seeds can persist in the soil for decades

Refer to the full Weed Risk Assessment for *J. effusus* 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

J. effusus was assigned a score of 3 in the "Impacts to Natural Communities" category due to its ability to invade sedge-dominated montane bog habitat. Bogs are considered a rare vegetation type in Hawaii, and Kauai possesses unique subtypes (Gagne and Cuddihy 1990). Additionally, bog obligate endangered and rare plant species exist on Kauai and could face extirpation or extinction from ecosystem transforming invasive plants. *J. effusus* is thought to be capable of transforming bog habitat as well as open streams and drainages due to its known capacity to form thickets on Maui and Oahu (Figure C28- 2). Given *J. effusus*'s ability to occupy shallow wetlands and moist grounds over a wide climatic and elevational gradient (Rana and Sellers 2009, HPWRA 2013), spread of this plant may also affect lowland restoration and preservation efforts in wetlands and culturally important fishponds.

Figure C28- 2. *Juncus* effusus infestation along boardwalk in the Pu'u Kukui Watershed Preserve, Maui. Photo by Kim and Forest Starr.

2. Impacts to Agriculture, Culture and other Human Systems

Score: 2 = Moderate impacts.

J. effusus received a score of 2 in the "Impacts to Agriculture" category due to its known history as a pasture weed in Florida (Rana and Sellers 2009). Although invasions of this plant are restricted to moist pastures with near surface water tables, *J. effusus* has been recorded at near 50% cover in these areas. This species is not palatable to cattle and increases in dominance with grazing pressure. Additionally, a study by Ervin and Wetzel (2000) suggests that *J. effusus* is allelopathic, which could further inhibit growth of desirable pasture species.

3. Impacts to Biotic and Abiotic Processes

Score: 2 = Moderate Impacts

J. effusus was assigned a score of 2 in the "Impacts to Biotic and Abiotic Processes" due to potential impacts on soil nutrient cycling. Recent studies on Irish peatlands indicate that *J. effusus* thickets may significantly increase the amount of methane discharged from the soil and add layers of debris that are slow to decompose, thereby drying out the rooting zone by increasing the distance between the bog surface and the water table (Henneberg et al. 2015). While European peatlands and Hawaiian bogs are likely too dissimilar to compare directly, this nonetheless indicates that an uncontrolled *J. effusus* invasion is a risk to natural soil carbon and hydrological cycling. Although a dense invasion affecting hydrology would undoubtedly cause permanent impacts (indicative of a Major impact = 3), these changes would likely take many years to occur. However, hydrological impacts may be expedited by climate change.

TOTAL INVASIVE IMPACTS SCORE: 7

Feasibility of Control Score

Feasibility of Control Scoring and rationale for *C. grandis* 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 *J. effusus* was given a score of 2 because the infestation is currently documented along a large portion of trail and terrain may be steep in some areas. Furthermore, the presence of one mature *J. effusus* occurrence in open bog habitat (ideal habitat) indicates that transects should be conducted within adjacent sedge-dominated bogs. Additionally, further surveys are necessary in North Bog and Kanaele bog. Some training is necessary to prevent people from confusing *J. effusus* with *Carex montis-eeka*, a native sedge.

Initial control:

Score: 3 = Minimal Effort

Feasibility of initial control for *J. effusus* was given a score of 3 because the majority of occurrences have already been treated by KRCP. Additionally, a number of different herbicides are effective on *J. effusus* (Rana and Sellers 2009). A recent survey of areas treated by KRCP 4 weeks prior using 3% Aquamaster revealed about 98% die back (Figure C28- 3). Treatment of the densest patch (250m from Pihea Peak) resulted in approximately 50% die back (Figure C28- 4).

Figure C28- 3. Photo of *J. effusus* 4 weeks after treatment with foliar herbicide by KRCP.

Figure C28- 4. Photo of the densest patch after application of foliar herbicide showing approximately 50% die back.

Monitoring:

Score: 1 = Substantial Effort

Feasibility of monitoring for *J. effusus* was given a score of 1 because a substantial amount of time is needed to commute from the KISC base yard, small plants are difficult to detect and may escape treatment, and the seed bank persists for over 10 years.

FEASIBILTY OF CONTROL SCORE: 6

COMBINED SCORE: 7 + 6 = 13

Literature Cited

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Williams and Brock 2015. Please see monograph attached.