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May 20, 2022

To: Advisory Committee on Plants and Animals

From: Matthew Tracy Johnson, Ph.D.
United States Department of Agriculture, Forest Service

Through: Christopher Kishimoto
Entomologist
Plant Quarantine Branch
Hawaii Department of Agriculture

Subject: Request to: (1) Preliminarily Review the Currently Unlisted Moth, *Euselasia chrysippe* (Lepidoptera: Riodinidae) for Future Placement on the List of Restricted Animals (Part A) As a Biocontrol Agent of *Miconia calvescens* by the United States Department of Agriculture Forest Service (USDA FS);

(2) Determine If the Release of the Moth *Euselasia chrysippe,* as a Biocontrol Agent of *Miconia calvescens,* by the USDA FS Poses No Significant Impact on the Environment;

(3) Provided the Moth, *Euselasia chrysippe* is Placed on the List of Restricted Animals (Part A), Allow the Release from Laboratory Quarantine of the Moth, *Euselasia chrysippe*, by Permit, For Biocontrol of *Miconia calvescens* by USDA FS.

(4) Provided the Moth *Euselasia chrysippe* is Placed on the List of Restricted Animals (Part A), Allow the Importation and Release of *Euselasia chrysippe*, by Permit, For Biocontrol of *Miconia calvescens,* by the USDA FS; and

(5) Provided the Moth *Euslasia chrysippe* is Placed on the List of Restricted Animals (Part A), Establish Permit Conditions For the Importation and Release of *Euselasia chrysippe* As a Biocontrol Agent of *Miconia calvescens,* by the USDA FS.

I. Summary Description of the Request

PQB NOTES: *The Plant Quarantine Branch (PQB) submittal for requests for import or possession permits, as revised, distinguishes information provided by the applicant, Dr. Matthew Tracy Johnson, from procedural information and advisory comment and evaluation presented by PQB. With the exception of PQB notes, hereafter "PQB NOTES," the text shown below in section III from page 4 through page 11 of the submittal was taken directly from the applicant's application and subsequent written communications provided by the applicant. For instance, the statements on pages 7 through 9 regarding effects on the environment are the applicant's statements in response to standard PQB questions and are not PQB's statements. This approach for PQB submittals aims for greater applicant participation in presenting import requests in order to move these requests to the Board of Agriculture (Board) more quickly, while distinguishing applicant provided information from PQB information. The portion of the submittal prepared by PQB, including the procedural background, summary of proposed list additions, environmental assessment, advisory review, and proposed permit conditions, are identified as sections II, IV, V, VI, and VII of the submittal, which starts at pages 3, middle of page 11, end of page 11, 12, and 16 respectively.*

COMMODITY: Various shipments of the moth *Euselasia chrysippe* (Lepidoptera: Riodinidae)

SHIPPER: Dr. Paul Hanson
Universidad de Costa Rica
Montes de Oca
San Pedro, San Jose
Costa Rica

IMPORTER: Dr. Matthew Tracy Johnson
Institute of Pacific Island Forestry
USDA Forest Service, Pacific Southwest Research Station
P.O. Box 236
Volcano, HI 96785

CATEGORY: *Euselasia chrysippe* is currently an unlisted animal. Animals not found on any list are considered prohibited until placed on a list. Additionally, Chapter 4-71, Hawaii Administrative Rules (HAR), allows importation of unlisted animals into Hawaii under special permit for the purpose of remediating medical emergencies or ecological disasters, or conducting scientific research that is not detrimental to agriculture, the environment, or humans by special permit on a case-by-case basis as approved by the Board.

PQB NOTES: *The applicant is requesting that the Board place Euselasia chrysippe on the List of Restricted Animals (Part A) for import and release as biological control of Miconia calvescens, a state listed, noxious weed.*

Euselasia chrysippe was originally brought into the Hawaii Volcanoes National Park Quarantine Facility from Costa Rica in 2012 for biocontrol research and host range testing.

In April 2020, a draft environmental assessment was submitted to the Office of Environmental Quality Control (OEQC) with an Anticipated Finding of No Significant Impact. The draft was published in OEQC's Environmental Notice on April 23, 2020 (See Attachment 2).

II. Procedural Background

USDA FS has requested that one of the lists in Chapter 4-71, Hawaii Administrative Rules (HAR), be amended to include the moth, *Euselasia chrysippe.* The species may be placed on the List of Conditionally Approved Animals, List of Restricted Animals (Part A or B), or the Prohibited List. Species on the Restricted and Conditionally Approved Lists may enter the State of Hawaii under permit with conditions approved by the Board. Until placement on a list, species are considered prohibited except as provided by Section 150A-6.2(c), Hawaii Revised Statutes (HRS).

Species on the List of Restricted Animals (Part A) are available for research by universities and government agencies, exhibition in municipal zoos and government-affiliated aquariums, and for other institutions for medical and scientific purposes as determined by the Board. All species listed for import require a permit for entry into the State. Based on the Board's decision, species preliminarily reviewed for future list placement on a specific list will be compiled in-house for a future rule amendment. The Board's action to preliminarily list a species for future placement on a list has no legal effect in terms of allowing importation. This procedure is solely for administrative ease in preparation for amendments to the various lists.

Provided the Board acts favorably on this request for future list placement, at a future date, the proposed amendments will be brought to the Board for preliminary approval to go to public hearings. A species is listed in the rules only after: (1) following Chapter 91, HRS, rulemaking procedures, which include the public hearing process, Board adoption, and Governor's approval: or (2) alternatively, the expedited amendment procedure through Board orders, which involves an abbreviated process available in certain circumstances. Generally speaking, once a species has been placed on a

respective list, it is eligible for import and/or possession. PQB can then process a permit application by having the Board approve the future importation and establishment of appropriate permit conditions for the organism and proposed purpose.

III. Information Provided by the Applicant in Support of the Application

PURPOSE:

The Hawai‘i Department of Agriculture and the Hawai‘i Department of Land and Natural Resources propose the field release on State lands in Hawai‘i of *Euselasia chrysippe* (Lepidoptera: Riodinidae), the golden sombermark butterfly, for biological control of miconia, *Miconia calvescens* (Melastomataceae), a state listed noxious weed. Miconia is considered one of Hawai’i’s most invasive plants, whose exceptionally large leaves shade and outcompete other species, effectively forming a monoculture. Uncontrolled growth can overwhelm highly diverse native wet forest ecosystems that are home to critically endangered species and essential to our freshwater resources. Despite major efforts using chemical control, this species continues to proliferate, particularly on Maui and Hawai‘i Islands. *E. chrysippe* is a natural herbivore of miconia in it‘s native range, whose larvae feed in large numbers on miconia leaves. Extensive testing has shown *E. chrysippe* to be host-specific to miconia and other closely related members of the Melastomataceae family, all of which are non-native weeds in Hawai‘i. Because *E. chrysippe* is limited to feeding on a small pool of closely related non-native weeds, and with its potential to provide control on miconia, its release is expected to be beneficial to the state’s forests and hydrology, and adverse effects are expected to be negligible.

DISCUSSION:

1. Person Responsible:

Dr. Matthew Tracy Johnson, Institute of Pacific Island Forestry**,** USDA FS, Pacific Southwest Research Station**,** Mailing address: P.O. Box 236, Volcano, HI 96785.

2. Safeguard Facility and Practices:

Initial quarantine will be at the USDA Forest Service, Hawaii Volcanoes National Park Quarantine Facility, Kilauea Research Station, Building 34. The *Euselasia chrysippe* colony will originate from insects collected from Costa Rica and shipped under USDA Plant Protection and Quarantine permit P526P-20-02009 to the Volcano quarantine facility, for rearing and screening to eliminate associated natural enemies. Dr. Tracy Johnson will positively identify the insects and determine them to be free of natural enemies in preparation for release.

3. Method of Disposition:

Roughly 300 insects at a time will be removed from quarantine as mature pupae ready to emerge as adult butterflies, independent of host plant material and other potential contaminants. Any unused material from the quarantine facility will be autoclaved on site. Butterflies will be released into patches of miconia where their behavior, survival and reproduction can be monitored. Offspring from initial environmental releases will be collected and screened, then used for further releases statewide.

4. Abstract of Organism:

The proposed biocontrol agent is *Euselasia chrysippe* (Lepidoptera: Riodinidae), the golden sombermark butterfly. The insect is native to Central America, where larvae form large cohorts on leaves and are herbivores of a narrow group of plants.

Taxonomy: *Euselasia chrysippe* (Bates 1866) is classified under the family Riodinidae, or metalmark butterflies, in the subfamily Euselasiinae. Euselasiinae is restricted to the subtropics and contains five genera; all except *Euselasia* contain few taxa. *Euselasia*, by contrast, contains around 170 described species.

Description of Adults: Males of this species have a reddish-orange discal area on the upper surface of wings, whereas females are yellowish-orange. Both sexes have 5–7 black spots along the margins on the underside of the hindwings (Nishida 2010).

Description of Larvae:
The caterpillars of each cohort develop through six instars. Description of sixth instar from Nishida (2010): The sixth instar *Euselasia chrysippe* is greenish-dark-gray to greenish-dull black; the head capsule width is ca. 1.65 mm; the color of the head is bright orange, black, or a mixture of these two; arrowhead setae are cone-shaped (not flattened), ridged, and spiraled apically; the curvature of the ventral margin of the labrum is narrowly angled (ca. 110°); the mandible is small (0.38 mm wide), with the dentation less distinct than in *E. bettina*, and the extension of the fifth tooth is somewhat widened at edge; the T1 shield is orange to bright orange and without iridescence; the pinacula on the dorsum have a pale-gray oval line; the iridescence on structural color plates is faint metallic-blue; a proleg on A10 has 11–13 crochets in mesoseries.

Distribution: The native range of *E. chrysippe* extends from southern Mexico to Colombia (DeVries 1997) and its elevational range starts at sea level and extends up to 1,500 meters (Nishida 2010). In Costa Rica, it is found on the Caribbean and Pacific slopes in primary and secondary rain forests (Allen 2012; Nishida 2010). Caterpillars and eggs of *E. chrysippe* have been collected only from plants in the family Melastomataceae, specifically several species within the genus *Miconia* and *Conostegia rufescens* (Nishida 2010).

Life History: In captive rearing conditions, the duration of the *E. chrysippe* life cycle from egg to emergence of the adult butterfly from the pupa is approximately 8 weeks. Both male and female adults have been shown to live for longer than a month (Nishida 2010). The caterpillars have six instars that feed and rest as a group, primarily on the undersides of fully opened leaves of their host, moving from leaf to leaf, ultimately consuming the equivalent of one whole leaf (Johnson 2010). As with all known members of the tribe Euselasiini, *E. chrysippe* caterpillars hatch, feed, rest, molt, and pupate together in a single sibling cohort of up to 100 individuals (Allen 2010; Nishida 2010). This gregarious behavior is thought to assist the species with feeding on tough leaves, which optimizes foraging. In addition, traveling as a large group provides a defense against predation and may contribute to the low parasitism rates on this species observed in their home range (Allen 2010).

Recorded host plants for the genus *Euselasia* include members of Euphorbiaceae, Clusiaceae, Myrtaceae, Melastomataceae, Sapotaceae, and Vochysiaceae; however, caterpillars and eggs of *E. chrysippe* have only been collected from the family Melastomataceae, specifically *Miconia calvescens, M. impetiolaris, M. trinervia, M. elata, M. appendiculata, M. donaena, M. longifolia,* and *Conostegia rufescens* (Nishida 2010). Preliminary no-choice host tests conducted by Nishida (2010) found that larvae collected from *M. impetiolaris* would feed on *Conostegia xalapensis* and *M. calvescens* (Melastomataceae) but exhibited no feeding on two *Eucalyptus* spp., *Eugenia truncata*, and *Psidium guajava* (Myrtaceae) or *Clusia flava* (Clusiaceae).

Natural Enemies: A factor commonly affecting lepidopteran insects introduced for weed biocontrol in Hawai‘i is parasitism by various insects previously introduced accidentally, or purposefully for biocontrol of lepidopteran pests. Reported parasitoids of the genus *Euselasia* include species of Chalcididae, Ichneumonidae, Trichogrammatidae (all in Hymenoptera), and Tachinidae (Diptera) (Nishida 2010). Fortunately, the known parasites of *E. chrysippe* do not occur in Hawaii: one egg parasitoid (*Encarsia* cf. *porteri* (Hymenoptera: Ahelinidae)) and two genera of solitary tachinid parasitoids that attack large larvae and emerge from pupae have been recorded in Costa Rica (Nishida 2010). Species in the subfamily Riodininae

do not share the usual parasitoids of Lepidoptera (Hanson et al. 2010), and no members of this family are native or have been introduced to Hawai‘i (Nishida 2002), which further reduces the chance that a specialized parasite of *E. chrysippe* currently exists here.

Generalist predators, however, might significantly impact the immature stages of *E. chrysippe*, which remain exposed on plants throughout their development. In particular, the long development time for eggs means that stage is vulnerable for an extended period. In Costa Rica, *E. chrysippe* eggs were preyed upon by ants, and larvae by hemipteran predators and vespid wasps (Allen 2012).

Effect on Target Weed: *Euselasia chrysippe* was selected as a biocontrol for miconia in Hawai‘i because its gregariously feeding larvae can cause substantial damage to leaves. In Costa Rica its eggs and larvae are found on a wide range of sizes of *Miconia* trees, from saplings less than 1m tall to large mature trees. When reared on potted plants, a cohort of 60–80 larvae will consume several hundred square centimeters of leaf tissue – equivalent to the area of one average-sized leaf (Puliafico et al. 2015). Damage is typically distributed across several leaves because larvae move to new feeding areas between meals. Small larvae feed on the under surface of leaves, creating windowing damage, while the later stages feed through the whole leaf lamina. Damage also includes removal of portions of uneaten leaves, presumably to reduce detection by natural enemies.

Although extensive defoliation by *E. chrysippe* is not observed in Costa Rica, its populations are presumed to be limited by natural enemies there. If introduced to Hawai‘i, population growth is expected to be less constrained by enemies, allowing numbers of *E. chrysippe* to increase to levels sufficiently high to cause substantial defoliation. Damage is unlikely to be severe enough to kill miconia trees, but repeated partial defoliations may reduce growth and reproduction of trees and enhance light levels for plants competing with miconia.

5. Potential Effects on the Environment and Health Effects:

The effect of the release of *E. Chrysippe* is predicted to be positive on the environment and health of Hawai‘i. Host specificity tests and observations in the insect’s native range clearly demonstrate that *E. chrysippe* is host-specific to a narrow subset of plants in the family Melastomataceae, all of which are invasive to Hawai‘i. Feeding by *E. chrysippe* is expected to reduce foliage and suppress vigor of miconia trees, allowing other species to persist and compete, to the long-term benefit of Hawai‘i’s forests and watersheds. Release of *E. chrysippe* is proposed

on all islands where miconia has established. Spread of the insect from initial release sites will occur both through natural dispersal and via artificial redistribution by land managers. It is expected that *E. chrysippe* will range statewide in all areas where miconia exists within a few years of release.

Observations in Native Range: In their native range, caterpillars and eggs of *E. chrysippe* have been collected only from the family Melastomataceae, specifically *Miconia calvescens, M. impetiolaris, M. trinervia, M. elata, M. appendiculata, M. donaena, M. longifolia,* and *Conostegia rufescens* (DeVries 1997; DeVries et al. 1992; Janzen and Hallwachs 2009; Nishida 2010). No-choice host tests conducted by Nishida (2010) found that larvae collected from *M. impetiolaris* would feed on *Conostegia xalapensis* and *M. calvescens* (Melastomataceae) but exhibited no feeding on two *Eucalyptus* spp., *Eugenia truncata*, and *Psidium guajava* (all Myrtaceae), or *Clusia flava* (Clusiaceae).

Host Specificity Testing: Host specificity tests with larvae of *E. chrysippe* were conducted from 2012-2014 in laboratories in Hawai‘i, at the Hawai‘i Volcanoes National Park Quarantine Facility, and in Costa Rica, at La Selva Biological Station. Larvae for tests were collected as eggs from several sites in Costa Rica on two of its host plants, *Miconia calvescens* and *Miconia impetiolaris*. An emphasis was placed on testing plants in the order Myrtales, specifically on species within the families Melastomataceae, Myrtaceae, Combretaceae, Lythraceae, and Onagraceae. Relationships within the Melastomataceae were based on Clausing and Renner (2001). In addition, species from more distantly related taxa but with economic, cultural, and/or ecological significance in Hawai‘i were selected based on input from the U.S. Fish and Wildlife Service, consultations with members of the agricultural community, and expert sources on native Hawaiian plants. In total, 73 species of plants from 19 families were examined for suitability as hosts for *E. chrysippe* (see attached summary of host specificity testing). No-choice tests, with cohorts of 5-10 larvae exposed to leaves of each plant species for 3 days in 90-mm petri dishes, were replicated 4-5 times. Further tests of a subset of melastomes were conducted over longer periods, on potted plants and in petri dishes with leaves replaced every few days, to determine if any are suitable for complete development of *E. chrysippe*.

Results of host specificity studies showed that among the 73 species tested, *E. chrysippe* larvae feed and survive primarily on *Miconia calvescens* and a few close relatives within the tribe Miconieae (see attached summary of host specificity testing). Very low levels of feeding occurred on a few plants in families outside of Melastomataceae, but in all cases, survival of the larvae past the 3-day mark on species in these families was extremely low, and none developed into larger

larvae. Among plants occurring in Hawai‘i, only two species other than *M. calvescens* experienced substantial levels of feeding: the melastomes *Clidemia hirta* and *Tetrazygia bicolor*, which have recently been found through genetic analyses to be better placed within the genus *Miconia* (Michelangeli et al. 2020).

No Melastomataceae are native to Hawai‘i, and nine of the 15 species naturalized in Hawai‘i have been declared state noxious weeds (Medeiros et al. 1997).

Studies have clearly demonstrated that *E. chrysippe* is host-specific to a narrow subset of Melastomataceae. Results of the host specificity studies are summarized below (Figures 5-7). Laboratory tests are consistent with field observations of *E. chrysippe* in Costa Rica, where eggs and larvae have been collected only from species of *Miconia* and *Conostegia rufescens*, a plant in the same tribe (Nishida 2010). A similar pattern of specificity holds for other species within the genus *Euselasia*. Across numerous studies in various parts of tropical America, *Euselasia* have been found to be narrowly host-specific, with each species specializing within a family of plants (Nishida 2010).

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IV. Summary of Proposed Additions to the List of Restricted Animals, Part A

The USDA FS permit application is requesting the following addition to the List of Restricted Animals (Part A) in Chapter 4-71, HAR:

§4-71-6.5, HAR, List of Restricted Animals (Part A)

Adds "Scientific Name: "Euselasia chrysippe" and Common Name "biocontrol, Miconia".

See Attachment 6 for proposed changes in Ramseyer Format. All other sections in Chapter 4-71, HAR will remain unchanged.

V. Environmental Assessment (EA):

Pursuant to a May 2008 Hawai'i Intermediate Court of Appeals decision ('Ohana Pale Ke Ao v. Board of Agriculture, 118 Haw. 247 (Haw. App. 2008), the Department of Agriculture's (Department's) import permit process is subject to the requirements of the Hawai'i Environmental Protection Act, chapter 343, Hawai'i Revised Statutes (HRS). Under this decision, the requirement for an EA as a condition of the import permit or related authorization applies in those circumstances where the underlying permit activity for the importation initiates a "program or project" and where the use of state or county funds or state or county lands is involved. When those circumstances are present, as they appear to be when a new organism is used in a new program or project located or taking place on state lands, an EA is required to determine whether the proposed project or program is likely to have a significant impact on the environment. However, certain activities may be eligible for "exemption" under provisions established through the Environmental Advisory Council, provided that the project or program is determined to have little or no impact on the environment.

Analysis of Application re EA: Under the above-cited court decision, the EA requirement is triggered under certain circumstances, including when an applicant proposes an action on state lands that requires agency approval and is not specifically exempted under Chapter 343, HRS. That is the case here. The applicant's request in this instance involves importation of *Euselasia chrysippe* for field-release research and biocontrol of *Miconia calvescens* in the environment. So, agency approval is required for the applicant's proposed action/activity on state lands or sensitive habitats. As PQB understands the court's analysis in the 'Ohana Pale decision, the activity proposed

under this permit application would initiate a project that may use state lands and/or sensitive habitats, initially triggering the EA requirement.

Dr. Johnson has submitted a Draft EA prepared by the Department of Land and Natural Resources with an Anticipated Finding of No Significant Impact, published in the Office of Environmental Quality Control's Environmental Notice on April 23, 2020 (See Attachment 2).

VI. Advisory Review

ADVISORY SUBCOMMITTEE REVIEW: This request was submitted to the Advisory Subcommittee on Entomology for its review and recommendation. Advisory Subcommittee recommendations and comments are as follows:

1. I recommend Approval ___/___Disapproval of future placement of the unlisted beetle, *Euselasia chrysippe* (Lepidoptera: Riodinidae) on the List of Restricted Animals (Part A) as a biocontrol agent for the noxious weed *Miconia calvescens*.

Dr. Peter Follett: Recommends Approval

Comments: "Miconia is a serious weed pest in Hawaii which can form monocultures on invaded land. This weed produces large numbers of seeds which can be dispersed by birds. Larvae of the lepidopteran biocontrol agent Euselasia chrysippe feed on miconia leaves. Results of host specificity testing in Hawaii and Costa Rica indicate that E. chrysippe is host specific to miconia and a few other melastomes, including Clidemia, another significant weed pest in Hawaii. There are no native melastomes and thus this biocontrol agent should pose no risk to native Hawaiian plants or the environment."

Dr. Daniel Rubinoff: Recommends Approval

Comments: "It shows great promise for being host specific and may help reduce miconia fecundity."

Dr. Jesse Eiben: Recommends Approval

Comments: "Host specificity and lack of biocontrol agents specific to the family in Hawaii leads to probable successful establishment and control of Melastome weeds."

Dr. Mark Wright: Recommends Approval

Comments: "The submitted materials show that this species is host specific on Melastomataceae, strongly preferring Miconia. While the larvae are not likely to cause Miconia plant death, they will reduce plant fitness and reduce leaf area, and thus reduce competitive impacts in forests."

Mr. Darcy Oishi: Recommends Approval

Comments: "*Euselasia chrysippe* for the control of *Miconia* is a partner project between the Hawaii Department of Agriculture Plant Pest Control Branch (PPC) and the US Forest Service per existing MOUs between the two agencies. As such, comments to the subcommittee, Advisory Committee on Plants and Animals, and the Board of Agriculture by myself or the entomologists of the PPC should be viewed as full partners on the project.

I recommend approval or future placement of *E. chrysippe* on the list of Restricted Animals Part A. Evaluations done in the native range and in containment indicate placement on the Restricted A list is both prudent and warranted to add to our tools for the management of *Miconia* in Hawaii."

2. I Agree___/___Disagree that the release of *Euselasia chrysippe* as a biocontrol agent of *Miconia calvescens* by the USDA FS poses no significant impact on the environment.

Dr. Peter Follett: Agree

Comments: "Studies indicate that release of E. chrysippe will be safe. Low risk was determined by host range testing in quarantine in Hawaii and host testing, literature, and observations in Costa Rica."

Dr. Daniel Rubinoff: Agree

Comments: "This is a VERY low risk release. There are very few butterflies that make significant host shifts, and out of the host plant family would be of negligible probability. The host range testing was more than adequate."

Dr. Jesse Eiben: Agree

Dr. Mark Wright: Agree

Comments: “The non-target screening data shows that no negative environmental impacts are expected.”

Mr. Darcy Oishi: Agree

Comments: Upon review of the material supplied by the applicant, there are no significant negative impacts on the environment once this insect becomes established in the environment.

3. Provided *Euselasia chrysippe* is placed on the List of Restricted Animals (Part A), I recommend Approval___/___Disapproval to Allow the importation and release of *Euselasia chrysippe*, by permit, for biological control of *Miconia calvescens by USDA FS*.

Dr. Peter Follett: Recommends Approval

Comments: “*E. chrysippe* will be collected in Costa Rica and shipped into quarantine in Hawaii. Paul Hanson, the cooperator in Costa Rica, is a taxonomist which reduces the chance of importation of contaminated material into Hawaii.”

Dr. Daniel Rubinoff: Recommends Approval

Dr. Jesse Eiben: Recommends Approval

Comments: “This should be expedited, the butterfly is an excellent candidate and as long as the stock imported is shown to be free of diseases and parasitoids – as the applicant has agreed, it poses no threat to the Hawaiian ecosystem.”

Dr. Mark Wright: Recommends Approval

Mr. Darcy Oishi: Recommends Approval

Comments: “As a partner project, I recommend this species for importation and release. Testing and evaluation has been very complete and well thought out. Dr. Johnson has a well-established track-record for biological control.”

4. Provided *Euselasia chrysippe* is placed on the List of Restricted Animals (Part A), I recommend Approval___/___Disapproval to establish permit conditions for the import and release of *Euselasia chrysippe* as a biocontrol agent of *Miconia calvescens* by USDA FS.

Dr. Peter Follett: Recommends Approval

Comments: “Handling of the biocontrol agent in quarantine and during field releases has been well thought out. I see negligible risk in this biocontrol project.”

Dr. Daniel Rubinoff: Recommends Approval

Comments: “As stated above, this butterfly provides an excellent opportunity to try and control noxious weeds. It doesn’t pose a threat to native Hawaiian ecosystems or agriculture.”

Dr. Jesse Eiben: Recommends Approval

Dr. Mark Wright: Recommends Approval

Comments: “Also see above comments; this species is very likely to be an environmentally safe and useful biological control agent of *M. calvescens*.”

Mr. Darcy Oishi: Recommends Approval

Comments: “The permit conditions presented here are consistent with permit conditions for a restricted article that is being imported and shipped from a source outside of Hawaii not with how biological control agents for classical biological control exist within the quarantine framework of Hawaii. Per 150A-5.5b, addresses what constitutes importation. The language states that importation of “articles quarantined in the biocontrol containment facilities of the department or other government agencies engaged in joint projects… may be released upon issuance of a permit approved by the board.” This statement therefore states IMPORTATION occurs when articles are removed from the biocontrol containment facilities with a permit from the Board of Agriculture. As such, this creates a conflict with permit conditions 5 which states screening will occur after importation. This means the insect will be outside of the bounds of the containment facility therefore negating the protection these facilities inherently offer to prevent unintentional impacts. This permit condition should be changed and reflect the need for screening prior to importation or release from the containment facility. Suggested language is “Upon entry into the state, the restricted article(s) shall be screened for other species, predators, parasites, parasitoids, or hyperparasitoids for a minimum of two generations in the USDA approved Insect Containment Facility, USDA FS, Hawaii Volcanoes National Park Quarantine Facility, Kilauea Research Station, Building 34, Volcano, HI 96718 prior to release from containment. A report shall be submitted to PQB

detailing the discovery of any organisms found other than the restricted article(s)" Note: as written, this will only allow screening to occur at the Volcano facility and does not include the potential to use the King St. Facility for screening and ultimately release.

Similarly, permit condition 11 is fraught with issues. HRS 150A-5.10 refers to specific ports by which entry into the state can be made. From a regulatory standpoint, biological control agents are inspected by APHIS PPQ as the first port of entry in the United States. Material is inspected by USDA at a Plant Inspection Station under permit. For Hawaii, this port of entry is at the Port of Honolulu. There can be exceptions if the first port of US entry is NOT Honolulu. However, permit condition 11, requires importation to be in the port of Honolulu. Entrance into the state and importation are two separate issues. Importation of a biocontrol agent could be removal from an approved containment facility or importation of material from other sources under permit which would mean importation and entrance would be the same. Limiting importation to the port of Honolulu creates a situation that is impractical and does not reflect reality. Requiring all shipments to ENTER through the port of Honolulu is do-able. The permit condition should be reframed to state: "All parcels containing the restricted article(s) shall be subject to inspection by the PQB prior to entering the State. Entry should be through the port of Honolulu as designated by the Board. Entry into Hawaii through another port is prohibited". This permit condition should also be listed as permit condition 5 as entrance occurs prior to importation and release."

PQB NOTE: *PQB has consulted with legal counsel and it has been determined that there is no requirement for Euselasia chrysippe to be transported back to Honolulu after the issuance of a permit.*

Permit condition #11 has been amended to comply with Chap. 150A-5.5(b).

VII. Proposed Permit Conditions

1. The restricted article(s), *Euselasia chrysippe*, which includes progeny, shall be used for field release and research, a purpose approved by the Board of Agriculture (Board), and shall not be sold, given away, or transferred in Hawaii, except as approved by the Board.

2. The permittee, Dr. Matthew Tracy Johnson, United States Department of Agriculture (USDA) Forest Service (FS), Hawaii Volcanoes National Park Quarantine Facility, Kilauea Research Station, Building 34, Volcano, HI 96718,

shall be responsible and accountable for all restricted article(s) imported, from the time of their arrival until their disposition.

3. The restricted article(s) shall be safeguarded and maintained at the USDA approved Insect Containment Facility, USDA FS, Hawaii Volcanoes National Park Quarantine Facility, Kilauea Research Station, Building 34, Volcano, HI 96718 or the Hawaii Department of Agriculture Plant Pest Control Branch Containment Facility, 1428 South King Street, Honolulu, Hawaii 96814, sites approved by the Plant Quarantine Branch (PQB), by trained or certified personnel designated by the permittee.

4. Upon request by the PQB, the permittee shall submit samples of the restricted article(s) prior to importation to the PQB.

5. Upon entry into a PQB approved containment facility, the restricted article(s) shall be screened for other species, predators, parasites, parasitoids, or hyperparasitoids for a minimum of two generations in the USDA approved Insect Containment Facility, USDA FS, Hawaii Volcanoes National Park Quarantine Facility, Kilauea Research Station, Building 34, Volcano, HI 96718 or the Hawaii Department of Agriculture Plant Pest Control Branch, 1428 South King Street, Honolulu, Hawaii 96814. A report shall be submitted to PQB detailing the discovery of any organisms found other than the restricted article(s).

6. In the event the restricted article(s) become parasitized or infected by disease, the permittee shall:

   a. Destroy the entire lot of the restricted article(s) by freezing;

   b. Autoclave all insects, dietary and ovipositional media; and

   c. Subject all used cages and equipment to autoclaving or treatment with a bleach solution containing at least 0.5% sodium hypochlorite concentration.

7. At least 48 hours prior to shipping any parcel containing the restricted article(s), the permittee shall notify the PQB chief in and provide the following information:

   a. Expected arrival date;

   b. Waybill, bill of lading, or tracking number;

   c. Name and address of the shipper;

d. Name and address of the importer or importer's agent in the State of Hawaii;

e. Number of packages;

f. Description of contents of each package (including scientific name); and

g. Port of entry into the State.

8. At least four sides of all parcels containing the restricted article(s) that are imported into the State shall be clearly and legibly marked: "**This parcel may be opened and delayed for agricultural inspection in Hawaii**." In 2-inch minimum sized font.

9. The restricted article(s) shall be shipped in sturdy PQB-approved containers designed to be escape-proof and leak-proof.

10. Each shipment of the restricted article(s) shall be accompanied by a complete copy of the PQB permit for the restricted article(s) and an invoice, packing list or other similar PQB approved document listing the scientific and common names of the restricted article(s), the quantity of the restricted article(s), the shipper, and the permittee(s) for the restricted article(s).

11. All parcels containing the restricted article(s) shall be subject to inspection by the PQB prior to entering the State and shall be imported through the port of Honolulu except as designated by the Board. Entry into Hawaii through another port is prohibited unless designated by the Board.

12. The approved site, restricted article(s), progeny, records, and any other documents pertaining to the restricted article(s) and progeny under this permit, may be subject to post-entry inspections by the HDOA PQB. The permittee shall make the site, restricted article(s), progeny, and records pertaining to the restricted article(s) available for inspection upon request by a PQB inspector.

13. Prior to release on each island, the applicant shall provide HDOA PQB and Plant Pest Control Branch the following:

a. Date and time of release.

b. Site of the release for each island.

c. Approximate number of individuals to be released.

d. Voucher specimens from the lab reared colony to be released into the Zoological Reference Collection housed at the HDOA Plant Pest Control Branch.

14. It is the responsibility of the permittee to comply with any applicable requirements of municipal, state, or federal law pertaining to the restricted article(s).

15. The permittee(s) shall submit to the PQB chief a copy of all valid licenses, permits, certificates or their equivalent required for the restricted article(s) or for their import, possession, movement, or transfer. The permit issued by the Plant Quarantine Branch chief may be cancelled upon revocation, suspension, or termination of any of the aforementioned documents.

16. The permittee shall submit an annual report to the PQB no later than January 31st of the following year, of the results of post release monitoring programs, that shall include the following:

    a. Amount of the restricted article(s) and number of releases for the year;

    b. Establishment and current field populations of the restricted article(s);

    c. Effect of the restricted article(s) on *Miconia calvescens*; and

    d. Effect of the restricted article(s) on native plant and animal species.

17. The permittee shall adhere to the use, facility, equipment, procedures, and safeguards described in the permit application, and as approved by the Board and the PQB Chief.

18. The permittee shall have a biosecurity manual available for review and approval by the PQB, at the time of the initial site inspection and any subsequent post-entry inspection(s), which identifies the practices and procedures to be adhered to by the permittee to minimize or eliminate the risk of theft, escape, or accidental release of the restricted article(s), including the risk of introduction and spread of diseases and pests associated with the restricted article(s) to the environment. The permittee shall adhere to all practices and procedures as stated in this biosecurity manual.

19. The permittee shall immediately notify the PQB Chief verbally and in writing under the following circumstances:

    a. If any escape, theft, accidental release, parasitoid, hyperparasitoid, or other

pest or disease outbreaks involving the restricted article(s) under this permit occurs.

b. Prior to any changes to the approved site, facility and/or procedures regarding the restricted article(s) are made, the permittee shall also submit a written report documenting the specific changes to the PQB Chief for approval.

c. If a shipment of the restricted article(s) is delivered to the permittee without a PQB "Passed" stamp, tag or label affixed to the article, container, or delivery order that indicates that the shipment has passed inspection and is allowed entry into the State, then the permittee shall not open or tamper with the shipment and shall secure, as evidence, all restricted article(s), shipping container(s), shipping document(s) and packing material(s) for PQB inspection.

d. If the permittee will no longer import or possess the restricted article(s) authorized under this permit.

20. The permittee shall be responsible for all costs, charges, or expenses incident to the inspection, treatment, or destruction of the restricted article(s) under this permit, as provided in Act 173, Session Laws of Hawaii 2010, section 13, including, if applicable, charges for overtime wages, fixed charges for personnel services, and meals.

21. Any violation of the permit conditions may result in citation, permit cancelation, and enforcement of any or all of the penalties set forth in HRS §150A-14.

22. A cancelled permit is invalid and upon written notification from the PQB Chief, all restricted article(s) listed on the permit shall not be imported. In the event of permit cancelation, any restricted article(s) imported under permit may be moved, seized, treated, quarantined, destroyed, or sent out of State at the discretion of the PQB Chief. Any expense or loss in connection therewith shall be borne by the permittee.

23. This permit or conditions of this permit are subject to cancellation or amendment at any time due to changes in administrative rules restricting or disallowing import of the restricted article(s) or due to Board of Agriculture action disallowing a previously permitted use of the restricted article(s).

24. These permit conditions are subject to amendment by the PQB Chief in the following circumstances:

a. To require disease screening, quarantine measures, and/or to place restrictions on the intrastate movement of the restricted article(s), as appropriate, based on scientifically validated risks associated with the restricted article(s), as determined by the PQB Chief, to prevent the introduction or spread of disease(s) and/or pests associated with the restricted article(s); or

b. To conform to more recent Board approved permit conditions for the restricted article(s), as necessary to address scientifically validated risks associated with the restricted article(s).

25. The permittee shall agree in advance to defend and indemnify the State of Hawaii, its officers, agents and employees for any and all claims against the State of Hawaii, its officers, agents, employees, or Board of Agriculture members that may arise from or be attributable to any of the restricted article(s) that are introduced under this permit. This permit condition shall not apply to a permittee that is a federal or State of Hawaii entity or employee, provided that the State or federal employee is a permittee in the employee's official capacity.

ADVISORY COMMITTEE REVIEW: May we request your recommendation and comments at the next meeting of the Advisory Committee on Plants and Animals.

State of Hawaii
Department of Agriculture
PLANT QUARANTINE BRANCH
1849 Auiki Street, Honolulu, HI 96819-3100
Phone: (808) 832-0566, FAX: (808) 832-0584

For Office Use Only

Fee: $_____ Receipt No. _____

☐ Approve Permit No._____ Date: _____

☐ Disapprove ☐Other _____

Processed by: _____ Date: _____

PERMIT APPLICATION FOR RESTRICTED COMMODITIES INTO HAWAII

Date: *June 15, 2021*

In accordance with the provision of Chapter 342, Hawaii Administrative Rules of the Division of Plant Industry, Department of Agriculture, a permit is requested for the following commodities:

Please type or print clearly.

Quantity	Commodity	Scientific Name
3000	leaf-eating butterfly for biological control of miconia	Euselasia chrysippe

RECEIVED
AUG 11 2021
PLANT QUARANTINE BRANCH

NO PAYMENT
Amount: Chk:
Date: 8/11/21 Initial: TSY

Name and address of shipper: USDA Forest Service, Hawaii Volcanoes National Park Quarantine Facility
Original source: P. Hanson, Universidad de Costa Rica, Montes de Oca, San Jose, Costa Rica
(Mainland or Foreign address)

Approximate date of arrival: _____

Mode of Shipment: ☐ Mail ☐ Air Freight ☐ Boat

Type of Permit:
--- Import
☐ one time only ☑ multi-shipments
--- Intrastate shipment
☐ one time only ☑ multi-shipments
☐ Possession

Object of importation:
☐ Kept caged at all time
☐ Used for propagation
☐ Imported for exhibition
☑ Imported for liberation
☐ Other purposes - specify field release of biocontrol agent from quarantine facility

Please type or print clearly.

Applicant's Name M. Tracy Johnson

Company Name USDA Forest Service (if applicable)

Hawaii Mailing Address PO Box 236
Volcano HI 96785

Telephone number 808-967-7122

Facsimile number 808-967-7158

Fee Amount Enclosed (cash, check or mail order) $_____

(complete reverse side)

PLEASE COMPLETE THE FOLLOWING INFORMATION (attach extra sheet if necessary)

1. State in detail the reasons for introduction (include use or purpose).

Euselasia chrysippe from Costa Rica has been evaluated as a biological control for managing invasive miconia in Hawaii. It is a narrowly host-specific leaf-feeding butterfly whose caterpillars are expected to reduce miconia foliage without affecting any native or otherwise valued plants. Suppression of miconia will benefit forest watersheds statewide. See attached biological summary.

2. Person responsible for the organism (include name, address and phone number).

Dr. M. Tracy Johnson
Institute of Pacific Islands Forestry
USDA Forest Service, Pacific Southwest Research Station
P.O. Box 236
Volcano, HI 96785
tel: 808-967-7122

3. Location(s) where the organism will be kept and used (include address, contact and phone number).

USDA Forest Service, Hawaii Volcanoes National Park, Magma House, Bldg 34
M. Tracy Johnson 808-967-7122

Hawaii Dept of Agriculture, Plant Pest Control Branch, Biocontrol Section
16 E. Lanikaula Street, Hilo; 1428 S. King Street, Honolulu
Stacey Chun 808-974-4140; Darcy Oishi 808-973-9524

4. Method of disposition.

Euselasia chrysippe shipped as eggs from San Jose, Costa Rica, will be released into the environment as adults after screening to eliminate associated natural enemies at the Hawaii Volcanoes National Park Quarantine Facility. Roughly 300 insects at a time will be removed from quarantine as mature pupae ready to emerge as adult butterflies, independent of host plant material and other potential contaminants. Butterflies will be released into patches of miconia where their behavior, survival and reproduction can be monitored. Offspring from initial environmental releases will be collected and screened, then used for further releases statewide.

5. Give an abstract of the organism with particular reference to potential impact on the environment of Hawaii (include impact to plants, animals and humans).

Euselasia chrysippe is a butterfly native to Costa Rica, where its caterpillars feed gregariously on leaves of several species of Miconia. Extensive testing has shown E. chrysippe to be host-specific to miconia and other closely related members of the melastome family, all of which are non-native weeds in Hawai'i. Because E. chrysippe is limited to feeding on a small pool of closely related species, all of which are invasive, its release is expected to be beneficial to Hawai'i's forests and hydrology, and adverse effects are expected to be negligible.

****

I request permission to import the articles as listed on the permit application and further, request that the articles be examined by an authorized agent of the Department of Agriculture upon arrival in Hawaii.

I agree that I, as the importer, will be responsible for all costs, charges or expenses incident to the inspection or treatment of the imported articles.

I further agree that damages or losses incident to the inspection or the fumigation, disinfection, quarantine, or destruction of the articles, by an authorized agent of the Department of Agriculture, shall not be the basis of a claim against the department or the inspectors for the damage or loss incurred.

Signature _____ **Date** 6/22/21
(Applicant)

ATTACHMENT 2

DAVID Y. IGE
Governor

JOSH GREEN
Lt. Governor

PHYLLIS SHIMABUKURO-GEISER
Chairperson, Board of Agriculture

MORRIS M. ATTA
Deputy to the Chairperson

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 South King Street
Honolulu, Hawaii 96814-2512
Phone: (808) 973-9600 FAX: (808) 973-9613

April 16, 2020

Director
Office of Environmental Quality Control
Department of Health, State of Hawaii
235 S. Beretania Street, Room 702
Honolulu, Hawaii 96813

Dear Director:

With this letter, the Hawaii Department Agriculture hereby transmits the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) for the Proposed Statewide Field Release of *Euselasia chrysippe* (Lepidoptera: Riodinidae) for Biological Control of Miconia, *Miconia calvescens* (Melastomataceae), for publication in the next available edition of The Environmental Notice.

Enclosed is a completed OEQC Publication Form, two copies of the DEA-AFONSI, an Adobe Acrobat PDF file of the same, and an electronic copy of the publication form in MS Word. Simultaneous with this letter, we have submitted the summary of the action in a text file by electronic mail to your office.

If there are any questions, please contact Christopher Kishimoto, Plant Quarantine Branch Entomologist at: (808) 832-0566 or Christopher.M.Kishimoto@hawaii.gov

Sincerely,

Jonathan Ho
Acting Manager
Plant Quarantine Branch

Enclosures:

1. OEQC Publication Form (Agency)
2. Draft Environmental Assessment for Field Release of *Euselasia chrysippe* (Lepidoptera: Riodinidae) for Biological Control of Miconia, *Miconia calvescens* (Melastomataceae), in Hawai'i

AGENCY
PUBLICATION FORM

Project Name:	Field Release of *Euselasia chrysippe* (Lepidotera: Riodinidae) for Biological Control of Miconia, *Miconia calvescens* (Melastomataceae), in Hawaii
Project Short Name:	Miconia Biological Control DEA
HRS §343-5 Trigger(s):	(1) Propose the use of state or county lands or the use of state or county funds
Island(s):	Statewide
Judicial District(s):	N/A – Statewide
TMK(s):	N/A
Permit(s)/Approval(s):	USDA-APHIS-PPQ and Board of Agriculture (HDOA Plant Quarantine Branch)
Proposing/Determining Agency:	State of Hawai'i Department of Agriculture
Contact Name, Email, Telephone, Address	Christopher Kishimoto; christopher.m.kishimoto@hawaii.gov; (808) 832-0566; 1849 Auiki Street, Honolulu, Hawai'i 96819
Accepting Authority:	(for EIS submittals only)
Contact Name, Email, Telephone, Address	
Consultant:	SWCA Environmental Consultants
Contact Name, Email, Telephone, Address	Danielle Frohlich; DFrohlich@swca.com ; (808) 548-7922; 307a Kamani Street Honolulu, Hawai'i 96813

Status (select one)	**Submittal Requirements**
__X__ DEA-AFNSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
____ FEA-FONSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
____ Act 172-12 EISPN ("Direct to EIS")	Submit 1) the proposing agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.
____ DEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.
____ FEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEIS, 4) a searchable PDF of the FEIS, and 5) a searchable PDF of the distribution list; no comment period follows from publication in the Notice.
____ FEIS Acceptance Determination	The accepting authority simultaneously transmits to both the OEQC and the proposing agency a letter of its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS; no comment period ensues upon publication in the Notice.
FEIS Statutory Acceptance	Timely statutory acceptance of the FEIS under Section 343-5(c), HRS, is not applicable to agency actions.
____ Supplemental EIS Determination	The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and

determines that a supplemental EIS is or is not required; no EA is required and no comment period ensues upon publication in the Notice.

____ Withdrawal Identify the specific document(s) to withdraw and explain in the project summary section.

____ Other Contact the OEQC if your action is not one of the above items.

Project Summary

Provide a description of the proposed action and purpose and need in 200 words or less.

The HDOA with support from the Hawai‘i Department of Land and Natural Resources proposes the field release of a small butterfly, *Euselasia chrysippe*, for biological control of the noxious weed *Miconia calvescens*.

Miconia calvescens, a fast-growing tree in the melastome family (Melastomataceae), is a major threat to forest ecosystems in Hawai‘i. Native to Central and South America, miconia is considered one of Hawai’i’s most invasive plants. With its exceptionally large leaves, it shades and outcompetes other species, effectively forming a monoculture. Uncontrolled growth can overwhelm highly diverse native wet forest ecosystems that are home to critically endangered species and essential to our freshwater resources.

Euselasia chrysippe is a natural herbivore of miconia in the plant’s native range of Costa Rica whose caterpillars feed externally on the leaves of several species of *Miconia*. Extensive testing has shown *E. chrysippe* to be host-specific to miconia and other closely related members of the melastome family, all of which are non-native weeds in Hawai‘i. Because *E. chrysippe* is limited to feeding on a small pool of closely related species, all of which are invasive, its release is expected to be beneficial to Hawai‘i’s forests and hydrology, and adverse effects are expected to be negligible.

Draft Environmental Assessment

Field Release of *Euselasia chrysippe* (Lepidoptera: Riodinidae) for Biological Control of Miconia, *Miconia calvescens* (Melastomataceae), in Hawai‘i

Prepared For:

Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl St., Room 325
Honolulu, Hawai‘i 96813

Prepared By:

SWCA Environmental Consultants

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

April 2020

PROJECT SUMMARY

Project Name: Field Release of *Euselasia chrysippe* (Lepidoptera: Riodinidae) for Biological Control of Miconia, *Miconia calvescens* (Melastomataceae), in Hawai‘i

Proposing Agency: Department of Agriculture
State of Hawai‘i

Project Location: Statewide

Property Owner: State of Hawai‘i

State Land Use Classification: Not Applicable

Agency Determination: Anticipated Finding of No Significant Impact (AFNSI)

Agencies, Organizations, and Other Stakeholders Consulted:

FEDERAL AGENCIES

- U.S. House of Representatives, Representative Tulsi Gabbard
- U.S. House of Representatives, Representative Colleen Hanabusa
- U.S. Senate, Senator Mazie Hirono
- U.S. Senate, Senator Brian Schatz
- National Park Service, Hawai‘i Volcanoes National Park
- National Park Service, Haleakalā National Park
- Natural Resources Conservation Service, Pacific Islands Area
- U.S. Army Garrison, Commander Col. Stephen E. Dawson
- U.S. Army Garrison, Environmental Division
- U.S. Army Garrison, Natural Resource Section
- U.S. Fish and Wildlife Service
- U.S. Fish and Wildlife Service, O‘ahu National Wildlife Refuge Complex
- U.S. Geological Survey, Pacific Island Ecosystems Research Center

STATE AGENCIES

- Aha Moku Councils
- Department of Business, Economic Development & Tourism
- Department of Hawaiian Homelands
- Department of Health
- Department of Health, Office of Environmental Quality Control
- DLNR Division of State Parks
- DLNR Land Division
- DLNR Office of Conservation and Coastal Lands
- DLNR State Historic Preservation Administration
- HDOA Plant Pest Control

- HDOA Plant Quarantine
- Land Use Commission
- Office of the Governor
- Office of Hawaiian Affairs
- University of Hawai‘i, College of Tropical Agriculture and Human Resources
- University of Hawai‘i, Environmental Center
- University of Hawai‘i, Pacific Cooperative Studies Unit

CITY AND COUNTY AGENCIES

- Honolulu City Council
- City and County of Honolulu, Office of the Mayor
- City and County of Honolulu, Board of Water Supply
- City and County of Honolulu, Department of Planning and Permitting
- Hawai‘i County Council
- Hawai‘i County, Office of the Mayor
- Hawai‘i County, Department of Water Supply
- Hawai‘i County, Department of Planning
- Kaua‘i County Council
- Kaua‘i County, Office of the Mayor
- Kaua‘i County, Department of Planning
- Kaua‘i County, Department of Water Supply
- Maui County Council
- Maui County Office of the Mayor
- Maui County, Department of Planning
- Maui County, Department of Water Supply

ORGANIZATIONS

- Big Island Invasive Species Committee
- Bishop Museum
- Conservation Council of Hawai‘i
- Environment Hawai‘i Inc.
- Hawai‘i Audubon Society
- Hawai‘i Cattlemen’s Council
- Hawai‘i Conservation Alliance
- Hawai‘i Forest and Trail
- Hawai‘i Forest Industry Association
- Hawaiian Botanical Society
- Hawaiian Trail and Mountain Club
- KAHEA
- Kamehameha Schools

- Kauaʻi Invasive Species Committee
- Koʻolau Mountains Watershed Partnership
- Maui Invasive Species Committee
- Molokaʻi Invasive Species Committee
- Native Hawaiian Advisory Council
- Native Hawaiian Legal Corporation
- Oʻahu Invasive Species Committee
- Pig Hunters Association of Oʻahu
- Plant Extinction Prevention Program
- Sierra Club, Oʻahu Chapter
- The Nature Conservancy of Hawaiʻi

CONTENTS

APPENDICES

FIGURES

TABLES

Acronyms and Abbreviations

AFNSI	Anticipated Finding of No Significant Impact
DEA	Draft Environmental Assessment
DLNR	State of Hawai‘i Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
FAP	Forest Action Plan
HDOA	State of Hawai‘i Department of Agriculture
HIBP	Hawai‘i Interagency Biosecurity Plan
HRS	Hawai‘i Revised Statutes
SWAP	State Wildlife Action Plan
USDA	U.S. Department of Agriculture

PROJECT SUMMARY DESCRIPTION

The Hawai‘i Department of Agriculture and the Hawai‘i Department of Land and Natural Resources propose the field release on State lands in Hawai‘i of a butterfly with gregarious larvae, *Euselasia chrysippe* (Lepidoptera: Riodinidae), for biological control of miconia, *Miconia calvescens* (Melastomataceae).

Miconia is a Hawai‘i State noxious weed, native to Central and South America - from Mexico to Argentina. In Hawai‘i, large infestations exist on the islands of Hawai‘i and Maui, and populations can also be found on Kaua‘i and O‘ahu. Miconia is shade-tolerant, growing and establishing in the understory of mesic to wet forests. With its exceptionally large leaves, it shades and outcompetes other species, effectively forming a monoculture.

Euselasia chrysippe is a natural herbivore of miconia in the plant’s native range in Costa Rica. Among the leaf-feeding natural enemies of miconia, *E. chrysippe* was found the most promising for biocontrol because its larvae feed together in groups, causing more damage to miconia leaves. This gregarious behavior also may improve its defense against parasitoids of lepidopteran species already present in Hawai‘i. Extensive testing has shown *E. chrysippe* to be host-specific to miconia and other closely related members of the Melastomataceae family, all of which are non-native weeds in Hawai‘i.

Release of *E. chrysippe* is currently proposed for State lands on all islands where miconia has established. Spread of the insect from initial release sites will occur both through natural dispersal and via artificial redistribution by land managers. It is expected that *E. chrysippe* will range statewide in all areas where miconia exists within a few years of release. State and federal land management agencies will closely monitor the effectiveness of the biocontrol release.

The proposed action requires a Plant Protection and Quarantine permit from the U.S. Department of Agriculture, Animal and Plant Health Inspection Service; a permit for import and liberation of restricted organisms from the Hawai‘i Department of Agriculture, Plant Quarantine Branch; and a permit for release and monitoring of the insect on State forest land from the Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife.

An alternative to the proposed action considered in this assessment is no action. Under this alternative, *E. chrysippe* would not be released on State forest land, and management of miconia would be limited to currently existing mechanical and chemical controls, which serve to limit spread to high value sites, but are economically and ecologically unviable at the landscape scale.

Because *E. chrysippe* is limited to feeding on a small pool of closely related species, all of which are invasive, its release is expected to be beneficial to Hawai‘i’s forests and hydrology, and adverse effects are expected to be negligible. Therefore, the anticipated determination from this Draft Environmental Assessment is an Anticipated Finding of No Significant Impact (AFNSI).

1.0 INTRODUCTION

This Draft Environmental Assessment (DEA) supports a proposed field release of a gregarious defoliating caterpillar, *Euselasia chrysippe,* which will be used to control miconia, *Miconia calvescens* (Melastomataceae), a Hawai‘i state noxious weed. The proposing agency for this program is the State of Hawai‘i Department of Agriculture (HDOA).

The proposed action of releasing a biological control agent has the potential to impact the local environment and involves the use of state and federal funds and approval of permits. Therefore, in accordance with Hawai‘i Revised Statutes (HRS) Chapter 343, the Hawai‘i Environmental Policy Act, and the National Environmental Policy Act, the proposing agencies have conducted an Environmental Assessment (EA) of the proposed project.

This DEA identifies proposed and alternative actions of the project, describes the affected physical and biological environments, and analyzes potential impacts to the existing environment resulting from the proposed action.

1.1 Purpose and Need

Under Hawai‘i State Law (HRS Chapter 152), a “noxious weed” is defined as “any plant species which is, or which may be likely to become, injurious, harmful, or deleterious to the agricultural, horticultural, aquacultural, or livestock industry of the State and to forest and recreational areas and conservation districts of the State, as determined and designated by the department from time to time.” The HDOA’s Plant Pest Control Branch is responsible for limiting plant pest populations that have the potential to cause significant economic damage in the state.

Miconia, a fast-growing tree in the Melastomataceae family, is a major threat to forest ecosystems in Hawai‘i. Miconia was first introduced to Hawai‘i in 1961 as an ornamental and quickly invaded Hawai‘i’s forests (Figure 1). It was declared a noxious weed in 1992 and continues to be one of Hawai‘i’s most threatening and invasive plants (Kaiser 2006).

Mechanical and chemical methods of control have been underway to attempt to keep the species from spreading; however, long-term management of miconia relies on biocontrol as a critical tool. Release of this proposed biocontrol agent will help to reduce tree vigor and growth, while future agents may aim to reduce seed production, population densities, and seedling establishment and survival.

1.1.1 Biocontrol

When a pest species is introduced to a novel habitat, either intentionally or accidentally, it often arrives without the species (pathogens, herbivores, or parasites) that keep its populations in check in its native range. The Enemy Release Hypothesis states that one of the reasons for the unusually high success of an invasive species in its new habitat is this lack of top-down control from a species’ natural enemies (Keane and Crawley 2002). One tool for controlling a species’ population is reintroducing the species’ natural enemy into the novel habitat in which it has become a pest. This process is called biological control, or biocontrol.

The use of biocontrol agents for invasive weeds in natural areas has some advantages over mechanical or chemical control. In particular, when a pest has spread across large areas and/or to remote locations, biocontrol can provide an enduring, cost-effective, and environmentally friendly solution (Howarth 1991). One concern about introducing a new species for biocontrol into a new habitat is the potential for adverse effects on species it was not intended to suppress, or what are termed “non-target impacts.” A candidate biocontrol species undergoes intensive testing in order to minimize risk of non-target impacts and maximize effectiveness.

1.2 Target Species: *Miconia calvescens* - Miconia

Figure 1. Miconia (*Miconia calvescens*); Photo by Forest and Kim Starr.

Taxonomy: *Miconia calvescens* DC. (Synonyms: *Cyanophyllum magnificum* Groenland, *Melastoma arborea* Velloso, *Melastoma mandioccana* Raddi, *Miconia arborea* Pav. ex Triana, *Miconia magnifica* Triana, *Miconia velutina* L. Linden & Rodigas) belongs to the pantropical Melastomataceae family. The genus *Miconia* Ruiz & Pavón is the largest genus of new world plants and contains more than 1,500 species ranging from Mexico to the Caribbean to Uruguay and northern Argentina (Mabberley 2017). *Miconia calvescens* is the main species in the genus to be popularized as an ornamental; uses for other species in the genus include lumber (*M. longistyla*), edible berries (*M. macrophylla*), dyeing (*M. cinnamomifolia*), and medicine (*M. agrestis, M. fothergilla*) (Meyer 2010).

Description: *Miconia calvescens* can grow up to 16 meters tall, but usually reaches 4–12 meters. Its oblong-elliptical to elliptical-ovate leaves are glabrous, 20–80 cm long and 8–30 cm wide, with acuminate tips and an obtuse or rounded base. The bicolored form seen in Hawai‘i has dark green leaves with purple undersides with entire or slightly toothed margins. Inflorescences are panicles 20–35 centimeters long. Sessile flowers are 5-merous and have oblong caducous bracteoles 2–3 mm in length. Hypanthium is 2–2.7 mm long; calyx tube is 0.6–0.7 mm long. Petals are white and glabrous on the surfaces but sometimes sparsely glandular around the edges, 2–3 mm long, 1–2 mm wide, oblong-obovate. Stamens slightly dimorphic; filaments 3–4 mm, glabrous or very sparsely glandular. Stigma slightly expanded; style glabrous or sparsely glandular, slightly immersed in the ovary apex; ovary 3-celled and 1/2–2/3 inferior, the apex granulose or sparsely glandular. Fruits are globose, purplish-black, 3.5–4.5 mm in diameter, containing ovoid to pyramidal seeds around 0.5 mm long (Weber 2003).

Distribution: Miconia is native to Central and South America, from Mexico to Argentina. In Hawai‘i, it was introduced to Wahiawa Botanical Garden by Joseph Rock in 1961, was subsequently introduced to other botanical gardens on Oahu, and had reached the island of Hawai‘i by 1964, Maui in the early 1970s, and Kauai by the early 1980s. Large infestations exist on the islands of Hawai‘i and Maui, and populations can also be found on Kaua‘i and O‘ahu. Efforts to control miconia were first initiated in 1991 on the island of Maui, near

Hana. By that time, it had already spread widely. More than 20,000 plants were removed from Hana between 1991 and 1993 (Thomas 1997).

Habitat: Miconia is rarely seen in its native range, which extends from southern Mexico to northern Argentina. The bicolored form with purple undersides to the leaves found in invaded regions is restricted to Central America. Miconia is found in tropical or wet forests where the mean annual rainfall is greater than 2,000 mm and mean temperature is over 22 degrees Celsius. It has a broad elevational range from the lowlands up to 1,800 meters in elevation and grows in disturbed or second-growth forests, in semi-open areas. Miconia is an early successional species, colonizing small gaps, forest edges, streambanks, and trailsides, and only rarely grows in the understory of dense primary forest. This species' invaded range is very similar to its native range (Meyer 2010).

Impact: Miconia is a major threat to forest ecosystems in Hawai‘i. It was declared a Hawai‘i state noxious weed in 1992 and continues to be one of Hawai‘i's most invasive plants (Kaiser 2006). Miconia trees form dense stands (Figure 2) and their large leaves shade out native forest trees. Over time, miconia can come to dominate a forest. Each plant can produce over 20,000 seeds per fruiting season, and each seed may remain viable for more than 16 years. Seeds are dispersed long distances by animals such as birds and rats and can be spread by wind, water, or humans (CABI 2019; Hawaii Invasive Species Council 2019).

Figure 2. *Miconia calvescens* infestation in Onomea, Big Island; Photo by Forest and Kim Starr.

Management: Early efforts to contain miconia's rampant spread formed the basis of Hawai‘i's invasive species management. Mechanical and chemical methods of control have been underway in Hawai‘i to attempt to keep the species from spreading, including the use of triclopyr herbicide and the use of Herbicide Ballistic Technology, which targets miconia plants from a helicopter. Despite sustained efforts using chemical control, this species continues to proliferate, particularly on Maui and Hawai‘i Islands, and long-term management of *M. calvescens* will depend on the use of biocontrol agents (Ashe 2017). To date only one biocontrol agent has

been released against miconia, the leaf spot pathogen *Colletotrichum gloeosporioides*, with only minor impacts in Hawaii (Seixas et al. 2007).

Natural Enemies: The first exploration for natural enemies of miconia within its native range was conducted in Costa Rica, Brazil, and Trinidad in 1993–1995 by Robert Burkhart, exploratory entomologist for the Hawai`i Department of Agriculture. Further exploratory work by plant pathologists in Brazil resulted in the 1997 introduction of a fungal pathogen for biocontrol in Hawaii (Seixas et al. 2007). Beginning in 2000, additional surveys and detailed studies of enemies of miconia were conducted by students at the University of Costa Rica (Hanson et al. 2010) and the Federal University of Vicosa, Brazil (Picanço et al. 2005). Collections have identified a wide variety of natural enemies feeding on miconia, including dozens of Lepidoptera species, many species of Coleoptera, some Hemiptera, and several plant pathogens. Some of these enemies have been prioritized for development as biocontrol agents (Johnson 2010).

1.3 Biocontrol Agent: *Euselasia chrysippe*

The proposed biocontrol agent is *Euselasia chrysippe*, a gregarious defoliating caterpillar. The native range of this species extends from southern Mexico to Colombia and its elevational range starts at sea level and extends up to 1,500 meters (Nishida 2010). In Costa Rica, it is found on the Caribbean and Pacific slopes in both primary and secondary rain forests (Allen 2012; Nishida 2010). Caterpillars and eggs of *E. chrysippe* have only been collected from species in the Melastomataceae family, specifically *Miconia calvescens*, *M. impetiolaris*, *M. trinervia*, *M. elata*, *M. appendiculata*, *M. donaena*, *M. longifolia*, and *Conostegia rufescens* (DeVries 1997; DeVries et al. 1992; Janzen and Hallwachs 2009; Nishida 2010). Release of this leaf-eating biocontrol will help to reduce tree vigor and growth. Other candidate agents for future release will aim to impact seed production, population densities, and/or seedling establishment and survival (Johnson 2010).

Taxonomy: *Euselasia chrysippe* (Bates 1866) is classified under the family Riodinidae, or metalmark butterflies, in the subfamily Euselasiinae. Euselasiinae is restricted to the subtropics and contains five genera; all except Euselasia contain few taxa. Euselasia, by contrast, contains around 170 described species. Despite the relative abundance of this genus, little is known about its members outside of a few pest species of *Eucalyptus* (Nishida 2010).

Description of Adults: Males of this species have a reddish-orange discal area on the upper surface of wings, whereas females are yellowish-orange. Both sexes have 5–7 black spots along the margins on the underside of the hindwings (Nishida 2010).

Description of Larvae: Sixth instar description from Nishida (2010):

> The sixth instar *Euselasia chrysippe* is greenish-dark-gray to greenish-dull black; the head capsule width is ca. 1.65 mm; the color of the head is bright orange, black, or a mixture of these two; arrowhead setae are cone-shaped (not flattened), ridged, and spiraled apically; the curvature of the ventral margin of the labrum is narrowly angled (ca. 110°); the mandible is small (0.38 mm wide), with the dentation less distinct than in *E. bettina*, and the extension of the fifth tooth is somewhat widened at edge; the T1 shield is orange to bright orange and without iridescence; the pinacula on the dorsum have a pale-gray oval line; the iridescence on structural color plates is faint metallic-blue; a proleg on A10 has 11–13 crochets in mesoseries.

Distribution: The native range of *Euselasia chrysippe* extends from southern Mexico to Colombia (DeVries 1997) and its elevational range starts at sea level and extends up to 1,500 meters (Nishida 2010). Studies reported here involve *E. chrysippe* collected from a few different sites on the Caribbean slope of Costa Rica, from two of its host plants, *Miconia calvescens* and *Miconia impetiolaris*.

Life History: In captive rearing conditions, the duration of the *E. chrysippe* life cycle from egg to emergence of the adult butterfly from the pupa is approximately 8 weeks. Both male and female adults have been shown to live for longer than a month (Nishida 2010). The caterpillars have six instars that feed and rest as a group, primarily on the undersides of fully opened leaves of their host, moving from leaf to leaf, ultimately consuming the equivalent of one whole leaf (Johnson 2010). As with all known members of the tribe Euselasiini, *E. chrysippe* caterpillars hatch, feed, rest, molt, and pupate together in a single sibling cohort of up to 100 individuals (Allen 2010; Nishida 2010). This gregarious behavior is thought to assist the species with feeding on tough leaves, which optimizes foraging. In addition, traveling as a large group provides a defense against predation and may contribute to the low parasitism rates on this species observed in their home range (Allen 2010).

Recorded host plants for the genus *Euselasia* include members of Euphorbiaceae, Clusiaceae, Myrtaceae, Melastomataceae, Sapotaceae, and Vochysiaceae; however, caterpillars and eggs of *E. chrysippe* have only been collected from the family Melastomataceae, specifically *Miconia calvescens, M. impetiolaris, M. trinervia, M. elata, M. appendiculata, M. donaena, M. longifolia,* and *Conostegia rufescens* (Nishida 2010). Preliminary no-choice host tests conducted by Nishida (2010) found that larvae collected from *M. impetiolaris* would feed on *Conostegia xalapensis* and *M. calvescens* (Melastomataceae) but exhibited no feeding on two *Eucalyptus* spp., *Eugenia truncata*, and *Psidium guajava* (Myrtaceae) or *Clusia flava* (Clusiaceae).

Natural Enemies: One of the biggest issues of concern when introducing a biocontrol and ensuring its success is parasitism by insects previously introduced either for the control of other arthropods, or through accidental means. Previously reported parasitoids of the genus *Euselasia* include species of Chalcididae, Ichneumoniadae, Trichogrammaditae (all in Hymenoptera), and Tachinidae (Diptera) (Johnson 2010; Nishida 2010). One egg parasitoid (*Encarsia* cf. *porteri* (Hymenoptera: Ahelinidae)) and two genera of solitary tachinid parasitoids that attack late instar larvae and emerge from the host once it has begun to pupate have been recorded from *E. chrysippe* (Nishida 2010). Species in the subfamily Riodininae do not share the usual parasitoids of Lepidoptera (Hanson et al. 2010) and no members of this family are native or have been introduced to Hawai‘i (Nishida 2002), which further reduces the chance that a specialized parasite of *E. chrysippe* currently exists here.

Effect on Target Weed: *Euselasia chrysippe* was selected as a leaf-feeding biocontrol for miconia in Hawai‘i because its gregariously feeding larvae can cause substantial damage to leaves. When reared on potted plants, a cohort of 60–80 larvae will consume several hundred square centimeters of leaf tissue – equivalent to the area of one average-sized leaf. Damage is typically distributed across several leaves because larvae move to new feeding areas between meals. Damage also includes removal of portions of uneaten leaves, presumably to reduce detection by natural enemies (Figure 3) (Puliafico et al. 2015).

Although extensive defoliation by *E. chrysippe* is not observed in Costa Rica, its populations are presumed to be limited by natural enemies there. If introduced to Hawai‘i, population growth is expected to be less constrained by enemies, allowing numbers of *E. chrysippe* to increase to levels sufficiently high to cause substantial defoliation. Damage is unlikely to be severe enough to kill miconia trees, but repeated partial defoliations may reduce growth and reproduction of trees and enhance light levels for plants competing with miconia (Johnson, T. pers. comm).

Figure 3. *Euselasia chrysippe* larvae defoliating *Miconia calvescens.*

1.3.1 Host Specificity

Understanding host specificity, the ability of a candidate biocontrol agent to carry out its life cycle on both the target and any possible non-target organisms, is an important step in evaluating potential effects of the candidate agent on non-target species. Potential non-target hosts of *E. chrysippe* were selected by employing the Centrifugal Phylogenetic Method. This method is based on the hypothesis that a candidate biocontrol is more likely to feed upon plant species that are closely related phylogenetically to the preferred host species. The pool of non-target species is chosen by initially testing species within the same genus as the known host, then expanding out to include species in higher taxonomic ranks (family, then order, and so on).

Host specificity tests with larvae of *E. chrysippe* were conducted from 2012-2014 in laboratories in Hawaii, at the Hawaii Volcanoes National Park Quarantine Facility, and in Costa Rica, at La Selva Biological Station. An emphasis was placed on plants in the order Myrtales, specifically on species within the Melastomataceae, Myrtaceae, Combretaceae, Lythraceae, and Onagraceae families. Relationships within the Melastomataceae were based on Clausing and Renner (2001). In addition, species from more distantly related taxa but with economic, cultural, and/or ecological significance in Hawai‘i were selected based on input from the U.S. Fish and Wildlife Service, consultations with members of the agricultural community, and expert sources on native Hawaiian plants. In total, 73 species of plants from 19 families were examined for suitability as hosts for *E. chrysippe* (Table 1). No-choice tests of each species (larvae exposed to only one plant species for 3 days) were conducted with leaves in 90-mm petri dishes and replicated 4-5 times.

Results of host specificity studies showed that among the 73 species tested, *E. chrysippe* larvae overwhelmingly prefer feeding and only survive on *Miconia calvescens* and a few close relatives within the tribe Miconieae (Table 1). Two species, *Miconia crenata* (prev. *Clidemia hirta*) and *Miconia bicolor* (prev. *Tetrazygia bicolor*), which have recently been found through phylogenetic analyses to be better placed within the genus Miconia (Judd et al. 2014; Mabberley 2017), experienced the highest level of non-target feeding by *E. chrysippe* of all the species tested that are currently naturalized in Hawai‘i. No Melastomataceae are native to Hawai‘i, and nine of the 15 species naturalized in Hawai‘i have been declared state noxious weeds (Medeiros et al. 1997). Very low levels of feeding occurred on a few plants in families outside of Melastomataceae (Figures 4-5), but in

all cases, survival of the larvae past the 3-day mark on species in these families was extremely low, and none developed into larger larvae.

Studies have clearly demonstrated that *E. chrysippe* is host-specific to a narrow subset of Melastomataceae. Results of the host specificity studies are summarized below (Figures 4-6); additional information can be found in the cited literature (DeVries 1997; DeVries et al. 1992; Janzen and Hallwachs 2009; Nishida 2010). Laboratory tests are consistent with field observations of host range of *E. chrysippe* in Costa Rica, where eggs and larvae have been collected only from species of *Miconia*, specifically *M. calvescens*, *M. donaeana*, *M. impetiolaris*, *M. appendiculata*, *M. longifolia*, *M. elata*, *M. trinervia*, and *Conostegia rufescens*, a plant in the same tribe (Nishida 2010). A similar pattern of specificity holds for other species within the genus *Euselasia*. Across numerous studies in various parts of tropical America, *Euselasia* have been found to be narrowly host-specific, with each species specializing within a family of plants (Nishida 2010).

Table 1. Plant species tested for *Euselasia chrysippe* larval feeding in 3-day no-choice trials

Order Family Tribe	Test Plant Species	Common Name(s)	Native Range*	Present in Hawai‘i?
Myrtales				
Melastomataceae				
Miconieae	*Clidemia dentata*		SCA	
	Clidemia discolor		SCA	
	Clidemia epiphytica		SCA	
	Clidemia hirta	clidemia, Koster’s curse	SCA	yes
	Conostegia subcrustulata		SCA	
	Conostegia xalapensis		SCA	
	Henriettea turberculosa		SCA	
	Leandra granatensis		SCA	
	Leandra longicoma		SCA	
	Miconia affinis		SCA	
	Miconia argentea		SCA	
	Miconia barbinervis		SCA	
	Miconia calvescens	miconia	SCA	yes
	Miconia cremadena		SCA	
	Miconia elata		SCA	
	Miconia gracilis		SCA	
	Miconia impetiolaris		SCA	
	Miconia longifolia		SCA	
	Miconia multispicata		SCA	
	Miconia nervosa		SCA	
	Miconia prasina		SCA	
	Miconia theizans		SCA	
	Tetrazygia bicolor		NA/SCA	yes
Bertolonieae	*Triolena hirsuta*		SCA	

Order Family Tribe	Test Plant Species	Common Name(s)	Native Range*	Present in Hawai'i?
Myrtales				
Melastomataceae				
Blakeeae	*Blakea litoralis*		SCA	
	Topobea maurofernandeziana		SCA	
Dissochaeteae	*Medinilla cummingii*		IM	yes
	Medinilla magnifica	showy medinilla	AU/IM	yes
Melastomeae	*Arthrostemma ciliatum*	pinkfringe	SCA	yes
	Dissotis rotundifolia	pink lady, rockrose	AF	yes
	Heterocentron subtriplinervium	pearlflower	SCA	yes
	Melastoma sanguineum	fox-tongued melastome	IM	yes
	Melastoma septemnervium	Asian melastome	IM	yes
	Pterolepis glomerata	false meadowbeauty	SCA	yes
	Tibouchina herbacea	cane tibouchina	SCA	yes
	Tibouchina longifolia	long leaf glory tree	SCA	yes
	Tibouchina urvilleana	princess flower, glorybush	SCA	yes
Combretaceae	*Terminalia catappa*	false kamani	AU/IM	yes
Lythraceae	*Cuphea ignea*	cigar flower	SCA	yes
	Lythrum maritimum	pukamole	SCA	yes
Myrtaceae	*Eucalyptus deglupta*	rainbow eucalyptus	IM	yes
	Eucalyptus globulus	blue gum	AU	yes
	Eugenia uniflora	Surinam cherry, pitanga	SCA	yes
	Lophostemon confertus	brushbox, Brisbane box	AU	yes
	Melaleuca leucadendra	weeping paperbark	AU/IM	yes
	Metrosideros macropus	lehua mamo	HI	yes
	Metrosideros polymorpha	'ohi'a lehua	HI	yes
	Plinia cauliflora	jaboticaba	SCA	yes
	Psidium cattleianum	strawberry guava	SCA	yes
	Psidium friedrichsthalianum	Costa Rican guava	SCA	yes
	Psidium guajava	common guava	SCA	yes
	Rhodomyrtus tomentosa	downy myrtle, rose myrtle	IM	yes
	Syzygium cumini	Java plum	IM	yes
	Syzygium malaccense	mountain apple,	AU/IM	yes
Onagraceae	*Epilobium ciliatum*	willowherb	NA/SCA/IM	yes
	Fuchsia magellanica	hardy fuchsia	SCA	yes
	Oenothera laciniata	cutleaf evening primrose	NA	yes
Geraniales				
Geraniaceae	*Geranium homeanum*	Australasian geranium	AU	yes

Order Family Tribe	Test Plant Species	Common Name(s)	Native Range*	Present in Hawai‘i?
Brassicales Caricaeae	*Carica papaya*	papaya	SCA	yes
Malvales Malvaceae	*Hibiscus rosa-sinensis*	hibiscus	IM	yes
	Theobroma cacao	cacao	SCA	yes
Sapindales Anacardiaceae	*Mangifera indica*	mango	IM	yes
Rutaceae	*Citrus* x *sinensis*	lemon	IM	yes
Sapindaceae	*Dodonaea viscosa*	a'ali'i	COS/HI	yes
Rosales Moraceae	*Artocarpus altilis*	ulu, breadfruit	IM	yes
Fabales Fabaceae	*Acacia koa*	koa	HI	yes
	Sophora chrysophylla	mamane	HI	yes
Gentianales Rubiaceae	*Coffea arabica*	coffee	AF	yes
Lamiales Scrophulariaceae	*Myoporum sandwicense*	naio	HI	yes
Proteales Proteaceae	*Macadamia integrifolia*	macadamia	AU	yes
Alismatales Araceae	*Anthurium*	anthurium	SCA	yes
Laurales Lauraceae	*Persea americana*	avocado	SCA	yes
Cyatheales Dicksoniaceae	*Cibotium glaucum*	hapu'u	HI	yes

*Native ranges: HI = Hawaiian native, SCA = Neotropical (South and Central America), NA = Nearctic (North America), AU = Australian, AF = Afrotropical, IM = Indomalayan, COS = Cosmopolitan

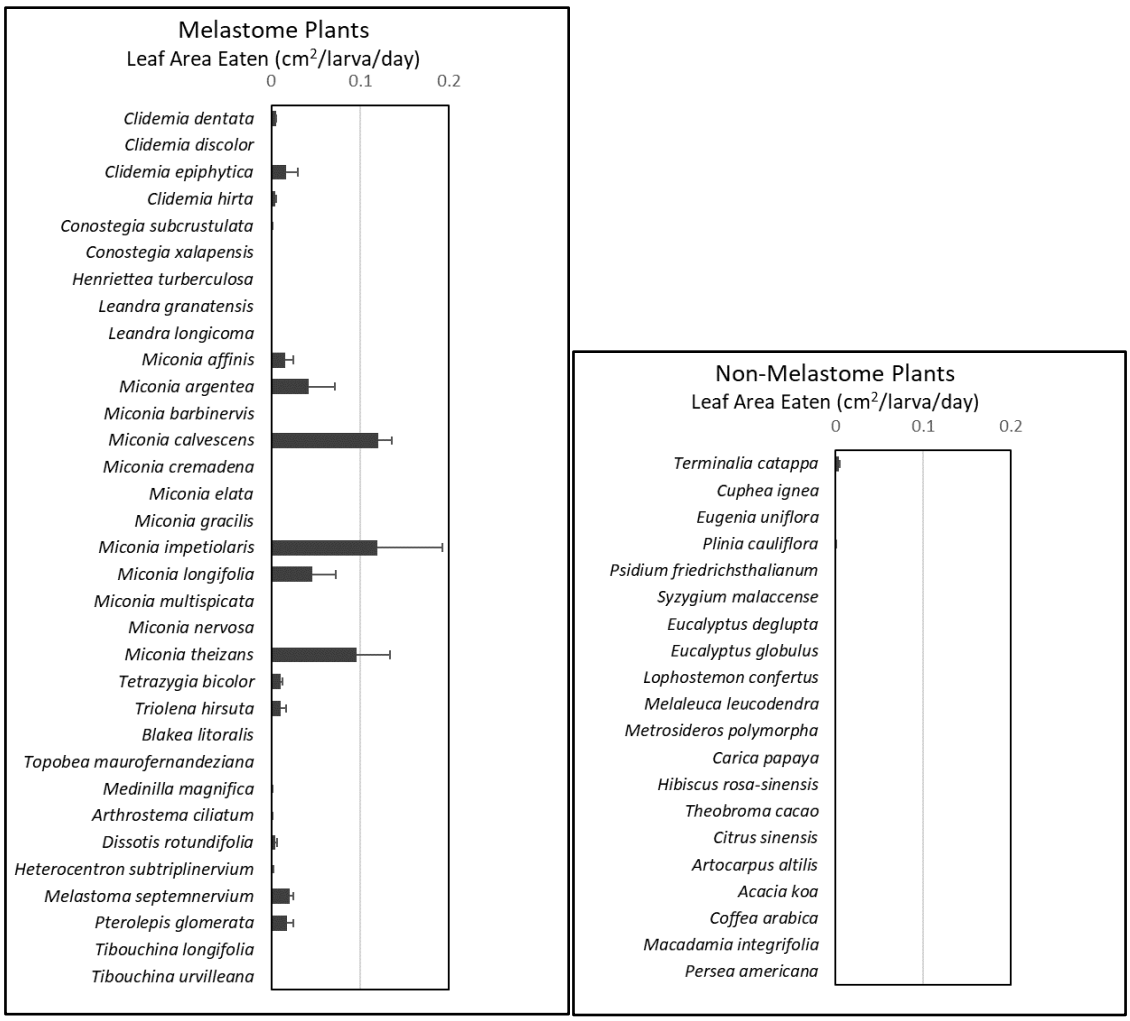

Figure 4. Average feeding damage by small larvae (instars 1–2) of *Euselasia chrysippe* on plant species in Costa Rica and Hawai'i exposed as fresh leaves for 3 days in 90-mm petri dishes in 2012–2014, measured from photos before and after testing (bar = standard error). Species in Melastomataceae on left are grouped according to genetic relatedness, and non-melastomes on right are listed in order of genetic distance from Melastomataceae.

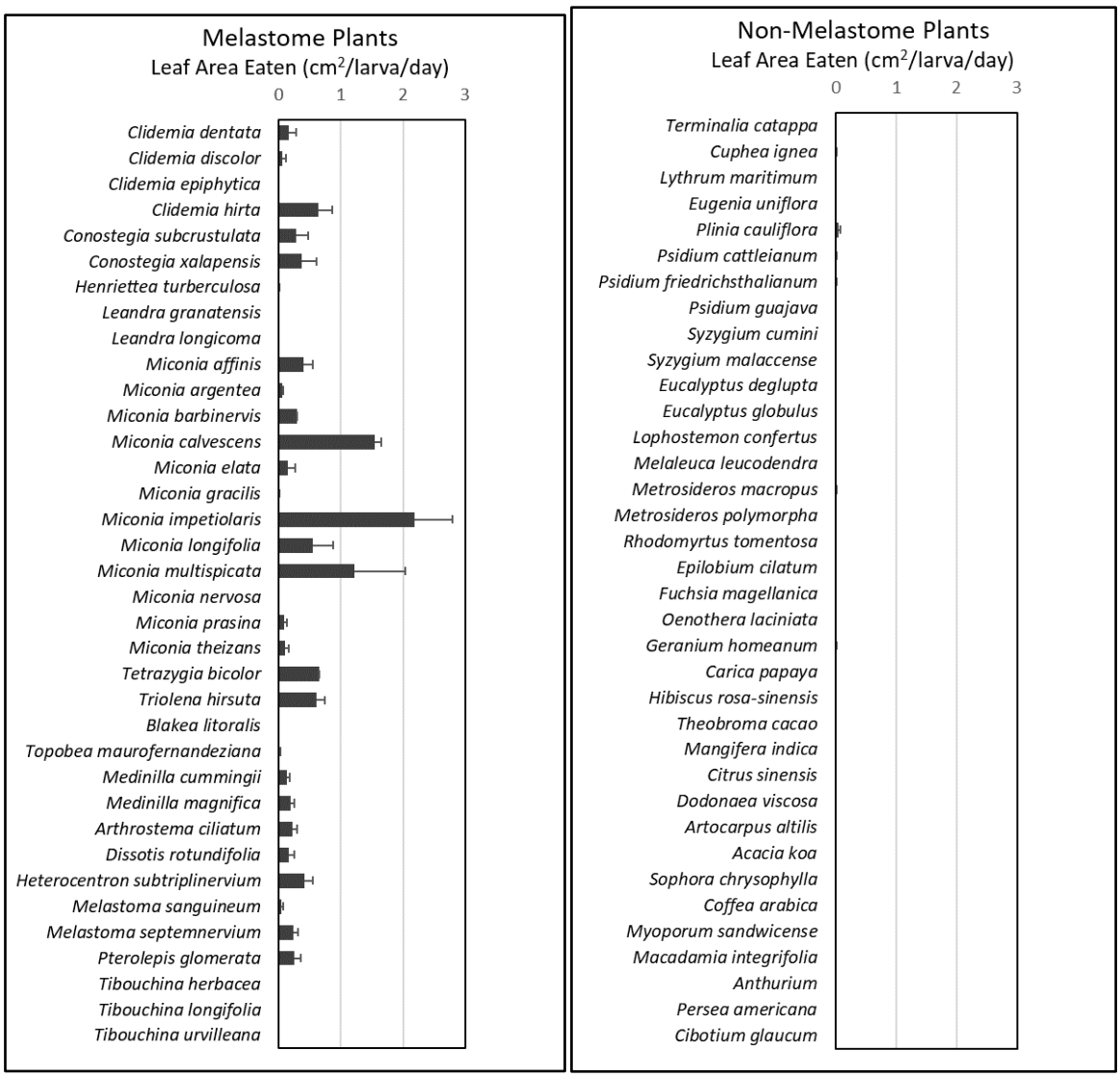

Figure 5. Average feeding damage by mid-sized larvae (instars 3–5) of *Euselasia chrysippe* on plant species in Costa Rica and Hawai'i exposed as fresh leaves for 3 days in 90-mm petri dishes in 2012–2014, measured from photos before and after exposure (bar = standard error). Species on left, in the family Melastomataceae, are grouped according to genetic relatedness, and non-melastomes on right are listed in order of genetic distance from Melastomataceae.

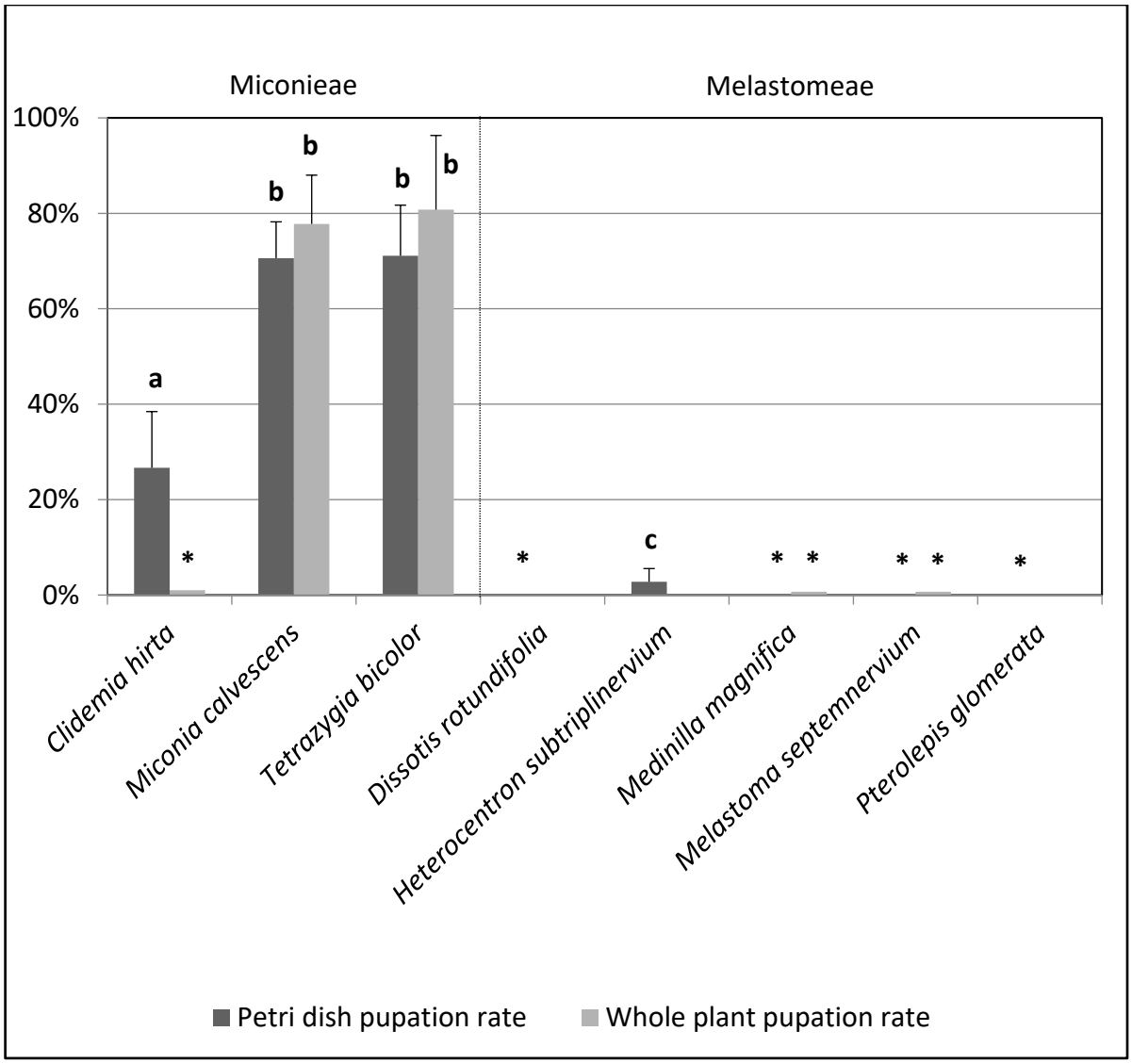

Figure 6. Survival of *E. chrysippe* larvae to pupation (percent average ± standard error) when exposed continuously to leaves in Petri dishes (dark gray) and whole plants (light gray) of test plant species in the tribes Miconieae and Melastomeae (family: Melastomataceae). Results with different letters (a,b,c) are statistically different. Results with an asterisk (*) had negligible survival and were not tested in the statistical model.

1.4 Proposed Action

An application will be submitted by the HDOA Plant Pest Control Branch to the HDOA Plant Quarantine Branch, 1849 Auiki Street, Honolulu, HI 96819, for a permit to introduce *Euselasia chrysippe* (Lepidoptera: Riodinidae), a gregarious defoliating caterpillar, into the State of Hawai‘i under the provisions of HRS Chapter 141, Department of Agriculture, and Chapter 150A, Plant and Non-Domestic Animal Quarantine. *Euselasia chrysippe* will be released to help control miconia *(Miconia calvescens* (Melastomataceae), which is considered one of the world’s worst weeds.

The U.S. Department of Agriculture (USDA) Forest Service will partner with land managers to monitor the impacts of the biocontrol after establishment, focusing on selected sites with abundant miconia in east Hawai‘i island and east Maui.

1.4.1 Project Cost

Although rearing of *E. chrysippe* requires specialized knowledge, the costs for distributing the insect for management will be relatively low after it is approved for release. Facilities, equipment, and personnel needed for rearing the insect are relatively simple; however, the process will require importation and careful screening of insects from Costa Rica. Establishing self-sustaining populations in field sites statewide likely can be accomplished within 1 year with a few staff working only part-time (estimate: $60,000 for technical support in Costa Rica and Hawai‘i). Additional funding ($60–100K) would support an organized effort to monitor establishment and impacts over the first 2 years following release. Agencies contributing to these efforts are expected to include the USDA Forest Service, HDOA, and State of Hawai‘i Department of Land and Natural Resources (DLNR). Invasive species committees, watershed partnerships, and others involved in weed management are expected to be active partners in identifying release sites and assisting in monitoring initial establishment.

Post-release monitoring, to determine whether the biocontrol is ultimately successful, will likely require a partnership of researchers and managers over a period of many years. Although specific methods have not yet been developed for the purpose of remote monitoring of insect feeding on miconia, it is likely possible to modify aerial detection techniques already in development.

1.5 Affected Area

The proposed release of *E. chrysippe* will be statewide. The first stage of release will focus on miconia infestations on east Maui and east Hawai‘i, where the host species is most abundant. Many areas where miconia is known to occur are under some level of active management, and it would be a waste of effort to release biocontrol on plants that will soon be killed with herbicide. This sort of interference might present a challenge in the short-term for release and monitoring of effectiveness of *E. chrysippe*. However, in the long term, suppression of miconia through biocontrol is expected to be compatible with other control methods. In areas where active management focuses on containing the spread of miconia, *E. chrysippe* would ideally work by rapidly colonizing new miconia plants, even plants located at substantial distances from established populations. A balance between use of biocontrol and other management tools will be established depending on the effectiveness of *E. chrysippe* releases and the availability of resources for other control methods (Johnson 2010).

Once successfully established, the butterfly may expand its range to other locations or islands both naturally and by additional releases. Actual dispersal rates are not known at this time but will be tracked and monitored following release.

1.6 Sources of Primary Environmental Impact

Primary impacts are defined in Hawaii Administrative Rule (HAR) §11-200-1 as “effects which are caused by the action and occur at the same time and place.” Primary impacts from the release of a biocontrol agent are the damages directly caused by the biocontrol agent; for example, feeding damage on the target weed or on non-target species. The potential impacts of this action are analyzed in Chapter 2.

1.7 Sources of Secondary Environmental Impact

Secondary impacts are defined in HAR §11-200-1 as “effects which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable.” For example, one possible secondary impact could be a change in vegetation composition after successful suppression of miconia.

1.8 Agency Identification

The HDOA is the proposing agency responsible for the proposed action in accordance with HRS Chapter 343 and the National Environmental Policy Act.

1.9 Required Permits

The proposed action requires the following permits:

- Plant Protection and Quarantine permit from the USDA, Animal and Plant Health Inspection Service
- a permit for import and liberation of restricted organisms from the HDOA Plant Quarantine Branch upon review and approval by the Hawai‘i Board of Agriculture
- a permit for access for release and monitoring of the insect on State forest land from the DLNR Division of Forestry and Wildlife (DOFAW)

1.10 Alternatives Considered

The No Action Alternative and Preferred Alternative (proposed action) are discussed below. Table 2 summarizes the advantages and disadvantages of each alternative.

1.10.1 No Action Alternative

Under the No Action Alternative, *E. chrysippe* will not be released for biocontrol of miconia. Under this alternative, control of miconia will be limited to the current options of using mechanical and chemical control methods. For incipient infestations of miconia that are easily accessible and limited in size, mechanical or chemical control may be preferred, since these methods have the advantage of a relatively short response time and minimal initial investment in staff time and resources. However, for large infestations or remote locations (as is the case on most infested islands), mechanical and chemical controls can be much less cost-effective, often requiring access by helicopter, and increase use of herbicides and staff time. Given the current extent of infestation, the environmental and economic impacts required to eradicate the target weed will be unacceptable, and, given this species' propensity to disperse and proliferate, the likelihood of it continuing to invade currently uncolonized suitable habitats and islands despite best efforts is high.

1.10.2 Proposed Action (Preferred Alternative)

The proposed action is to issue permits for the release of a gregarious defoliating caterpillar, *Euselasia chrysippe*, in the State of Hawai‘i for biocontrol of *Miconia calvescens.*

The Preferred Alternative has the advantage of providing long-term control of miconia at a landscape scale. Although the cost of research and development for biological control can seem relatively high compared to conventional mechanical and chemical controls, the benefits of a successful biocontrol release would accumulate over time, saving amounts of money that far surpass the up-front cost (Wright et al. 2012).

Although field release will be permanent and there is a possibility of non-target effects, extensive host-specificity trials have shown that the candidate biocontrol agent has a very limited host range within the Melastomataceae family, which contains no native species, and nine of the 15 species in this family naturalized in Hawai‘i are classified as noxious weeds.

Table 2. Summary of Alternatives Considered and Their Associated Advantages/Disadvantages

	ACTIONS	ADVANTAGES	DISADVANTAGES
NO ACTION	NOT RELEASING *E. CHRYSIPPE*; MANAGEMENT OF *M. CALVESCENS* WILL RELY ON MECHANICAL AND CHEMICAL CONTROLS.	1. EFFECTIVE FOR INCIPIENT INFESTATIONS IF RESPONSE IS WELL-TIMED. 2. LOW INITIAL INVESTMENT REQUIRED. 3. SHORT-TERM NEGATIVE EFFECTS ARE LIKELY REVERSIBLE.	1. ONLY PROVIDES SHORT-TERM CONTROL; CONTINUAL EFFORTS REQUIRED. 2. ECONOMICALLY PROHIBITIVE FOR WIDESPREAD INFESTATION. 3. INCREASED USE OF HERBICIDES AND STAFF TIME. 4. GIVEN THE RESOURCES AVAILABLE, THE ENVIRONMENTAL IMPACT OF THE INVASIVE PLANTS WILL WORSEN.
PROPOSED ACTION	FIELD RELEASE OF A GREGARIOUS DEFOLIATING CATERPILLAR SPECIES, *E. CHRYSIPPE*, IN THE STATE OF HAWAI'I FOR BIOCONTROL OF *M. CALVESCENS*	1. PROVIDES LONG-TERM, SUSTAINABLE CONTROL. 2. ECOLOGICAL AND ECONOMIC BENEFITS ACCRUE PERMANENTLY. 3. ABLE TO REACH AREAS THAT ARE INFEASIBLE BY MECHANICAL AND CHEMICAL CONTROLS.	1. REQUIRES SIGNIFICANT INVESTMENT IN RESEARCH AND MONITORING. 2. IRREVERSIBLE ONCE ESTABLISHED. 3. POSSIBLE NON-TARGET EFFECTS.

2.0 AFFECTED ENVIRONMENT AND IMPACT ASSESSMENT

This section presents an overview of baseline, biological, physical, socio-economic, and cultural environments that the project may affect and the assessment of potential impacts and mitigation measures, when negative impacts are anticipated.

2.1 Biological Environment

Field observations in Costa Rica of *E. chrysippe* and quarantine studies in Hawai'i strongly indicate that the proposed release of this biocontrol agent will not have any undesirable, negative, non-target effects on the biological environment of the Hawaiian Islands. Environmental impacts associated with the No Action Alternative of not issuing permits for release of *E. chrysippe* are those resulting from continued damage to the environment caused by miconia and those caused by other methods employed to control miconia infestations, both of which are now occurring. The proposed release and establishment of *E. chrysippe* is intended to reduce these impacts. In the absence of effective natural enemies of miconia, possible negative environmental impacts caused by repeated use of herbicides to control infestations add to the existing negative impacts caused by the displacement of desirable plants by the pest. Use of chemical herbicides to control miconia would be reduced if the proposed biological control agent becomes permanently established in the environment and is able to sufficiently impact population densities of miconia. The probability of establishment of the biocontrol and degree of control can only be determined after the proposed releases are made, but the outcome would fall between no effect (if the biological control agent fails to establish) and widespread suppression of the target species. There is risk for a biological agent to affect non-target species; however, rigorous tests on the host range can minimize this risk.

2.1.1 Direct Effect on the Target Species

The direct effect on the target species is the reduction in fitness and abundance through herbivory. Feeding by *Euselasia chrysippe* will reduce the fitness of miconia wherever the insect and the plants interact. The degree of control will likely vary by location.

2.1.2 Direct Effect on Non-Target Species

Extensive studies have demonstrated that *E. chrysippe* overwhelmingly prefers feeding and that larvae only survive on *Miconia calvescens* and a few close relatives within the tribe Miconieae (see Figure 5). No Melastomataceae are native to Hawai‘i, and nine of the 15 species naturalized in Hawai‘i have been declared state noxious weeds (Medeiros et al. 1997).

2.1.3 Indirect Effect on Flora

If the biocontrol release and establishment is successful, the sites previously occupied by miconia will become available to other plants. In less-degraded wet forest, native plants may benefit from the natural resources previously occupied by miconia. In more degraded plant communities, the target species are more likely to be replaced by nearby non-native species. These impacts are likely to progress slowly over a period of several years, which will allow time for appropriate management responses.

2.1.4 Indirect Effect on Fauna

Native fauna is expected to benefit from the successful control of miconia, which poses a threat to native forests. Although miconia is a bird-dispersed species, there is no evidence that native birds use this species as a food source. A small number of native fauna might be indirectly affected by the proposed action if the target weeds are used for shelter; however, the effect is expected to be insignificant, as the native fauna that adapted to use the introduced species would be generalists, capable of using alternative plant species once the target species is removed.

2.1.5 Uncertainty of Non-Target Effect

There is no action that has consequences that are completely predictable, and thus there is uncertainty associated with any proposed action, including this one. This uncertainty must be weighed against potential benefits of an action and the adverse impacts that are likely to continue to occur if an action is not undertaken. There is a consensus among biologists in Hawai‘i that miconia has a detrimental effect on native forests and that the severity of ecosystem damage is continually increasing. Uncertainty in the case of the proposed biocontrol release has been significantly reduced through rigorous testing of the biocontrol agent. When weighed against the certainty of the continued threat miconia poses to Hawaiian forests and resources, the level of uncertainty associated with the proposed action is found to be acceptable.

2.2 Physical Environment

The following assesses potential impacts on the elements of the physical environment that may be affected by the proposed action.

2.2.1 Climate

The proposed action will have no to very little effect on long-term or regional climate patterns. The proposed action may affect microclimates that are influenced by the invasive vegetation. Successful control of the invasive weeds is expected to enable the native vegetation to recolonize the invaded area, which will reduce the negative effect of the invasive weeds on the microclimates and should be beneficial to native biota.

2.2.2 Hydrology

Although the proposed action will not directly affect hydrology, the successful suppression of miconia has the potential to indirectly affect hydrology in a positive direction. A study by Giambelluca et al. (2010) postulated that miconia, with its large leaves that both shade out other species and produce large drops off their tips, has the potential to impact hydrology by increasing erosion and flooding. This plausible hypothesis remains to be thoroughly tested. In addition, miconia's shallow root system can cause erosion and landslides when the trees are taken down by heavy rainfall. Once miconia is suppressed, it is expected that hydrological function of the invaded forest would improve due to decreased erosion and landslides.

2.2.3 Soils

The proposed action of suppressing miconia through the release of a natural enemy of this species is expected to decrease miconia's negative impacts on soil processes, including erosion and landslides.

2.2.4 Wildland Fires

The proposed action is expected to have negligible effects on wildland fire. Although the biocontrol has the potential to create small amounts of dead biomass of miconia, the range of this species is in mesic to wet forests, where the risk of wildland fire is low.

2.3 Cultural Resources

ASM Affiliates Hawai‘i, a Heritage and Cultural Resource Management firm, prepared a Cultural Impact Assessment (CIA) for the proposed action, summarized below and attached as Appendix B. The CIA was prepared in adherence with the Office of Environmental Quality Control (OEQC) *Guidelines for Assessing Cultural Impacts*, adopted by the Environmental Council, State of Hawai‘i.

In general, a CIA is intended to inform environmental studies that are conducted in compliance with HRS Chapter 343. The purpose of a CIA is to gather information about the practices and beliefs of a cultural or ethnic group or groups that may be affected by the actions subject to HRS Chapter 343.

The primary focus of the CIA is to elucidate the cultural and historical context of miconia in Hawai‘i. It includes a cultural-historical context of the settlement of the Hawaiian Islands by early Polynesian settlers and the transformation of their beliefs and practices associated with the land following western contact, an overview of the history of biocontrol in Hawai‘i, and a discussion of the introduction of miconia to the Hawaiian Islands. It also includes a discussion of potential impacts as well as appropriate actions and strategies to mitigate those impacts.

2.3.1 Location

Normally, a CIA assesses the potential impacts on cultural practices and features within a geographically defined "project area," which is usually defined by an established Tax Map Key number or numbers. However, CIAs conducted for biocontrol projects differ in that the assessment must consider statewide impacts with an emphasis on those areas where the target species is most abundant.

2.3.2 Consultation

The goal of conducting interviews for the CIA was to identify potential cultural resources, practices, and beliefs associated with miconia and its invaded habitat. Gathering input from community members with genealogical ties and/or long-standing residency or relationships to the anticipated areas of impact or target species is vital to the process of assessing potential impacts to resources, cultural practices, and belief systems.

In an effort to identify individuals knowledgeable about traditional cultural practices and/or uses associated with miconia or the habitat in which it thrives, a public notice was submitted to the Office of Hawaiian Affairs (OHA) for publication in their monthly newspaper, Ka Wai Ola, and was published in the May 2019 issue. No responses were received as a result of the Ka Wai Ola publication, so 45 individuals were contacted directly. These individuals were selected because they were either recognized cultural practitioners, plant experts, or Native Hawaiian organizations who utilize Hawai‘i’s forest resources for cultural purposes or were believed to have cultural knowledge about the target species or other plants found within the target species habitat. Of the forty-five individuals contacted, twenty individuals responded to our request with either brief comments, referrals, or accepting the interview request. The names and affiliations of these twenty individuals are listed in Table 3 below. Of the twenty respondents, ASM staff successfully conducted interviews with nine individuals (see summaries in Table 3). A complete list of all people contacted for consultation is available upon request.

The interviewees were asked a series of questions regarding their background and experience and their knowledge of the target species and its habitat. Additional questions focused on any known cultural uses, traditions, or beliefs associated with miconia. The interviewees were also asked their opinions on the cultural appropriateness of using biocontrol control agents and any potential cultural impacts that could result from the use of biocontrol control, as well as any recommendations to mitigate any identified cultural impacts.

Table 3. Persons contacted for consultation.

Name	***Affiliation, Island***	***Initial Contact Date***	***Comments***
Shalan Crysdale	The Nature Conservancy, Ka‘ū Preserve, Hawai‘i	3/6/2019	See summary in Appendix B
John Repogle	Retired from The Nature Conservancy, Ka‘ū Preserve, Hawai‘i	3/6/2019	See summary in Appendix B
Nohealani Ka‘awa	The Nature Conservancy, Ka‘ū Preserve, Hawai‘i	3/6/2019	See summary in Appendix B
Arthur Medeiros	Auwahi Forest Restoration Project, Maui	3/7/2019	Responded via email on March 11, 2019, stating “Thank you for your valuable work supporting this essential action to attempt to slow the loss of Hawaiian biota.”
Jen Lawson	Waikōloa Dry Forest Initiative, Hawai‘i	4/3/2019	See summary in Appendix B
Robert Yagi	Waikōloa Dry Forest Initiative, Hawai‘i	4/3/2019	See summary in Appendix B
Wilds Brawner	Ho‘ola Ka Manaka‘ā at Ka‘ūpūlehu, Hawai‘i	4/9/2019	See summary in Appendix B
Sam ‘Ohu Gon III	The Nature Conservancy, O‘ahu	4/22/2019	Responded to interview request but was unable to provide input on this project.
Mike DeMotta	National Tropical Botanical Gardens, Kaua‘i	4/22/2019	See summary in Appendix B
Wili Garnett	Cultural practitioner, Moloka‘i	5/7/2019	Responded via email, but response did not include comments about *Miconia calvescens* biocontrol.
Emily Grave	Laukahi Network, O‘ahu	5/7/2019	Responded via email stating that she was not aware of cultural uses of this plant.

Name	*Affiliation, Island*	*Initial Contact Date*	*Comments*
Kim Starr	Starr Environmental, Maui	5/9/2019	See summary in Appendix B
Forest Starr	Starr Environmental, Maui	5/9/2019	See summary in Appendix B
Manaiakalani Kalua	Cultural practitioner, Hawai‘i	5/30/2019	See summary in Appendix B
Robert Keano Ka‘upu	Cultural practitioner, O‘ahu	6/16/2019	Responded via phone that he has been interested in learning about the cultural uses of *wiliwili* but was not aware of any uses or of anyone else who used this wood for cultural purposes.
Hinaleimoana Wong-Kalu	Cultural practitioner, O‘ahu	7/16/2019	Responded to interview request but was unable to secure an interview.
Pelehonuamea Harman	Cultural practitioner, Hawai‘i	7/31/2019	Referred ASM staff to Dennis Kana‘e Keawe
Dennis Kana‘e Keawe	Cultural practitioner, Hawai‘i	8/12/2019	See summary in Appendix B
Iliahi Anthony	Cultural practitioner, Hawai‘i	8/30/2019	See summary in Appendix B
Talia Portner	Honolulu Botanical Gardens, O‘ahu	6/3/2019	Responded to interview request but was unable to secure an interview.

2.3.2 Summary of Findings, Identification of Cultural Impacts, and Proposed Mitigative Measures

There is no evidence to suggest that miconia is important in any ethnic groups' cultural history, identity, cultural practices, or beliefs, nor does it meet the significance criteria outlined in the CIA. On the other hand, the mesic to wet forests this species invades could be considered significant as a traditional cultural property under Criterion E, since they are home to many culturally important indigenous and endemic taxa which are still used in Hawaiian cultural practices.

Based on background research and the interviews conducted for the CIA, it is the assessment of this study that the release of the proposed biocontrol agent, *Euselasia chrysippe*, will not result in impacts to any valued cultural, historical, or natural resources. On the other hand, if no action is taken to further reduce remaining populations of miconia from claiming more of Hawai‘i's mesic to wet forest habitat, impacts to this valuable habitat would be anticipated.

2.4 Socio-economic Environment

The action is not expected to negatively affect the socio-economic environment. The successful control of miconia will benefit the environment and may release the effort and resources expended by using chemical and mechanical control for other purposes.

2.4.1 Population

The proposed action is expected to have negligible effect on population. Miconia has no economic value and the locations where biocontrol will interact with miconia are mostly uninhabited natural areas.

2.4.2 Existing Land Use

The proposed locations of the biocontrol release will largely consist of conservation areas that are mainly used for watershed protection, conservation of native flora and fauna, and public recreation. The successful control of miconia is expected to benefit these intended uses by improving the integrity of the native forest, which is crucial to the conservation of biodiversity as well as recreational and watershed value.

2.4.3 Recreation

Recreational use of the affected area is expected to benefit from the proposed action. The target species is a noxious weed that can degrade the recreational value of natural areas. Therefore, the control of miconia is expected to benefit recreation.

2.4.4 Scenic and Visual Resources

The proposed action is expected to have negligible effect on scenic and visual resources. The effect of successful biocontrol will take place gradually over the span of years to decades. The change in scenic or visual value of the invaded area, therefore, will not dramatically change in a short time period. The areas of infestation are expected to be replaced by other vegetation and have minimal visual change at landscape level. The proposed action will have insignificant effect in scenic value and visual resources.

2.4.5 Household Nuisance

Euselasia chrysippe is expected to remain localized on and near miconia, which grows mainly in uninhabited forested areas. Because of this, it is unlikely that *E. chrysippe* would become a nuisance to residents and visitors.

3.3 Consistency with Government Plans and Policies

The proposed action is consistent with all government plans and policies, especially those that call for conservation of natural resources.

3.3.1 Hawai‘i State Plan

The *Hawai‘i State Plan* was adopted in 1978. It was revised in 1986 and again in 1991 (HRS Chapter 226, as amended). The Plan establishes a set of goals, objectives, and policies that are meant to guide the State’s long-term growth and development activities. The proposed project is consistent with State goals and objectives that call for increases in employment, income and job choices, and a growing, diversified economic base extending to the neighbor islands.

HRS Chapter 226-4 sets forth goals associated with the *Hawai‘i State Plan*:

1. A strong, viable economy characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawai‘i’s present and future generations.
2. A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people.
3. Physical, social, and economic well-being, for individuals and families in Hawai‘i, that nourishes a sense of community responsibility, of caring, and of participation in community life.

The aspects of the plan most pertinent to the proposed classification are the following:

HRS Chapter 226-11 *Objectives and policies for the physical environment—land-based, shoreline, and marine resources*. Planning for the State’s physical environment with regard to land-

based, shoreline, and marine resources shall be directed towards achievement of prudent use of Hawai‘i’s land-based, shoreline, and marine resources and effective protection of Hawai‘i’s unique and fragile environmental resources. To achieve the land-based, shoreline, and marine resource objectives, it shall be the policy of the State to:

- Exercise an overall conservation ethic in the use of Hawai‘i’s natural resources.
- Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.
- Take into account the physical attributes of areas when planning and designing activities and facilities.
- Manage natural resources and environs to encourage their beneficial and multiple uses without generating costly or irreparable environmental damage.
- Consider multiple uses in watershed areas, provided such uses do not detrimentally affect water quality and recharge functions.
- Encourage the protection of rare or endangered plant and animal species and habitats native to Hawai‘i.
- Pursue compatible relationships among activities, facilities, and natural resources.
- Promote increased accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes.

The proposed action is consistent with the goals, objectives and policies of the *Hawai‘i State Plan*. Specifically, it will encourage the protection of rare or endangered plant and animal species and habitats through the control of invasive miconia.

3.3.2 Hawai‘i County General Plan

The County of Hawai‘i’s General Plan is the policy document expressing the broad goals and policies for the long-range development of the Island of Hawai‘i. The plan was adopted by ordinance in 1989 and amended in 2005. The chapter on Natural Resources and Shoreline is the most relevant to the proposed project and include the following goals and policies:

Natural Resources and Shoreline – Goals:

- Protect and conserve the natural resources from undue exploitation, encroachment, and damage.
- Protect rare or endangered species and habitats native to Hawai‘i.
- Protect and effectively manage Hawai‘i’s open space, watersheds, shoreline, and natural areas.

Natural Resources and Shoreline – Policies:

- Coordinate programs to protect natural resources with other government agencies.
- Encourage public and private agencies to manage the natural resources in a manner that avoids or minimizes adverse effects on the environment and depletion of energy and natural resources to the fullest extent.
- Encourage an overall conservation ethic in the use of Hawai‘i’s resources by protecting, preserving, and conserving the critical and significant natural resources of the County of Hawai‘i.

- Encourage the protection of watersheds, forest, brush, and grassland from destructive agents and uses.
- Work with the appropriate State and federal agencies, as well as private landowners, to establish a program to manage and protect identified watersheds.

The proposed action would help to protect and conserve native species and habitats and is consistent with the policies for encouraging conservation ethics, watershed protection, and interagency coordination for the management of natural resources.

3.3.3 Kaua‘i County General Plan

The General Plan for the County of Kaua‘i is the document expressing the broad goals and policies for the long-range development and resource management for the Island of Kaua‘i. First adopted in 1971, the Plan was revised in 1984 and 2000. The General Plan is thematically arranged, discussing issues including management of public facilities, preservation of rural character, and caring for land, water, and culture, among others. The General Plan also includes a chapter entitled "*Vision for Kaua‘i 2020",* which states:

> In 2020, management of development, agriculture, and other activities on Kaua‘i is based on the related principles of ahupua‘a and watershed. Land is developed and used in ways that conserve natural streams and streamflows; conserve habitat for native species of plants and animals, both on land and in the ocean; and preserve sandy beaches and coral reefs. Best management practices used by government agencies, agricultural companies, other businesses, and individuals are effective in avoiding increases in floodwaters downstream; preventing beach loss; and minimizing pollution of ocean waters. All of Kaua‘i's waters are fishable and swimmable.

The proposed action is consistent with the vision of the Kaua‘i County General Plan, specifically the successful control of miconia, and would contribute to conserving habitat for native plants and animals.

3.3.4 Maui County General Plan

The Maui County General Plan is a long-term, comprehensive blueprint for the physical, economic, environmental development, and cultural identity of the county. The plan, adopted on March 24, 2010, provides broad goals, objectives, policies, and implementing actions that portray the desired direction of the County's future. Furthermore, this Countywide Policy Plan provides the policy framework for the development of the Maui Island Plan and nine Community Plans. The Countywide Policy Plan is the outgrowth of and includes the elements of the earlier General Plans of 1980 and 1990. The portions of the plan pertaining to the Protection of the Natural Environment are the most relevant to the proposed project and include the following goals and objectives.

Goals: Maui County's natural environment and distinctive open spaces will be preserved, managed, and cared for in perpetuity.

Objective: Improve the opportunity to experience the natural beauty and native biodiversity of the islands for present and future generations. Policies to achieve the objective include the following:

- Perpetuate native Hawaiian biodiversity by preventing the introduction of invasive species, containing or eliminating existing noxious pests, and protecting critical habitat areas.
- Preserve and reestablish indigenous and endemic species' habitats and their connectivity.
- Restore and protect forests, wetlands, watersheds, and stream flows, and guard against wildfires, flooding, and erosion.
- Expand coordination with the State and nonprofit agencies and their volunteers to reduce invasive species, replant indigenous species, and identify critical habitat.

The proposed action is consistent with the goals, objectives, and policies of the Maui County General Plan to protect the natural environment through the control of miconia in order to conserve and restore native ecosystems and watersheds.

3.3.5 City and County of Honolulu General Plan

The City and County of Honolulu General Plan (1992 edition, amended in 2002) is a statement of objectives and policies that sets forth the long-range goals of O‘ahu’s residents and the policies to achieve them. It is the focal point of a comprehensive planning process that addresses the physical, social, economic, and environmental concerns affecting the City and County of Honolulu.

The policies most relevant to the proposed action are in the Natural Environment section:

- Seek the restoration of environmentally damaged areas and natural resources.
- Protect plants, birds, and other animals that are unique to the State of Hawai‘i and the Island of O‘ahu.
- Increase public awareness and appreciation of O‘ahu’s land, air, and water resources.

The proposed action is consistent with the objectives and policies of the plan concerning the natural environment. Specifically, the proposed action would contribute to the restoration of the natural environment and protection of native plants and animals through the control of invasive miconia.

3.3.6 Hawai‘i’s State Wildlife Action Plan

The 2015 edition of Hawai‘i’s State Wildlife Action Plan (SWAP) details the strategy and plans of the DLNR and its partners to address the conservation needs of more than 10,000 species native to Hawai‘i. This document is an update to the Comprehensive Wildlife Conservation Strategy 2005 plan and outlines a statewide strategy for conserving native wildlife species.

The SWAP identified the major threats to Hawai‘i’s native wildlife, which include the following:

- Loss and degradation of habitat resulting from human development, alteration of hydrology, wildfire, recreational overuse, natural disaster, and other factors
- Invasive species (e.g., habitat-modifiers, including weeds, ungulates, algae and corals, predators, competitors, disease carriers, and disease)
- Ecological consequences of climate change
- Limited information and insufficient management of information
- Uneven compliance with existing conservation laws, rules, and regulations
- Overharvesting and excessive extractive use
- Management constraints
- Inadequate funding

The SWAP sets goals to guide conservation efforts across the state to ensure protection of Hawai‘i’s Species of Greatest Conservation Need and the diverse habitats that support them. The following seven objectives have been identified as the elements necessary for the long-term conservation of Hawai‘i’s native wildlife:

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication

- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs
- Strengthen existing partnerships and create new partnerships and cooperative efforts
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i
- Support policy changes aimed at improving and protecting native species and habitats
- Enhance funding opportunities to implement needed conservation actions

Miconia is an invasive species posing threats to native ecosystems that are not adequately addressed with existing tools, due to management constraints and limited funding. The proposed project is consistent with goals of SWAP because it provides a cost-effective tool for resource managers to combat miconia, one of Hawai‘i’s worst weeds, which will assist with maintaining, protecting, managing, and restoring native species and habitats.

3.3.7 Hawai‘i Interagency Biosecurity Plan

The 2017–2027 Hawai‘i Interagency Biosecurity Plan (HIBP) is the State’s first multi-agency, comprehensive biosecurity plan that includes coordinated strategies to protect Hawai‘i’s agriculture, environment, economy, and health from invasive species. The HIBP identifies gaps in the current biosecurity system, which consists of a network of state agencies and partners working within the areas of pre-border, border, and post-border management, as well as public engagement. The plan creates a shared path forward to address these gaps through 147 actions.

This project is consistent with the actions identified in the HIBP related to biological control, which is an essential tool to address widespread invasive species that are difficult to control through conventional methods. Those actions include the following:

- Increase funding and staffing for Hawai‘i’s biological control programs
- Hire a biological control program coordinator, doubling the size of HDOA’s Biological Control Section Staff
- Build state-of-the-art biocontrol facilities equipped to develop effective biocontrol for high-impact target species

3.3.8 Hawai‘i Forest Action Plan

The DLNR DOFAW is the lead agency in the development of the 2016 Hawai‘i Forest Action Plan (FAP), which covers all forest land ownerships (state, private, and federal) and enables DOFAW to continue to seek funding for landscape-scale management and to integrate the many programs the division administers through one planning document. The plan identifies nine priority areas for Hawai‘i’s forests, including the following:

- Water quality and quantity
- Forest health, invasive species, insects, and disease
- Wildfire
- Urban and community forestry
- Climate change and sea-level rise
- Conservation of native biodiversity
- Hunting
- Nature-based recreation
- Tourism

Miconia is an invasive plant species that poses a threat to water quality and quantity and conservation of native biodiversity. The FAP identifies plants that are non-native, invasive, and habitat-modifying as one of the current, most pervasive threats to native biodiversity in Hawai‘i, and discusses the negative impacts that invasive plants can have on the hydrological processes of forested watersheds.

The proposed project is consistent with the goals of the FAP, which supports and recommends a substantial increase in resources for biocontrol as a necessary tool in invasive species management and identifies biocontrol as one of the management approaches in the FAP.

4.0 ANTICIPATED DETERMINATION

Section 11-200-12 of the HAR sets forth the criteria by which the significance of environmental impacts shall be evaluated. The following discussion restates these criteria individually and evaluates the project's relation to each.

1. *The project will not involve an irrevocable commitment or loss or destruction of any natural or cultural resources.*

The proposed action deals with specific interactions between the biological control agent and the target weed and is not expected to involve irrevocable commitment or loss or destruction of any natural or cultural resources.

2. *The project will not curtail the range of beneficial uses of the environment.*

The proposed action involves specific interactions between the biological control agent and the target weed and is not expected to curtail any beneficial uses of the environment.

3. *The project will not conflict with the State's long-term environmental policies.*

The proposed action is expected to benefit the environment by reducing the negative impact caused by invasive miconia. This is in line with the State's long-term environmental policies.

4. *The project will not substantially affect the economic or social welfare of the community or State.*

The proposed action involves specific interactions between the biological control agent and the targeted noxious weed species and is not expected to affect the economic or social welfare of the community or State.

5. *The project does not substantially affect public health in any detrimental way.*

The proposed action involves specific interactions between the biological control agent and the target weed and will not impact public health.

6. *The project will not involve substantial secondary impacts, such as population changes or effects on public facilities.*

The proposed action involves specific interactions between the biological control agent and the target weed and is not expected to cause substantial secondary impacts.

7. *The project will not involve a substantial degradation of environmental quality.*

The proposed action deals with specific interactions between the biological control agent and the target weed and is expected to improve environmental quality by reducing the negative impacts caused by miconia to the environment.

8. *The project will not substantially affect any rare, threatened, or endangered species of flora or fauna or habitat.*

The proposed action is expected to benefit many rare, threatened, or endangered species of flora and fauna by reducing the negative impact caused by miconia on the biological environment.

9. *The project is not one which is individually limited but cumulatively may have considerable effect upon the environment or involves a commitment for larger actions.*

The proposed action does not involve a commitment for larger actions, and the cumulative effect is expected to be beneficial by reducing the overall impact of this invasive species on the environment.

10. *The project will not detrimentally affect air or water quality or ambient noise levels.*

The proposed action involves specific interactions between the biological control agent and the target weed species and is not expected to affect air or ambient noise levels. The suppression of this noxious weed species is expected to reduce erosion and runoff, leading to improved water quality.

11. *The project will not affect or will not likely be damaged by being located within an environmentally sensitive area such as floodplains, tsunami zones, erosion-prone areas, geologically hazardous lands, estuaries, fresh waters or coastal waters.*

The proposed action involves specific interactions between the biological control agent and the target weed and is not subject to damage by being located within an environmentally sensitive area.

12. *The project will not substantially affect scenic vistas or viewplanes identified in county or state plans or studies.*

The proposed action may gradually reduce vegetation cover by miconia in affected natural areas but is not expected to substantially affect scenic vistas or viewplanes.

13. *The project will not require substantial energy consumption.*

The proposed action involves specific interactions between the biological control agent and the target weed species and will not require substantial energy consumption.

4.1 Conclusion

For the reasons above, and in consideration of comments received during early consultation, the HDOA, with support from the DLNR DOFAW, has concluded that the proposed project will not have a significant impact in the context of HRS Chapter 343 and Section 11-200-12 of the HAR, and has determined an Anticipated Finding of No Significant Impact (AFNSI) with the DEA.

5.0 DOCUMENT PREPARERS

This DEA was prepared for the State of Hawai‘i, DLNR DOFAW. Agencies, firms, and individuals involved included the following:

SWCA Environmental Consultants (Consultant):

Danielle Frohlich, Botanist/Invasive Species Specialist
M.S., 2009, Botany/ Ecology, Evolution, and Conservation Biology, University of Hawai‘i at Mānoa
B.A., 2000, Environmental, Population, and Organismic Biology, University of Colorado

DLNR DOFAW:

Robert Hauff, State Protection Forester
Master of Forestry, 1998, Yale University
B.A. International Relations, 1993, University of Washington

USDA Forest Service, Pacific Southwest Research Station:

Tracy Johnson, Research Entomologist, Institute of Pacific Islands Forestry
Ph.D. Entomology, 1995, M.S. Entomology, 1990, North Carolina State University
A.B. Biology, 1984, University of California, Berkeley

6.0 LITERATURE CITED

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APPENDIX A: COMMENTS RECEIVED DURING EARLY CONSULTATION

Thirteen letters of correspondence were received during the 30-day public comment period for release of *E. chrysippe* for the biological control of miconia.

ALAN M. ARAKAWA
Mayor

DAVID S. TAYLOR, P.E.
Director

GLADYS C. BAISA
Deputy Director

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAII 96793-2155
www.mauiwater.org

June 13, 2018

Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu HI 96713
Attn: Robert D. Hauff

RE: Early Consultation on Environmental Assessment for the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*

Dear Mr. Hauff:

Thank you for the opportunity to provide comments on the above-stated project.

A sustainable future water supply depends on healthy watershed forests for adequate surface and groundwater recharge. DWS has granted over $5 million in financial support to the Maui Invasive Species Committee (MISC) through our Watershed Protection Grants Program since 1999. Their main project directive has been to contain and eradicate several major invasive species. *Miconia calvescens* is their primary ground and aerial operations target. Highly specialized herbicide ballistic technology (HBT) has been applied strategically since 2012 to protect the most remote watershed areas while minimizing the footprint on the landscape.

The remote possibility of undetected *Miconia calvescens* population(s) cannot be ruled out, but we are proud of MISC's significant accomplishment to keep the species out of the West Maui Mountains Watershed. However, the fight continues on the windward side of the East Maui Mountains with core infestations in remote, lower-elevation, areas near Hana and Nahiku. Aggressive efforts are being implemented in response to control established populations and to disrupt incipient populations from moving further up the mountain. We welcome any supporting countermeasure. So, based on the promising test results against invasive melastomes in Hawai'i, we support the coordinated use of the *Euselasia chrysippe* (Lepidopter: Riodinidae) butterfly for biological control of Miconia calvescens, Clidemia hirta, and other closely related weeds.

Should you have any questions, please call Robert De Robles at our Water Resource and Planning Division at (808) 463-3113.

Sincerely,

G. Baisa

Gladys C. Baisa
Deputy Director

"By Water All Things Find Life"

DAVID Y. IGE
GOVERNOR
STATE OF HAWAII

DOUGLAS S. CHIN
LT. GOVERNOR
STATE OF HAWAII

JOBIE M. K. MASAGATANI
CHAIRMAN
HAWAIIAN HOMES COMMISSION

WILLIAM J. AILA, JR.
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
160 BAKER AVENUE
HILO, HAWAII 96720

May 30, 2018

Robert Hauff, State Protection Forester
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, Hawai`i 96813

Dear Mr. Hauff:

Subject: Early Consultation on Environmental Assessment for the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*

The Department of Hawaiian Home Lands acknowledges receiving the request for comments on the above-cited project. After reviewing the materials submitted, due to its lack of proximity to Hawaiian Home Lands, we do not anticipate any impacts to our lands or beneficiaries from the project.

However, we highly encourage all agencies to consult with Hawaiian Homestead community associations and other (N)native Hawaiian organizations when preparing environmental assessments in order to better assess potential impacts to cultural and natural resources, access and other rights of Native Hawaiians.

Mahalo for the opportunity to provide comments. If you have any questions, please call Rae Ann Hyatt, at 620-9480 or contact via email at raeann.p.hyatt@hawaii.gov.

Aloha,

M. Kaleo Manuel
Acting Planning Program Manager

Harry Kim
Mayor

Diane L. Ley
Director

Ron Whitmore
Deputy Director

County of Hawai'i

DEPARTMENT OF RESEARCH AND DEVELOPMENT

25 Aupuni Street, Room 1301 • Hilo, Hawai'i 96720-4252
(808) 961-8366 • Fax (808) 935-1205
E-mail: chresdev@hawaiicounty.gov

June 22, 2018

TO: Robert D. Hauff, State Protection Forester, DLNR

FR: Diane Ley, Director, Department of Research and Development

RE: Early Consultation on Environmental Assessment for the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*

Thank you for the opportunity to provide consultation on the Environmental Assessment for the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens.*

Miconia is an aggressive invasive species that readily encroaches upon public and private lands contributing to the shading out of native and non-native trees and undergrowth; thus, effectively disrupting healthy forests and landscape ecosystems and ultimately exposing soils to erosion. Extensive efforts and public expense were put forth to control this tree, with little success. Today, with the outbreak of Rapid Ohia Death, it is more important than ever that Hawaii's forests are protected from aggressive species as Miconia.

A successful biocontrol candidate, such as *Euselasia chrysippe*, would be a welcome tool to control the further spread of Miconia throughout the Island of Hawaii.

C: Harry Kim, Mayor

University of Hawai'i, Manoa
Pacific Cooperative Studies Unit
3190 Maile Way, St. John 410, Honolulu, Hawai'i 96822
E-mail dduffy@hawaii.edu Ph: (808) 956-8218 Fax: (808) 956-4710

MEMORANDUM

TO: Dr. R. Hauff, State Protection Forester
Hawaii Department of Land and Natural Resources

FROM: David Duffy — signing for David Duffy
PCSU Unit Leader/PI c/o Botany

RE: Environment Assessment of *Euselasia chrysippe* as a biological control agent against *Miconia calvescens*.

OANRP encourages the release of *Euselaseia chrysippe* against *Miconia calvescens*, a serious potential threat but not yet present on lands that we manage on Oahu. It has not become a serious problem for us because it has been aggressively managed by the Oahu Invasive Species Committee (OISC) who have contained it to some few sites in the Koolau range. Were funds for OISC to lapse Miconia would be spread rapidly by birds.

This biological control agent is not very specific within the Melastomataceae, an added benefit. It will attack almost all other established melastomes in Hawaii with the exception of *Tibouchina* for which the state has already proposed the release of another biological control agent. Its minor feeding on *Psidium cattleianum* could possibly be of benefit in the control of that species. We are particularly supportive of the release of this biocontrol agent because of its potential to damage *Clidemia hirta* which is a significant weed in many areas managed by OANRP.

OANRP does not have *Miconia calvescens* on lands that it manages. If we can assist in other way, please us know.

Mr. Robert Hauff
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl St. Rm 325
Honolulu, HI 96813

June 21, 2018

Dear Mr. Hauff,

The O'ahu Invasive Species Committee (OISC) supports the release of a natural enemy to control the growth and spread of miconia (*Miconia calvescens*). Biocontrol is an effective tool to reduce populations of invasive plants that have already become too widespread to eradicate or suppress with surveys, hand-pulling and herbicides.

Biocontrol will be an enormous help to management efforts on Hawai'i Island and Maui where miconia is very widespread. OISC has been controlling miconia on O'ahu since 2001 and we have been able to suppress the population enough that there were only 12 trees found over 13,000 acres surveyed in 2017. Although OISC intends to continue with its program until miconia is eradicated from O'ahu, it would be helpful to have the biocontrol released elsewhere in the state in the event we lose funding or are unable to keep up with our suppression program. We have been able to keep the number of mature trees to just 12 trees over 13,000 acres surveyed so we are optimistic that biocontrol will not be needed, however, it takes a full-time field crew using ground and helicopter surveys to achieve this. If we are not able to keep up the effort decades into the future, a miconia biocontrol will be a key component to protecting 'ōhi'a forests on O'ahu.

Miconia's large leaves allow it to flourish in dense shade intolerable to most other plants. It matures quickly and produces millions of bird-dispersed seeds. It is estimated that in 60 years, this species turned 60,000 acres of Tahitian forest into single species stands where nothing else can grow. To put that number in perspective, the Ko'olau Range watershed is approximately 100,000 acres. Once miconia takes over, understory plants cannot survive in the deep shade of its canopy and the forest floor becomes bare earth and more susceptible to erosion. Miconia is a particularly devastating invasive species and we are pleased to see that a biocontrol is finally ready for release. Mahalo for the opportunity to comment.

Regards,

Rachel Neville

Rachel Neville
OISC Manager

743 Ulukahiki Street • Kailua, Hawaii 96734 • Ph: (808) 266-7994 Fax: (808) 266-7995
www.oahuisc.org

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 21, 2018

State of Hawaii
Department of Land and Natural Resources
Division of Forestry & Wildlife
Attention: Mr. Robert Hauff, State Protection Forester via email: robert.d.hauff@hawaii.gov
1151 Punchbowl Street, Room 325
Honolulu, Hawaii 96813

Dear Mr. Hauff:

SUBJECT: Early Consultation on Environmental Assessment of the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR) Land Division distributed or made available a copy of your report pertaining to the subject matter to Land Division's Districts for their review and comments.

At this time, enclosed are comments from the Land Division's Oahu, Maui, Hawaii and Kauai Districts on the subject matter. Should you have any questions, please feel free to call Lydia Morikawa at 587-0410. Thank you.

Sincerely,

Russell Y. Tsuji
Land Administrator

Enclosure(s)
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED
LAND DIVISION
2018 JUN 21 AM 10:53
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

May 25, 2018

MEMORANDUM

FROM
~~TO:~~

DLNR Agencies:
___Div. of Aquatic Resources
___Div. of Boating & Ocean Recreation
___Engineering Division
___Div. of Forestry & Wildlife
___Div. of State Parks
___Commission on Water Resource Management
___Office of Conservation & Coastal Lands
X Land Division – OLDO/HDLO/MDLO/KDLO
___Historic Preservation

TO

~~FROM~~: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation on Environmental Assessment of the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*
LOCATION: State-wide
APPLICANT: Department of Land and Natural Resources, Division of Forestry and Wildlife

Transmitted for your review and comment is information on the above-referenced project. We would appreciate your comments by **June 22, 2018**.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Lydia Morikawa at 587-0410. Thank you.

(✓) We have no objections.
( ) We have no comments.
( ) Comments are attached.

Signed: [signature]
Print Name: Wesley T. Matsunaga
Date: 6/7/18

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

2018 MAY 31 A 10:44
RECEIVED
LAND DIVISION
HILO, HAWAII

May 25, 2018

2018 JUN -8 AM 10:57
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII
RECEIVED
LAND DIVISION

FROM:

MEMORANDUM

TO: **DLNR Agencies:**
___Div. of Aquatic Resources
___Div. of Boating & Ocean Recreation
___Engineering Division
___Div. of Forestry & Wildlife
___Div. of State Parks
___Commission on Water Resource Management
___Office of Conservation & Coastal Lands
_X_Land Division – OLDO/HDLO/MDLO/KDLO
___Historic Preservation

TO:

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation on Environmental Assessment of the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*
LOCATION: State-wide
APPLICANT: Department of Land and Natural Resources, Division of Forestry and Wildlife

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(✓) We have no objections.
( ) We have no comments.
( ) Comments are attached.

Signed: _____

Print Name: GORDON C. HEIT
Date: 6/5/18

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

May 25, 2018

MEMORANDUM

TO: **DLNR Agencies:**
___Div. of Aquatic Resources
___Div. of Boating & Ocean Recreation
___Engineering Division
___Div. of Forestry & Wildlife
___Div. of State Parks
___Commission on Water Resource Management
___Office of Conservation & Coastal Lands
X Land Division – OLDO/HDLO/MDLO/KDLO
___Historic Preservation

RECEIVED
2018 JUN 15 AM 11:25
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII
LAND DIVISION

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation on Environmental Assessment of the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*
LOCATION: State-wide
APPLICANT: Department of Land and Natural Resources, Division of Forestry and Wildlife

Transmitted for your review and comment is information on the above-referenced project. We would appreciate your comments by **June 22, 2018**.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Lydia Morikawa at 587-0410. Thank you.

RECEIVED MAY 31 2018

( ) We have no objections.
(X) We have no comments.
( ) Comments are attached.

Signed:
Print Name: Daniel Ornellas
Date: 6/6/18

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

May 25, 2018

RECEIVED
LAND DIVISION
2018 JUN -4 PM 1:44
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

MEMORANDUM

TO: **DLNR Agencies:**
___Div. of Aquatic Resources
___Div. of Boating & Ocean Recreation
___Engineering Division
___Div. of Forestry & Wildlife
___Div. of State Parks
___Commission on Water Resource Management
___Office of Conservation & Coastal Lands
_X_ Land Division – OLDO/HDLO/MDLO/KDLO
___Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation on Environmental Assessment of the state-wide release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*
LOCATION: State-wide
APPLICANT: Department of Land and Natural Resources, Division of Forestry and Wildlife

Transmitted for your review and comment is information on the above-referenced project. We would appreciate your comments by **June 22, 2018**.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Lydia Morikawa at 587-0410. Thank you.

( ) We have no objections.
(x) We have no comments.
( ) Comments are attached.

Signed: Darlene Bryant-Takamatsu
Print Name: Darlene Bryant-Takamatsu
Date: 6/4/18

Attachments
cc: Central Files

R. Fenstemacher PhD
1386 Manu Mele Street
Kailua, Hawaii 96734
(808) 235-1813
hale underscore noa at yahoo dot com
21 June 2018

Mr. Hauff
State Protection Forester
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, Hawaii 96813

Dear Mr. Hauff:

I have been hiking in Hawaii for a long time. The beauty and scientific wonder of Hawaii's unique native forests and the endemic flora they contain have captivated my imagination since the very start.

While out in the forest, I have seen with my own eyes how both miconia and wililaiki live up to their reputation as truly terrible weeds that significantly damage the forest. With time, these weeds invade and take over large areas of previously intact native forest, almost exclusively as a monoculture, and choke out large swaths of the native plants that were growing there. These disastrous growth habits severely degrade unique natural habitat, which results in severely negative consequences to our watersheds and the native flora. Highly invasive weeds like these are an existential threat to Hawaii's unique native forests.

Because neither miconia nor wililaiki appear to have any substantially redeeming benefits enough to counterbalance an overwhelming tendency to do harm, I support the planned release of biocontrol agents that specifically target miconia and wililaiki. The environmental impact of successfully controlling highly invasive weeds like these, which pose an existential threat to Hawaii's unique flora, would be to encourage native forest recovery and enhancement of our island watersheds.

Mahalo for this opportunity to comment. Please keep me in the loop.

Me ke aloha,

R. Fenstemacher

R. Fenstemacher

Robert Hauff, State Protection Forester 18 June 2018
Department of Land and Natural Resources
Kalanimoku Building, room 325, 1151 Punchbowl Street
Honolulu, Hawaii 96813

RE: Early Consultation on Environmental Assessment for *Pseudophilothrips Ichini* and *Euselasia chrysippe* for biological control of the noxious weeds *Schinus terebinthifolia* and *Miconia calvescens*, respectively.

Dear Sir:

Aloha. The Hawaii Botanical Society would like to express support of biocontrol efforts for the invasive weeds, miconia (*Miconia calvescens*) and wililaiki (*Schinus terebinthifolia*).

Wililaiki overpowers mesic habitat and chokes out native plants that should grow there. It expands as a monoculture to impoverish one of Hawaii's most threatened and unique ecosystems. Release of targeted biocontrol agents specific to wililaiki should aid recovery of these vanishing native mesic forests, recovery of the associated unique biota from those areas, and enhance the watershed.

Likewise, biocontrol of miconia (*Miconia calvescens*) should also be very positive. Miconia has a track record of invading native wet forests as a monoculture, which degrades that ecosystem, too. Release of targeted biocontrol agents specific to miconia should aid recovery of these native forests and enhance this ecosystem's vital watershed function.

In summary, both of these species are noxious, invasive weeds, and releasing biocontrol specific for them would be good for Hawaii's forests and watershed.

Me ke aloha,

Rebecca Barone, President
Hawaii Botanical Society
c/o UH Botany
3190 Maile way
Honolulu, HI 96822

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
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DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

KIRK CALDWELL
MAYOR

KATHY K. SOKUGAWA
ACTING DIRECTOR

TIMOTHY F. T. HIU
DEPUTY DIRECTOR

EUGENE H. TAKAHASHI
DEPUTY DIRECTOR

2018/ELOG-1065(rns4)
1602440

June 14, 2018

Mr. Robert Hauff
State Protection Forester
Division of Forestry and Wildlife
State of Hawaii
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, Hawaii 96813

Dear Mr. Hauff:

SUBJECT: State-wide Release of the Butterfly *Euselasia chrysippe* for Biological Control of the Noxious weed *Miconia calvescens*

We have reviewed your May 23, 2018 request for comments on proposed release of the butterfly *Euselasia chrysippe* for biological control of the noxious weed *Miconia calvescens*. The purpose of the release is to protect the "highly diverse native wet forest ecosystems."

We rely on the experts of the State Department of Land and Natural Resources to evaluate the ecological impacts of invasive species and the appropriate methods of controlling those invasive species, as informed by the best local, national, and international science.

Protection of Oahu's native wet forest ecosystems is consistent with City policies in the Oahu General Plan, the eight Development Plans and Sustainable Communities Plans, and the Oahu Watershed Management Plan. These Plans call for protection of natural resources, support of watershed infiltration and aquifer recharge, and reduction of sedimentation and toxic pollution of streams and coastal water caused by excessive storm water flows, all which will be supported by control of invasive species like *Miconia calvescens*.

Thank you for the opportunity to provide comments on this matter. Should you have any questions, please contact Lisa Imata of our staff at 768-8041.

Very truly yours,

Eugene H. Takahashi
Deputy Director

EHT:bkg

APPENDIX B: CULTURAL IMPACT ASSESSMENT FOR THE PROPOSED STATEWIDE RELEASE OF A BUTTERFLY (*EUSELASIA CHRYSIPPE*) AS BIOCONTROL FOR MICONIA (*MICONIA CALVESCENS*)

A Cultural Impact Assessment for the Proposed Statewide Release of a Butterfly (*Euselasia chrysippe*) as Biocontrol for Miconia (*Miconia calvescens*)

State of Hawai‘i

FINAL

Prepared By:
Lokelani Brandt, M.A.

Prepared For:

Division of Forestry and Wildlife, Department of Land and Natural Resources
1151 Punchbowl Street, #325
Honolulu, HI 96813

October 2019

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ASM Project Number 31270.00

A Cultural Impact Assessment for the Proposed Statewide Release of a Butterfly (*Euselasia chrysippe*) as Biocontrol for Miconia (*Miconia calvescens*)

State of Hawai‘i

ASM affiliates

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1. INTRODUCTION

At the request of the Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) and Hawai‘i Department of Agriculture (HDOA), referred to hereafter as the State of Hawai‘i, ASM Affiliates (ASM) has prepared this Cultural Impact Assessment (CIA) for the proposed statewide release of a butterfly (*Euselasia chrysippe*) as a biocontrol agent targeting *Miconia calvescens* (*Miconia*), a noxious fast-growing tree in the melastome family (Melastomataceae). Native to Central and South America, *Miconia* was introduced to the island of O‘ahu in 1961 as an ornamental plant and has become a major threat to Hawai‘i’s wet forest ecosystems (Medeiros et al. 1997). In 1991, the first efforts to control the spread of *Miconia* were initiated on Maui and in 1992, under Hawai‘i Administrative Rules, Chapter 68, it was officially listed as a noxious weed in the State of Hawai‘i (ibid.). In the State of Hawai‘i the term “invasive species” is any “alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Invasive Species Advisory Committee 2006:1). By 1996, management programs to eradicate known populations and to control the spread of *Miconia* were initiated on the islands of Kaua‘i, O‘ahu, and Hawai‘i (Leary et al. 2013). While removal and containment through applied herbicides and mechanical action have been the primary means of control, the increased operational cost associated with the spread of *Miconia* into more remote regions compounded by averse policy has shifted management strategies (Leary et al. 2013; Medeiros et al. 1997). To enhance Hawai‘i’s *Miconia* management efforts, DOFAW is proposing to release a natural enemy, a small butterfly *E. chrysippe*.

The current CIA is intended to inform an Environmental Assessment (EA) conducted in compliance with Hawai‘i Revised Statutes (HRS) Chapter 343. This CIA was prepared in adherence with the Office of Environmental Quality Control (OEQC) *Guidelines for Assessing Cultural Impact*, adopted by the Environmental Council, State of Hawai‘i, on November 19, 1997. As stated in Act 50, which was proposed and passed as Hawai‘i State House of Representatives Bill No. 2895 and signed into law by the Governor on April 26, 2000, “environmental assessments . . . should identify and address effects on Hawaii’s culture, and traditional and customary rights . . . native Hawaiian culture plays a vital role in preserving and advancing the unique quality of life and the ‘aloha spirit’ in Hawai‘i. Articles IX and XII of the state constitution, other state laws, and the courts of the State impose on governmental agencies a duty to promote and protect cultural beliefs, practices, and resources of native Hawaiians as well as other ethnic groups.”

The primary focus of this report is on understanding the cultural and historical context of *Miconia* with respect to Hawai‘i’s host culture. This CIA is divided into four main sections, beginning with an introduction of the proposed action followed by a physical description of *Miconia* and the proposed biocontrol agent *E. chrysippe*. Part two of this report provides a cultural-historical context of the settlement of the Hawaiian Islands by early Polynesian settlers and the transformation of their beliefs and practices associated with the land following Western contact. An overview of the history of biocontrol in Hawai‘i is also provided, and this section concludes with a detailed discussion of the introduction of *Miconia* to the South Pacific and into the Hawaiian Islands; all of which combine to provide a geographical and cultural context in which to assess the proposed action. The results from the consultation process are then presented, along with a discussion of potential impacts as well as appropriate actions and strategies to mitigate any such impacts.

PROPOSED ACTION

DOFAW has been working cooperatively with HDOA and the United States Forest Service (USFS) to control the harmful impacts of certain widespread invasive plant or pest species through the use of biological control (also referred to as biocontrol). Classical biocontrol is the strategy of using an invasive species' natural enemies from its native range to reduce the impacts of the invasive species. Biocontrol projects typically require years of research and survey work to find potential candidates that are subjected to a host of tests. Only those candidates that are host-specific, meaning they can only complete their life cycle on their intended invasive species host and shown to only negatively impact the growth and abundance of the target invasive species are considered for release. Once testing has been successfully completed, agencies must comply with national and state regulatory requirements for the release of the biocontrol agent. As such, the proposed action involves the use of state lands and funds, which necessitates compliance with Hawai‘i Revised Statutes (HRS) Chapter 343, also known as the Hawai‘i Environmental Policy Act (HEPA). The proposing agencies are conducting an Environmental Assessment (EA) of the proposed action to evaluate potential environmental impacts and this CIA is an essential component of the EA to ensure compliance with HRS Chapter 343.

MICONIA CALVESCENS AND THE PROPOSED BIOLOGICAL CONTROL AGENT

Native to the montane forests of Central and South America, *Miconia calvescens* (Melastomataceae) is a mid-story tree that measures 12 to 15 meters tall (Figure 1) (Leary et al. 2013). This tree has strongly trinerved, oblong-shaped leaves that can reach lengths of 80 centimeters (ibid.) (Figure 2). The species present in Hawai‘i, French Polynesia, southern Mexico, and Costa Rica are of a bicolor form with a purple leaf underside and green left topside (see Figure 2) (Medeiros et al. 1997). This attractive characteristic has made it favorable amongst plant collectors and horticulturalists who value the plant's vibrant colors and velvety texture (Leary et al. 2013). Flowers and fruits of the *Miconia* plant grow on stalks and in clusters and the inflorescence can vary in color from white to pink (Figure 3). *Miconia* can flower/fruit between two to three times per year and in moist conditions, it grows rapidly and can reach maturity within four to five years and produces millions of propagules in a single reproductive cycle (ibid.). This tree produces small purple-colored edible fruits that measure approximately 5.9 millimeters in diameter that are dispersed, in a natural setting by both frugivorous bird populations and natural dispersal such as gravity and water (Figure 4). Seeds can also be spread by human when seed filled soil adheres to shoes, clothing, equipment or vehicles. Each fruit is packed with anywhere from 50-200 minuscule seeds with each fruit measuring about 0.5 millimeters in diameter, which unceasingly accumulates in the soil and can remain viable for more than sixteen years (ibid.). Once sunlight penetrates the soil, dormant *Miconia* seeds can quickly germinate. Germination of dormant seeds is exacerbated when herbicidal or natural (i.e. high winds or hurricanes) defoliation occurs allowing more sunlight to permeate the forest floor. Areas containing high densities of *Miconia* are known to shade out the understory vegetation and is presumed to promote surface soil erosion in steep terrains (ibid.).

To supplement existing biological control efforts, DOFAW and the United State Forest Service (USFS) is proposing a statewide release of *Euselasia chrysippe* (Lepidoptera: Riodinidae), a small golden colored butterfly native to Costa Rica whose caterpillars feed externally on leaves of several species of *Miconia*. Larvae hatch from large egg masses and continue to molt and move in unison to feeding sites, helping to optimize foraging and deter enemies. *E. chrysippe* has been evaluated as a potential biological control agent for *Miconia calvescens* through research in its native Costa Rica as well as in containment facilities in Hawai‘i. Tests have been conducted on a variety of native and non-native plants to identify the butterfly larvae's potential host range. Results indicate that it does not have the capacity to impact native or economic plants in Hawai‘i, and its host range is limited to *M. calvescens* and closely related weeds within the melastome family. Melastomes in Hawai‘i includes *Miconia*, *Clidemia* (*Clidemia hirta*) and other invasive alien species, but no native plants.

Figure 1. Tall stands of *Miconia* growing along the Onomea scenic route in South Hilo, Hawai‘i.

Figure 2. Trinerved and bicolor leaves of *Miconia*.

Figure 3. White inflorescence growing on stalks at the top of a *Miconia* plant.

Figure 4. Mature dark purple fruits on the pink stalks of a *Miconia* plant.

2. BACKGROUND

The following section contains a cultural-historical context of the settlement of the Hawaiian Islands by early Polynesian settlers and the transformation of their beliefs and practices associated with the land following western contact. An overview of the history of biocontrol in Hawai‘i is also provided and this section concludes with a detailed discussion of the introduction of *Miconia* to the Hawaiian Islands and its impacts to Hawai‘i’s wet forests.

GEOGRAPHICAL AND CULTURAL CONTEXT OF HAWAI‘I

The Hawaiian Islands are located within the vast and remote Pacific Ocean, situated more than 3,200 kilometers (2,000 miles) from the nearest continent (Juvik and Juvik 1998). The 16,640 square kilometers (6,425 square miles) of land consists of eight main large volcanic islands, Hawai‘i, Maui, Kaho‘olawe, Lāna‘i, Moloka‘i, O‘ahu, Kaua‘i, and Ni‘ihau and 124 smaller islands, reefs, and shoals (ibid.) (Figures 5 and 6). Due to its geographical placement in the middle of the vast Pacific Ocean, coupled with its diverse climatic conditions, the Hawaiian Islands boasts the highest levels of endemism in both native plants and animals, with over 10,000 species found nowhere else in the world (Cannarella 2010).

While the question of the timing of the first settlement of Hawai‘i by Polynesians remains unanswered, several theories have been offered that derive from various sources of information (i.e., archaeological, genealogical, mythological, oral-historical, radiometric). However, none of these theories are today universally accepted. What is more widely accepted is the answer to the question of where Hawaiian populations came from and the transformations they went through on their way to establish a uniquely Hawaiian culture. More recently, with advances in palynology and radiocarbon dating techniques, Kirch (2011) and others (Athens et al. 2014; Wilmshurst et al. 2011) have convincingly argued that Polynesians arrived in the Hawaiian Islands, sometime between A.D. 1000 and A.D. 1200 and expanded rapidly thereafter (c.f., Kirch 2011). The initial migration to Hawai‘i is believed to have occurred from Kahiki (the ancestral homelands of Hawaiian gods and people) with long distance voyages occurring fairly regularly through at least the 13th century. It has been generally reported that the sources of the early Hawaiian populations originated from the southern Marquesas Islands (Emory in Tatar 1982). In these early times, Hawai‘i’s inhabitants were primarily engaged in subsistence-level agriculture and fishing (Handy and Handy 1991). This was a period of great exploitation and environmental modification when early Hawaiian farmers developed new subsistence strategies by adapting their familiar patterns and traditional tools to their new environment (Kirch 1985; Pogue 1978). According to Fornander (1969), the Hawaiians brought from their homeland certain Polynesian customs and belief: the major gods Kāne, Kū, Lono, and Kanaloa; the *kapu* system of law and order; the *pu‘uhonua* (places of refuge), the *‘aumakua* concept, and the concept of *mana*.

For generations following initial settlement, communities were clustered along the watered, windward (*Ko‘olau*) shores of the Hawaiian Islands. Along the *ko‘olau* shores, streams flowed and rainfall was abundant, and agricultural production became established. The *ko‘olau* region also offered sheltered bays from which deep-sea fisheries could be easily accessed, and nearshore fisheries, enriched by nutrients carried in the fresh water, could be maintained in fishponds and coastal waters. It was around these bays that clusters of houses where families lived could be found (McEldowney 1979). In these early times, Hawai‘i’s inhabitants were primarily engaged in subsistence-level agriculture and fishing (Handy and Handy 1972). Following the initial settlement period, areas with the richest natural resources became populated and perhaps crowded, and by about A.D. 1200, the population began expanding to the Kona (leeward side) and more remote regions of the island (Cordy 2000).

As the population continued to expand so did social stratification, which was accompanied by major socioeconomic changes and intensive land modification. Most of the ecologically favorable zones of the windward and coastal regions of all major islands were settled and the more marginal leeward areas were being developed. During this expansion period, additional migrations to Hawai‘i occurred from Tahiti in the Society Islands. Rosendahl (1972) has proposed that settlement at this time was related to the seasonal, recurrent occupation in which coastal sites were occupied in the summer to exploit marine resources, and upland sites were occupied during the winter months, with a focus on agriculture. An increasing reliance on agricultural products may have caused a shift in social networks as well; as Hommon (1976) argues, kinship links between coastal settlements disintegrated as those links within the *mauka-makai* settlements expanded to accommodate the exchange of agricultural products for marine resources. This shift is believed to have resulted in the establishment of the *ahupua‘a* system sometime during the A.D. 1400s (Kirch 1985), which added another component to an already well-stratified society. The implications of this model include a shift in residential patterns from seasonal, temporary occupation, to the permanent dispersed occupation of both coastal and upland areas.

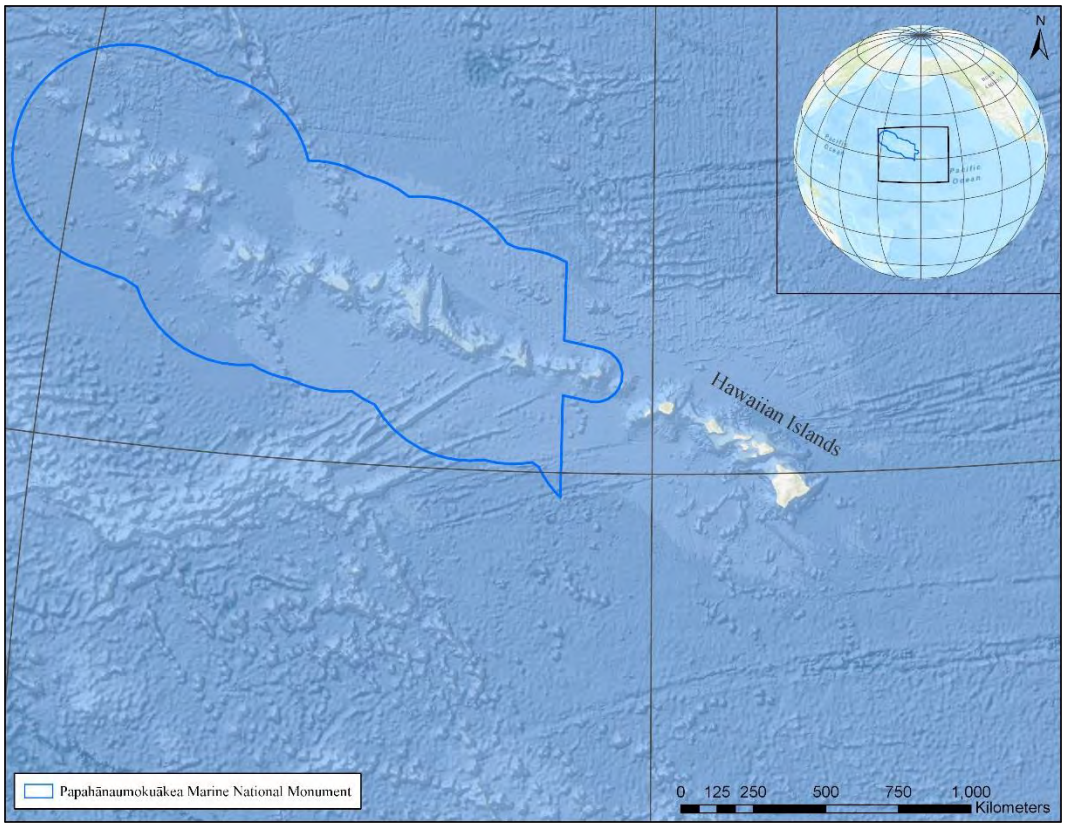

Figure 5. Map of the Hawaiian archipelago.

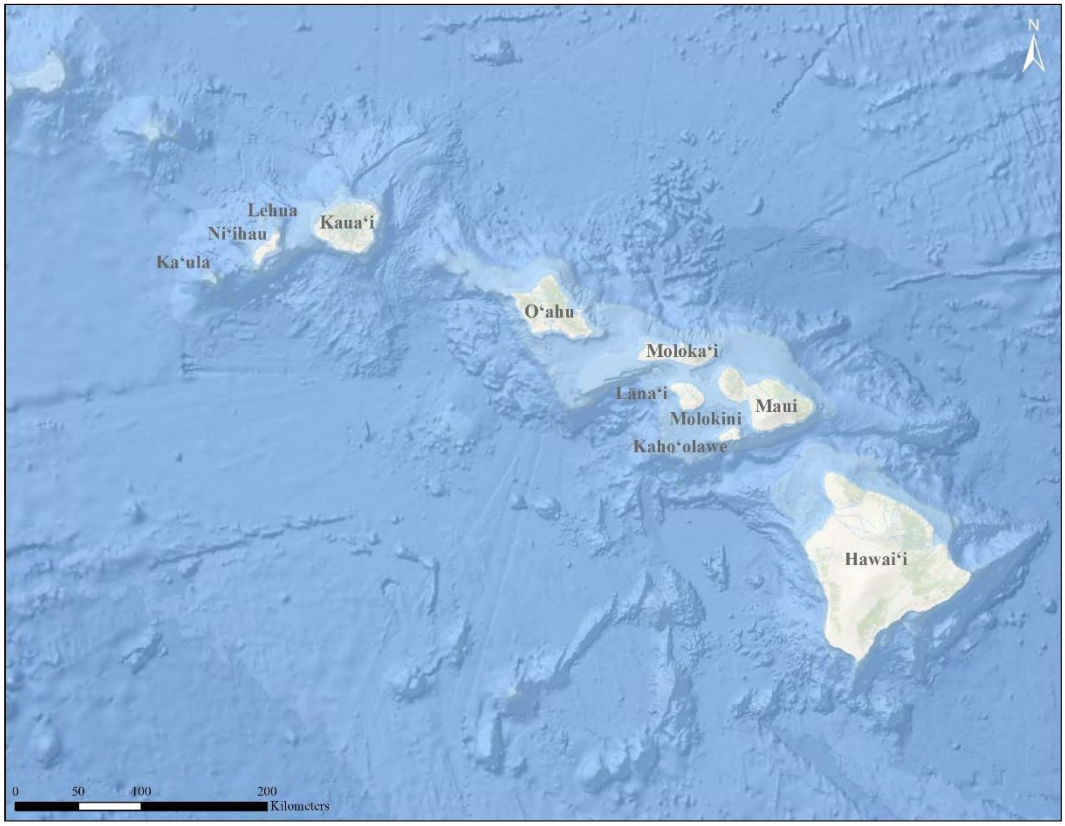

Figure 6. Map of the main Hawaiian Islands

Adding to an already highly-complex society was the development of the traditional land division system, which included the *ahupua'a*—the principle land division that functioned for both taxation purposes and furnished its residents with nearly all of the fundamental necessities. *Ahupua'a* are land divisions that typically incorporated all of the eco-zones from the mountains to the sea and for several hundred yards beyond the shore, assuring a diverse subsistence resource base (Hommon 1986). Although the *ahupua'a* land division typically incorporated all of the eco-zones, their size, shape, and resource base varied greatly (Cannelora 1974). In summarizing the types of ecozones that could be found in a given *ahupua'a*, Hawaiian scolar and historian, Samuel Kamakau writes:

> Here are some names for [the zones of] the mountains—the *mauna* or *kuahiwi*. A mountain is called a *kuahiwi*, but *mauna* is the overall term for the whole mountain, and there are many names applied to one, according to its delineations (*'ano*). The part directly in back and in front of the summit proper is called the *kuamauna* , mountaintop; below the *kuamauna* is the *kuahea*, and makai of the *kuahea* is the *kuahiwi* proper. This is where small trees begin to grow; it is the *wao nahele*. Makai of this region the trees are tall, and this is the *wao lipo*. Makai of the *wao lipo* is the *wao 'eiwa*, and makai of that the *wao ma'ukele*. Makai of the *wao ma'ukele* is the *wao akua*, and makai of there is the *wao kanaka*, the area that people cultivate. Makai of the *wao kanaka* is the *'ama'u*, fern belt, and makai of the *'ama'u* the *'apa'a*, grasslands.
>
> A solitary group of trees is a *moku la'au* (a "stand" of trees) or an *ulu la'au*, grove. Thickets that extend to the *kuahiwi* are *ulunahele*, wild growth. An area where *koa* trees suitable for canoes (*koa wa'a*) grow is a *wao koa* and mauka of there is a *wao la'au*, timber land. These are dry forest growths from the *'apa'a* up to the *kuahiwi*. The places that are "spongy" (*naele*) are found in the *wao ma'ukele*, the wet forest.
>
> Makai of the *'apa'a* are the *pahe'e* [*pili* grass] and *'ilima* growths and makai of them the *kula*, open country, and the *'apoho* hollows near to the habitations of men. Then comes the *kahakai*, coast, the *kahaone*, sandy beach, and the *kalawa*, the curve of the seashore—right down to the *'ae kai*, the water's edge.
>
> That is the way *ka po'e kahiko* [the ancient people] named the land from mountain peak to sea. (Kamakau 1976:8–9)

The *hoa'āina* (native tenants) and *'ohana* (families) who lived on the land had rights to the gather resources for subsistence and for tribute (Jokiel et al. 2011). As part of these rights, the *ahupua'a* residents were also required to supply resources and labor that supported the royal community of regional and/or island kingdoms. The *ahupua'a* became the equivalent of a local community, with its own social, economic, and political significance and served as the taxable land division during the annual *Makahiki* procession (Kelly 1956). During this annual procession, the highest chief of the land sent select members of his retinue to collect *ho'okupu* (tribute and offerings) in the form of goods from each *ahupua'a*. The *hoa'āina* (native tenants) who resided in the *ahupua'a* brought their share of *ho'okupu* to an *ahu* (altar) that was symbolically marked with the image of a *pua'a* (pig). *Ahupua'a* were ruled by *ali'i 'ai ahupua'a* or chiefs who controlled the *ahupua'a* resources; who, for the most part, had complete autonomy over this generally economically self-supporting piece of land (Malo 1951). *Ahupua'a* residents were not bound to the land nor were they considered the property of the *ali'i*. If the living conditions under a particular *ahupua'a* chief were deemed unsuitable, the residents could move freely in pursuit of more favorable conditions (Lam 1985). This structure safeguarded the well-being of the people and the overall productivity of the land, lest the chief loses the principle support and loyalty of his or her supporters. *Ahupua'a* lands were in turn, managed by an appointed *konohiki* or lesser chief-landlord, who oversaw and coordinated stewardship of an area's natural resources (ibid.). In some places, the *po'o lawai'a* (head fisherman) held the same responsibilities as the *konohiki* (Jokiel et al. 2011). When necessary, the *konohiki* took the liberty of implementing *kapu* (restrictions and prohibitions) to protect the *mana* of the area's resources from physical and spiritual depletion.

Many *ahupua'a* were further divided into smaller land units termed *'ili* and *'ili kūpono* (often shortened to *'ili kū*). *'Ili* were created for the convenience of the *ahupua'a* chief and served as the basic land unit to which the *hoa'āina*, retained for often long periods of time (Jokiel et al. 2011; MacKenzie 2015). As the *'ili* themselves were typically passed down in families, so too were the *kuleana* (responsibilities, privileges) that were associated with it. The right to use and cultivate *'ili* was maintained within the *'ohana*, regardless of any change in title of the *ahupua'a* chief (Handy and Handy 1991). Malo (1951), recorded several types of *'ili*: the *'ili pa'a,* a single intact parcel and the *'ili lele*, a discontinuous parcel dispersed across an area. Whether dispersed or wholly intact, the *'ili* land division required a cross section of available resources, and for the *hoa'āina*, this generally included access to agriculturally fertile lands and coastal fisheries. While much of the same resource principles applied to the *'ili kūpono*, these land units were

politically independent of the *ahupua'a* chief. This designation was applied to specific areas containing resources that were highly valued by the ruling chiefs, such as fishponds (Handy and Handy 1991).

The *ali'i* who presided over the *ahupua'a* (*ali'i-'ai-ahupua'a*), in turn, answered to an *ali'i 'ai moku* (chief who claimed the abundance of the entire *moku or* district) (Malo 1951). Although *moku* (districts) were comprised of multiple *ahupua'a*, they were considered geographical subdivisions with no explicit reference to rights in the land (Cannelora 1974). This form of district subdividing was integral to Hawaiian life and was the product of resource management planning that was strictly adhered to. As knowledge of place developed over the centuries and passed down intergenerationally by direct teaching and experience, detailed information of an area's natural cycles and resources were retained and well-understood. Decisions were based on generations worth of highly informed knowledge and sustainably adapted to meet the needs of a growing population. This highly-complex land management system mirrors the unique Hawaiian culture that coevolved with these islands.

Evolution of Hawaiian Land Stewardship Practices and the Impacts on Hawai'i's Native Forests

Their ancient and ingrained philosophy of life tied them to their environment and helped to maintain both natural, spiritual, and social order. In describing the intimate relationship that exists between Hawaiians and *'āina* (land), Hawaiian historian and cultural specialist, Kepā Maly writes:

> In the Hawaiian context, these values—the "sense of place"—have developed over hundreds of generations of evolving "cultural attachment" to the natural, physical, and spiritual environments. In any culturally sensitive discussion on land use in Hawai'i, one must understand that Hawaiian culture evolved in close partnership with its' natural environment. Thus, Hawaiian culture does not have a clear dividing line of where culture and nature begins.
>
> In a traditional Hawaiian context, nature and culture are one in the same, there is no division between the two. The wealth and limitations of the land and ocean resources gave birth to, and shaped the Hawaiian world view. The *'āina* (land), *wai* (water), *kai* (ocean), and *lewa* (sky) were the foundation of life and the source of the spiritual relationship between people and their environs. (Maly 2001)

The Hawaiian *'ōlelo no'eau* (proverbial saying) "*Hānau ka 'āina, hānau ke ali'i, hānau ke kanaka*" (Born was the land, born were the chiefs, born were the commoners), conveys the belief that all things of the land including *kanaka* (humans) were literally born (*hānau*), and are thus connected through kinship links that extend beyond the immediate family (Pukui 1983:57). *'Āina* or land, was perhaps most revered, as another *'ōlelo no'eau* notes, "*He ali'i ka 'āina; he kauwā ke kanaka,*" which has been translated by Pukui (1983:62) as "The land is a chief; man is its servant." The lifeways of early Hawaiians, which were derived entirely from the finite natural resources of these islands, necessitated the development of sustainable resource management practices. Over time, what developed was an adaptable management system that integrated the watershed, freshwater, nearshore fisheries, all of which are connected through the many unique ecosystems that extend from the mountains to the sea (Jokiel et al. 2011).

Kilo or astute observation of the natural world became one of the most fundamental stewardship tools used by the ancient Hawaiians. The vast knowledge acquired through the practice of *kilo* enabled them to observe and record the subtlest changes, distinctions, and correlations in their natural world. Examples of their keen observations are evident in Hawaiian nomenclature, where numerous types of rains, clouds, winds, stones, environments, flora, and fauna, many of which are geographically unique, have been named and recorded in centuries-old traditions such as *oli* (chants), *mele* (songs), *pule* (prayers), *inoa 'āina* (place names), *'ōlelo no'eau* (proverbial sayings), all of which were transmitted orally through the ages. Other traditional Hawaiian arts and practices including, (but not limited to) *hula* (traditional dance), *lapa'au* (traditional healing), *lawai'a* (fishing), *mahi'ai* (farming) further reinforced knowledge of and connection to the natural environment.

Their exclusive dependency on a thriving natural environment led Hawaiians to develop a sophisticated and comprehensive system of land stewardship that was reinforced through the strict adherence to practices that maintained and enhanced the *kapu* and *mana* of all things in the Hawaiian world. In Hawaiian belief, all things natural, places, and even people, especially those of high rank, possesses a certain degree of *mana* or "divine power" (Pukui et al. 1972; Pukui and Elbert 1986:235). *Mana* is believed to be derived from the plethora of Hawaiian gods (*kini akua*) who were embodied in elemental forces and natural resources, such as the land, mountains, plants, animals, water and certain material objects and persons (Crabbe et al. 2017). Buck (1993) expanded on this concept noting that *mana* was associated with "the well-being of a community, in human knowledge and skills (canoe building, harvesting) and in nature (crop fertility, weather, etc.)" (in Else 2004:244). Hawaiian cultural practitioner and conservation biologist, Sam Gon III adds that this belief "imposes familial responsibilities on people, and engenders respect and care for native plants and animals" (Gon III 2010:1–2).

To ensure the *mana* of the resources, certain places, and people remained protected from over-exploitation and defilement, *kapu* of various kinds were implemented and strictly enforced. According to Elbert and Pukui (1986:132) *kapu* are defined as "taboo, prohibitions; special privilege or exemption..." Kepelino (1932) notes that *kapu* associated with the gods applied to all social classes, while the *kapu* associated with the chiefs were applied to the people. As the laws of *kapu* dictated social relationships, it also provided "environmental rules and controls that were essential for a subsistence economy" (Else 2004:246). Juxtaposed to the concept of *kapu* was *noa*, translated as "freed of taboo, released from restrictions, profane, freedom" (Pukui and Elbert 1986:268). Some *kapu*, particularly those associated with maintaining social hierarchy and gender differentiation were unremitting, while those *kapu* placed on natural resources were applied and enforced according to seasonal changes. The application of *kapu* to natural resources ensured that such were resources remained unspoiled and available for future use. When the *ali'i* or the lesser chiefs (including *konohiki* and *po'o lawai'a*) determined that a particular resource was to be made available to the people, a decree was proclaimed indicating that *kapu* had been lifted, thereby making it *noa*. Although transitioning a resource from a state of *kapu* to *noa* allowed for its use, people were still expected to practice sustainable harvesting methods and pay tribute to the ruling chief and the gods and goddesses associated with that resource. *Kapu* were strictly enforced and violators faced serious consequences including death (Jokiel et al. 2011). Violators who managed to escape death sought refuge at a *pu'uhonua*, a designated place of refuge or sometimes were freed by the word of certain chiefs (Kamakau 1992). After completing the proper rituals, the violator was absolved of his or her crime and allowed to reintegrate back into society.

This ancient and ingrained way of life underwent serious transformations following the arrival of Captain James Cook in 1778. This year marks the end of what is often referred to as Hawai'i's Precontact Period and the beginning of the Historic Period. While this time mark signifies an important date in Hawaiian history, it is vital to note that throughout the early Historic Period, even with Western influences, the Hawaiian chiefs still held outright rule over the land and its resources and maintained strict adherence to the *kapu* system—the very system from which their power was derived. For many Hawaiian historians, the abrogation of the *kapu* system in 1819, also marked significant socio-religious changes. Some scholars have argued that the abolishment of the *kapu* system undermined the very foundation upon which traditional Hawaiian society was built, ultimately altering the relationship between the chiefs and the people as well as their relationship to the land (Else 2004; Kame'eleihiwa 1992). At the outset of the Historic Period, there was a continued trend toward craft and status specialization, intensification of agriculture, *ali'i* controlled aquaculture, the establishment of upland residential sites, and the enhancement of traditional oral history. The veneration of traditional gods and the strict observation of the *kapu* system were at their peaks (Kent 1983; Kirch 1985). With the influx of foreigners, many of whom were quick to introduce the idea of trade for profit, Hawai'i's traditional culture, and the socio-political economy began to shift to meet the growing demands of the foreign populations.

The Arrival of Foreign Plants and Animals and the Transformation of the *Kapu* System

By the time Kamehameha had conquered O'ahu, Maui, and Moloka'i, in 1795, Hawai'i saw the beginnings of a market system economy and the work of the native tenants shifted from subsistence agriculture to the production of foods and goods that could be traded with early explorers and whalers (Kent 1983). Introduced fruit trees and garden vegetables, often grown for trade with Westerners included yams, coffee, melons, Irish potatoes, Indian corn, beans, figs, oranges, guavas, and grapes (Wilkes 1845). Animals such as goats, sheep, pigs, cattle, horses, and turkeys that were left by Cook and other early visitors between 1778 and 1803 were allowed to roam freely (Kuykendall 1938). Of all the foreign introductions, cattle had the most profound impact. Setting the foundations of Hawai'i's livestock industry, in 1793, Captain George Vancouver, who had visited the islands during Cook's 1778 voyage, gifted the first cattle to Kamehameha. The lack of quality cattle feed proved to be detrimental to the animals. To combat this, Kamehameha, at the demand of Captain George Vancouver, enforced a *kapu*, which lasted until the 1830s that prohibited the killing of the animals (Bergin 2004; Kuykendall 1938). The first head of steer and sheep that were gifted by Vancouver were driven into the upland plains of Waimea on Hawai'i Island and allowed to roam and multiply (Barrera 1983). The unrestrained populations of cattle had increased significantly and by the 1830s had become a nuisance to native farmers. Additionally, the environmental degradation of the native forests had become apparent to Kamehameha's sons and heirs who began to take steps to control the ravenous cattle population. In an effort to protect their crops, and to reduce the risk of encountering the large and often dangerous animals, native farmers began constructing taller enclosures to prevent the animals from plundering their gardens and destroying their homes. On Hawai'i Island, where cattle populations are said to have numbered in the tens of thousands, tall rock walls that stretched for miles were built around the more densely populated areas (Bergin 2004). While the introduced plants and animals contributed to the development of Hawai'i's early market economy, the exportation of native hardwoods, particularly *'iliahi* or sandalwood compounded the preexisting environmental degradation and wreaked havoc on the native lifeways.

The *ʻiliahi* or sandalwood (*Santalum ellipticum*) trade established by Euro-Americans in 1790 quickly turned into a viable commercial enterprise (Oliver 1961). By 1810, and with the backing of Kamehameha and other chiefs, this industry flourished, as farmers and fishermen were ordered into the mountains of their district to cut sandalwood and carry it to the coast. Although the laborers were compensated with *kapa* (material), food and fish (Kamakau 1992), the neglect of their personal subsistent duties lead to food shortages and famine. The harsh working conditions coupled with lack of nutrition severely degraded the health and *mana* of the native people, ultimately contributing to a population decline. This industry also began to erode the relationship between the *aliʻi* and the common people (Else 2004). Kamakau (ibid.:204) described the collapse of a traditional subsistence system and the industry's detrimental effects on the people: "…this rush of labor to the mountains brought about a scarcity of cultivated food . . . The people were forced to eat herbs and tree ferns, thus the famine [was] called Hi-laulele, Haha-pilau, Laulele, Pualele, ʻAmaʻu, or Hapuʻu, from the wild plants resorted to." Once Kamehameha realized the dire effects this industry on his people, he "declared all the sandalwood the property of the government and ordered the people to devote only part of their time to its cutting and return to the cultivation of the land" (ibid.: 1992:204). Kamehameha also proclaimed sustainable harvesting strategies as noted by Kamakau, who wrote, "He ordered the sandalwood cutters to spare the young trees and, not to let the felled trees fall on the saplings" (ibid.:209-210).

On May 8th, 1819, Kamehameha, who had seen the onset of impacts brought about by foreign introductions, died at his royal residence at Kamakahonu in Kailua-Kona and named his son ʻIolani Liholiho heir to his kingdom (Kamakau 1992). By May 21st ʻIolani Liholiho (Kamehameha II) at the age of twenty-one began his rule. As traditional custom dictated and to allow for all people to rightfully mourn the loss of their chief, all *kapu* were relaxed following the death of a chief (ibid.). It was the responsibility of the new ruler to conduct the proper rituals and ceremonies to reinstate all *kapu.* However, Liholiho's attempts to reinstate the long-standing *kapu* system was futile and the future of the *kapu* system stood in a state of uncertainty. *Kuhina Nui* (Premier), Kaʻahumanu (the wife of Kamehameha and the *hānai* (adopted) mother of Liholiho) and his biological mother Keōpūolani lured the young chief back to Kona and the *kapu* system was symbolically abolished when Liholiho ate in the presence of his mothers. While Liholiho, his mothers and other chiefs favored the complete abolishment of the *kapu* system, others including Kekuaokalani and his followers prepared to wage war, determined to have the ancient laws reinstated. After several failed attempts at negotiation, Liloliho's army led by Kalaimoku went head-to-head against the forces of Kekuaokalani in the Battle of Kuamoʻo (Fornander 1918–1919). Western weaponry had already permeated traditional Hawaiian warfare and Kekuaokalani, who stood behind the ancient laws of the land was killed by gunfire on the battlefield alongside his wife Manono, thereby extinguishing the last public display of resistance. The abolishment of the *kapu* system in 1819, began to undermine the very foundations upon which traditional Hawaiian culture was formed. Adding to an already socio-politically fractured society was the arrival of Protestant missionaries who sought to fill the spiritual void of the Hawaiian people.

In October of 1819, just five months after the death of Kamehameha, the first American Protestant missionaries aboard the Brig. *Thaddeus* left Boston, Massachusetts and by March 30th, 1820, sailed to Kawaihae on the northwest coast of Hawaiʻi Island (Hawaiian Mission Children's Society 1901). Having heard of the overturning of the ancient *kapu* system, these early missionaries formed close alliances with some of Hawaiʻi's royalty, including Kaʻahumanu who held a tremendous amount of political power. Starting in 1823, these early missionaries, one of which included William Ellis (1917) set out into the remote parts of the islands in search of suitable locations for future mission stations and within a few short years, mission stations were being constructed outside of the main town centers. Christian beliefs quickly spread and soon established a firm foothold in the islands. The missionaries quickly discovered that many Hawaiians were selective about what aspects of Christianity they were willing to adopt. In striving for complete conversion, the missionaries with the help of the *aliʻi* implemented laws that enforced Euro-American beliefs on the Hawaiian people. To an extent, this furthered the efforts of the missionaries. Despite these massive cultural changes, many Hawaiians continued to hold to their ancient beliefs, especially those associated with their relationship to the land. Throughout the remainder of the 19th century, introduced diseases and global economic forces continued to degrade the traditional life-ways of the Hawaiian people.

Private Property and Its Effects on Traditional Concepts of Land and Land Use Practices

By the mid-19th century, the ever-growing population of Westerners in the Hawaiian Islands forced socioeconomic and demographic changes that promoted the establishment of a Euro-American style of land ownership. By 1840, the first Hawaiian constitution had been drafted and the Hawaiian Kingdom shifted from an absolute monarchy into a constitutional government. Convinced that the feudal system of land tenure previously practiced was not compatible with a constitutional government, the *Mōʻī* Kauikeaouli and his high-ranking chiefs decided to separate and define the ownership of all lands in the Kingdom (King n.d.). The change in land tenure was further endorsed by missionaries and Western businessmen in the islands who were generally hesitant to enter business deals on leasehold lands that

could be revoked from them at any time. The push for exclusive private property rights culminated in the *Māhele ʻĀina* of 1848 and the subsequent *Kuleana* Act or Enabling Act of 1850.

While the formalization of private property rights was a success for many Westerners, this ultimately led to the displacement of many Hawaiians from their ancestral lands—lands that they had come to know so intimately. In general, although many Hawaiians were awarded lands during this period, it was realized that the parcels they were awarded were insufficient to sustain their traditional subsistence lifestyles. Additionally, access to resources that were once a part of the now fragmented *ahupuaʻa* system further curtailed traditional subsistence activities. As many Hawaiian continued to migrate to the populated centers around the islands and even elsewhere, large tracts of land that were once dotted with small communities and extensive traditional agricultural fields were being prospected for large scale commercial agriculture and ranching. Although these industries added to the cultural tapestry of the islands, such operations required vast amounts of land and water. The mass acquisition of land and the diversion of water from their natural courses during the 19th and 20th centuries resulted in numerous court battles between Western businessmen competing to increase their operations and native Hawaiians who willfully held to their traditional lifeways. Such issues continue to be vetted in Hawaiʻi courtrooms.

Formerly forested lands were being grazed down and, in some places, planted with introduced species of grass and various shrubs to form natural fencing and to be used as livestock feed (Henke 1929). In the drier leeward area of Hawaiʻi, the planting of *kiawe* or algaroba (*Prosopis robusto*) proved to be useful for the cattle and apiary industry (ibid.). By the mid-19th century, the apparent destruction of native forest habitat had severely diminished the water supply of islands, ultimately prompting action by the Hawaiian Kingdom government. In 1876, the Kingdom legislature under the administration of King David Kalākaua passed "An Act for the Protection and Preservation of Woods and Forests" (Planters' Labor and Supply Company 1887:438)." Between 1876-1910, uncoordinated efforts between the government and various agricultural sectors were undertaken to remedy the loss of native forests and to increase water supply (Cannarella 2010). Wild ungulates were removed from some native forests habitats—an effort that began in the 1830s—and efforts to fence off sections of intact forests set the foundation for Hawaiʻi's forest reserves. To replenish severely degraded forests, a large number of non-native species were experimentally planted, including, *paina* or ironwood (*Casuarina equisitifolia*), silver oak (*Grevillea robusto*), wind acacia, sour plum, and a number of other species (Henke 1929). Efforts to diversify the Kingdom's economy and the long-standing trend of introducing exotic plant and animal species to the islands continued to mount.

The introduction of large-scale planting of sugar cane during the mid- to late-19th century resulted in massive land clearing efforts around the islands. The success and growth of the sugar industry within the more arid parts of the islands was highly dependent upon an ample supply of irrigation water (Wilcox 1996). Occasional wildfires and pests such as the leafhopper threatened the burgeoning sugar industry (Campbell and Ogburn 1990). To ensure economic prosperity, these sugar companies invested in experimental agriculture. New varieties of cane collected from various parts of the world were introduced without restraint and tested to meet the climatic challenges of growing cane in Hawaiʻi. By the 1890s, under the administration of King David Kalākaua, efforts to regulate plant and animal imports, many of which carried pests that were unknown to the islands, had become a priority for the Hawaiian Kingdom government.

HISTORY OF BIOCONTROL IN THE HAWAIIAN ISLANDS

The use of classical biocontrol, "the suppression of pest populations by introduction and liberation of natural enemies," has been actively undertaken in the Hawaiian Islands for roughly 130 years with varying degrees of success (Funasaki et al. 1988:105; Lai 1988). Throughout the latter half of the 19th century, as the Hawaiian Islands became an agricultural hotspot for sugar cane and other crops, many new plant species, some carrying insect pests, were introduced without restraint. In 1890, the Hawaiian Kingdom Government, under the administration of King David Kalākaua established the Commissioners of Agriculture to prevent unwanted immigrant pests from entering the islands, and to control those that had already been introduced. The duties of the Commissioners were detailed in Chapter II of *Session Laws of 1890*. Chapter II titled "An Act Relating to the Suppression of Plant Disease, Blight, and Insect Pests" reads:

> SECTION 2. It shall be the duty of such Commissioners to seek to prevent the introduction into this Kingdom of any plant disease, blight, or insect pests injurious to any tree or trees, plant or plants, or vegetation; and to seek to exterminate any such diseases, blight or insect pests now existing or hereafter introduced.
>
> They shall have the power to enter upon any premises where they have reason to believe there is any tree, plant, or vegetation affected with any disease, blight, or insect pest; and to take all reasonable and proper steps to prevent the spread of any such disease, blight or insect pest, and if

> after due trial (such trial to be not longer than ten days) it is found by said Commissioners, or one of them, that the trees, plants or vegetation cannot be cured, or the blight destroyed, that then an in such case he or they may order the same destroyed. (Kalakaua 1890:4–5)

The initiation of the 1890 laws was in response to unregulated efforts to control pests—an act that prior to 1890 was being initiated at the whim of private citizens. The earliest accounts of the unregulated use of biocontrol can be traced back to 1865, when Dr. William Hillebrand, a physician, and naturalist, brought the mynah bird (*Acridotheres tristis*) from India to Hawai‘i to control army worms that were infesting Hawai‘i’s pastures (Funasaki et al. 1988). Because of the mynah bird’s appetite for rotting and decomposed things, and for its use of garbage as nesting material, the bird was given the Hawaiians name of “*manu-‘ai-pilau,*” which can be translated as the bird that consumes rotten things (Pukui and Elbert 1986:486). The mynah bird is also known in Hawaiian as “*piha‘ekelo”*, literally translated as “full of ‘ekelo sound,” a name given because of its raucous nature (ibid.:326). The debate over whether the introduction of the mynah bird was successful in controlling army worms spilled over into local newspapers. Proponents of the mynah bird emphasized its success, however, others alleged that such comments poorly represented the birds’ impacts to agriculture and to the people. An article published in *The Pacific Commercial Advertiser* in 1876 challenged some of the alleged successes:

> THOSE CATERPILLARS.—The *Gazette* says that owing to the large increase of *mynah birds*, “not a caterpillar is to be seen in this regions,” (Honolulu) while at points outside of this favored range of the birds the grass has been destroyed. This would be a very pretty and pleasing statement in favor of the usefulness of the *mynahs*, if it were true, as unfortunately it is not. Right here and now, in the immediate neighborhood of the city, on the plains and elsewhere the birds abound, caterpillars do much more abound,—in such immense quantities that it would be simply impossible for the former to make any perceptible impressions on the mass. No doubt the *mynah* would not refuse a fat caterpillar now and again; but we don’t believe they prefer them as a regular diet, for the bird is something of an epicure and delights to range from stolen beefsteak to a nest of pigeon’s or dove’s eggs. Chickens are very good at destroying the vermin, so far as their capacities go; and turkeys are better. But the plague is usually of but brief duration. (The Pacific Commercial Advertiser 1876:3)

Complaints of the mynah bird attacking people and livestock filled the local newspapers throughout the late 19th century. The noisy mynah bird had become such a nuisance to the residents of Honolulu that some people took to the city with guns to exterminate the birds. The mynah bird proponents fired back and proposed a law that would prevent the killing of the birds. An article written in the November 9th, 1894, issue of *The Hawaiian Star* blamed the mynah bird and the dove for aiding in the spread of another noxious introduction, *Lantana camara*, which was brought to the islands from “tropical America in the year 1858” (The Hawaiian Star 1894:3).

During Hawai‘i’s sugar plantation era, rats had become a serious pestilence to sugar plantation owners and considerable attempts to bring Hawai‘i’s rat population under control were being actualized. An article published in the March 31, 1883, edition of *The Pacific Commercial Advertiser* details the proposed introduction of the infamous mongoose (*Herpestes javanicus*), a native of India to Hawai‘i’s cane fields:

> THE Planters’ Monthly has lately been proposing the introduction of a little animal from India called the mongoose, as a destroyer of rats. He is a famous ratter, surpassing the cat or the ferret. He is described as a lively little urchin, about the size of a weasel, as having a snaky body, vicious looking claws, a sharp nose, a villainous eye and looks like “murder incarnate.” In speaking of his action in capturing rats, it is said that he crawls sinuously up to his victim until within easy distance for a rush, and then strikes with unerring aim, snapping rats just at the base of the brain. The rat has not time even to squeak, so sudden and deadly is the onslaught. Wherever the rat can enter the mongoose can follow. Thus as a ratter this lively little Indian is incomparable, but the trouble is he will not confine his operations to what is deemed his legitimate business. Some writers have endeavored to save his credit as a poultry destroyer, but a naturalist, who has carefully observed his characteristics, says that he is a general destroyer, not only of everything under, but of many creatures over his size. When in a cage the sight of a small living creature made him frantic and whenever he escaped, as he sometimes did, he made a sensation in the poultry house. The mongoose is not content with marauding forays in the yard, but he seems to pervade the house when domesticated…The rat is unquestionably a great pest of the cane and rice planter and grain cultivator in all parts of the world. The rat pest was deemed so serious here some fifty years ago that an enlightened and enterprising Commissioner of the Hawaiian Government, sent inquest of Chinese…to procure a species of snake famed as a destroyer of rats; but the Hawaiian people, whose sacred soil had been kept free from snakes and toads by some patron saint equal in influence to St. Patrick, conceived a holy terror of the snake, notwithstanding his possible utilities, and passed a decree that Hawaii would have no

> snake in her plantations. The destruction of rats in the cane-fields was hardly deemed a sufficient compensation to the Hawaiian mind for the probable presence every now and then of his snakeship in the thatch of the Hawaiian *hale pili*…(The Pacific Commercial Advertiser 1883:2)

By September of 1883, Mr. William H. Purvis, a plant collector and investor in the Pacific Sugar Mill at Kukuihaele on Hawai‘i Island, imported seven mongooses, fowls, and exotic plants from Australian colonies (Daily Honolulu Press 1883). The imported mongooses were "…intended for the damp lands of the Kukuihaele plantation at Hamakua…" (ibid.:4). A number of *‘iole manakuke* or mongooses, were liberated in the cane fields of both Hilo and Hāmākua (Funasaki et al. 1988; Pukui and Elbert 1986). Subsequently, in 1885, mongooses were released on Maui, Moloka‘i, O‘ahu, and Kaua‘i. While mongoose populations had quickly established themselves on Maui, Moloka‘i, and O‘ahu, to date, the mongoose has not established itself on Kaua‘i. Both introductions rapidly multiplied and spread beyond their intended target species. While the introduction of the mongoose appears to have some success in combatting the rodents, their impacts were highlighted in newspaper editorials as early as 1886, from writers complaining that the mongooses were becoming a pest in their own. One such article read:

> The mongoose is a useful little creature for the destruction of rats. He was brought here for that purpose, and, we believe, had done his work thoroughly well on several plantations. But the mongoose does not confine himself to rats, and complaints come from some quarters that ducks and chickens are being destroyed by wholesale. The mongoose may ultimately prove to be a greater nuisance than a benefit. (The Daily Bulletin 1886:2)

By the late 19th-century, the mongoose had become a sort of cultural symbol. A review of newspaper articles published in Hawai‘i during this period reveals that the mongoose was often used to reference people or things that exhibited wild behavior and for people who came to Hawai‘i that had no intent to leave. However useful these introductions were in controlling its intended target, over time, their unintended impacts had become obvious. In its wake, the mongoose destroyed livestock, the eggs of native bird species, and the noisy mynah bird is associated with aiding in the proliferation of the noxious weed, *Lantana camara* (Funasaki et al. 1988). These early and poorly thought out introductions are what Funasaki et al. (1988:106) described as a classic example of "biological control gone astray." Funasaki et al. (ibid.) emphasize that:

> However, it must be realized that prior to 1890, planning and evaluation before the introduction of any organism were nonexistent simply because they were not required. There were no laws or regulations restricting or prohibiting the importation of any plant or animal from other geographical areas into Hawaii.

While these early introductions appear to have been a practical solution to a growing problem, ultimately, the lack of regulation, adequate pre-release testing protocols, and post-release monitoring created even more problems for Hawai‘i's environment and people. In response to these ill-fated early and unregulated releases, Hawai‘i's government leaders began to formalize a plan that would limit the introduction of unwanted pest species and control those that had already been introduced.

Regulated Efforts to Control Unwanted Pest in Hawai‘i

By the late 19th century, efforts to study the natural enemies of unwanted pests that were impacting Hawai‘i's agricultural industry were being formalized. In 1893, the year of the unlawful overthrow of Queen Lydia Lili‘uokalani, the provisional government of the Republic of Hawai‘i appointed Albert Koebele as the entomologist to biologically control the many species of immigrant pests (Funasaki et al. 1988). Koebele is credited with being "one of the first, if not the very first entomologist, to engage in the introduction of natural enemies as a method of combating insect pests" (Giffard et al. 1925:340). Between 1893 and 1910, Koebele spent much of his time traveling to places like Australia, Fiji, Japan, China, Ceylon (modern-day Sri Lanka), Mexico, and California where he studied various insects that he thought would be beneficial to combat pests that were introduced to the islands. In 1893, Koebele successfully used biocontrol to combat the cottony cushion scale (*Icerya purchasi*) . In summarizing Koebele's biological introductions to the Hawaiian Islands, Giffard et al. (1925:342) remarked:

> He made the beginning in this line of work, and much of the time was working alone, yet seventeen species of lady beetles were successfully introduced by him and have become valuable factors in keeping reduced such pests as scale insects, mealybugs, plant lice and leaf mites. At least six other lady beetles were introduced and became established, but after a few years disappeared. The eight lantana insects were introduced by him, and about the same number of miscellaneous parasites of Diptera and Lepidoptera, etc. Following Mr. Koebele in this line of work, the other entomologists have introduced a larger number of beneficial insects, and some of them have produced more

> spectacular and valuable results, but this should not in any way lessen the credit to be given to him who was the pioneer in Hawaii in this important branch of entomological work.

Encouraged by Koebele's successes, in 1903, the Territorial Government (formalized in 1898), enacted laws to create the Board of Commissioners of Agriculture and Forestry (the precursor to the Hawaii Department of Agriculture (HDOA)). These early laws provided for facilities and materials "to obtain, propagate, study, and distribute beneficial species of insects to control pest species of insects and weeds" (Funasaki et al. 1988:107). Additionally, a quarantine system to prevent new immigrant pests from entering the islands was also created. Another early organization responsible for the release of a number of biological control agents was the Hawaiian Sugar Planters' Association (HSPA), founded in 1895. In 1904, HSPA instituted an Entomology branch and from its founding to about 1942, this branch aided in combatting a variety of pests that were plaguing Hawai'i's cane fields and threatening the economic promise of the sugar industry (ibid.). Throughout the early to mid-20th century, as Hawai'i's agricultural interest grew to include pineapple and other tropical fruit, additional institutions were organized to study and combat its share of pests. Such organizations included the United States Bureau of Entomology and Plant Quarantine's Fruit Fly Laboratory (now U.S. Department of Agriculture's Tropical Fruit and Vegetable Research Laboratory), Experiment Station of the Pineapple Producers Cooperative Associations, HSPA's Experiment Station, Hawaii Agricultural Experiment Station of the University of Hawaii's Collee of Tropical Agriculture, the California Agricultural Experiment Station of the University of California, and the Hawaii Department of Health (ibid.). By the 1940s and 1950s, the creation and introduction of chemical pest control had become the favored alternative (Howarth 1983). While chemical pest control still maintains its place in managing unwanted pests, the environmental and health risks associated with its use has led to the adoption of stricter regulations and a push towards finding more natural and low-cost alternatives (ibid.).

Collectively, the laws passed in 1890 to regulate unwanted immigrant pests set the foundation for what is known today as Hawai'i Revised Statutes (HRS) Chapter 141, which governs the State of Hawai'i, Department of Agriculture (HDOA)—the state agency responsible for protecting and diversifying Hawai'i's agricultural industry. HDOA's Plant Industry Division maintains three branches: Pesticides Branch, Plant Pest Control Branch, and the Plant Quarantine Branch that collectively work "to protect Hawaii's agricultural industries, environment, and [the] general public by preventing the introduction and establishment of harmful insects, diseases, illegal non-domestic animals, and other pests…" (Department of Agriculture 2016). In 2003, under Hawai'i Revised Statutes (HRS), Chapter 194, the State of Hawai'i legislature authorized the creation of the Hawai'i Invasive Species Council (HISC), the agency responsible for coordinating efforts between various local, state, federal, and international agencies and organizations to stop the introduction and spread of invasive species in the islands (State of Hawai'i 2005). Since the creation of the HISC, millions of dollars have been allocated to various local councils and government departments and programs to combat invasive species. Efforts have been directed at prevention, response and control, research and technology, and outreach (ibid.). There are four invasive species committees that represent each of the four counties (Kaua'i, O'ahu, Maui, and Hawai'i Island) in addition to an aquatic invasive species team (ibid.).

Historically, Hawai'i's biological control programs were aimed at controlling weeds and pests that were adversely impacting the agricultural industry. During the 1970s and 1980s, the heightened interest in native and endemic taxa, fueled by the passing of federal legislation to protect endangered plants coupled with the growth of native-plant organizations has led to greater consideration of the potential risk of introduced biological control agents on endemic taxa (Pemberton 2004). Hawai'i as a "hub for tourism, trade, and military transport" and the state's continued reliance on globally imported goods perpetuates the ongoing assault of introduced foreign species (Messing and Wright 2006). Funasaki et al. (1988:108) report that "more biological control projects against immigrant species of insect pests have been conducted in Hawaii than anywhere else in the world" and nearly a third of the introduced species (roughly 200 pest species) are known to be established. Reimer (2002:86) reports that "many of these introductions appear to have been successful in that the pest populations eventually did drop to acceptable levels, although scientific evaluations of the effectiveness of these introductions have been virtually non-existent." The lack of natural enemies to combat such pests has propelled state agencies, namely HDOA to continue to identify the pests' natural enemies and to develop stringent host-range testing protocols for the study and release of such agents. Although the application of classical biocontrol in Hawai'i has, at times proven to be economically successful, it is recognized that environmental risks are inherent in biological control programs (Holland et al. 2008; Howarth 1983; Pemberton 2004).

Historically, several individuals and agencies have participated in the study and release of biocontrol agents in the Hawaiian Islands. Today, the U.S. Department of Agriculture-Animal Plant Health Inspection Service-Plant Pest Quarantine (USDA-APHIS-PPQ) and the HDOA regulates the importation of biocontrol agents (Reimer 2002). While these agencies have distinct mandates and jurisdictions, there is some overlap with respect to the regulated use of biocontrol. Efforts to improve pre-release testing has resulted in a federal and state permitting process which includes an environmental review. In summarizing this process, Reimer (ibid.:87) writes:

All biocontrol agents imported for weed control attack plants and are by definition plant pests. They are, therefore, regulated by USDA.

The USDA requires separate permits for

1) Importation of a plant pest into the U.S.;

2) Movement of a plant pest between States; and

3) Release of a plant pest into the environment.

The federal permitting process requires the submission of PPQ Form 526 (Application for Release) that is forwarded to the HDOA for review and recommendations. All applications to date, for which HDOA has recommended rejection, have also been denied by the USDA. If approval is recommended by HDOA, USDA then reviews the application. This process usually involves review by the Technical Advisory Group; however, Hawai‘i applications are exempt from TAG review due to the thoroughness of the HDOA review process. A draft environmental assessment (EA) is requested from the applicant for any requests for the release of weed biocontrol agents. The USDA prepares the final EA. If endangered or threatened species potentially are affected by the release of a biocontrol agent then the application is sent to the U.S. Fish and Wildlife Service for review. A release permit is issued if the evaluation of the EA produces a finding of no significant impact (FONSI).

While there are some similarities between the federal and state process, Chapter 150A of the Hawai‘i Revised Statutes (HRS) regulates the importation of any plant or animal into the State of Hawai‘i whether or not it is a plant pest (Reimer 2002). HRS 150A strictly prohibits the importation of all non-domestic animals and microorganisms unless approval is obtained by the Board of Agriculture. The review process for a state importation permit application involves six steps. Reimer (ibid.:88-89) provides a synthesis of the six-step process:

First, the application is submitted to the HDOA with all of the required and pertinent information, including information on host specificity, distribution, preferred habitat, temperature requirements, etc. Host specificity studies may be carried out either in the country of origin or in one of the three approved containment facilities in Hawai‘i. The Advisory Subcommittee then reviews the application. The recommendations from this subcommittee are passed on to the Plants and Animals Committee for their recommendations to the BOA. The BOA either approves or disapproves the application. If approved, the application is submitted to a public hearing process. Comments from the public are brought back to the BOA for discussion, followed by final approval or disapproval of the application. If approved, a State permit is issued. The organism may be imported and released if both State and Federal permits have been issued and permit conditions are met by the importers. The HDOA review process for the introduction of biocontrol agents has evolved into an effective system that screens agents for host specificity and potential negative

Additionally, efforts to improve public transparency following the decision rendered by the Hawai‘i Intermediate Court of Appeals (*Ohana Pale Ke Ao v. Board of Agriculture, State of Hawaii*, 118 Hawaii 247, 249-50, 188 P.3d 761, 763-64 [Hawaii Ct. App. 2008]) has made the HDOA recognize that such biocontrol activities are subject to Chapter 343, Hawai‘i Revised Statutes (Hawai‘i Environmental Policy Act, HEPA) (Holland et al. 2008). Between 1890 and 1999, a total of 708 natural enemies have been released in Hawai‘i, of which 286 have become established and the majority (237) of the introduced agents have contributed to the control of the target pest species (Reimer 2002). Prior to 1944 (before the formalization of the BOA), only 54% of the introduced agents were host-specific. This percentage has increased over the years with 77% host specificity being reported between the years 1944-1975. Since 1975, host specificity for all released biocontrol agents increased to 100% (ibid.). While stricter regulations have been adopted and modified over the years to reduce the environmental risk associated with the use of biological control agents, continued field research and open dialogue remains as a critical component to improving our understanding and mitigating the environmental, economic, and cultural risks associated with such actions.

INTRODUCTION OF *MICONIA* TO THE HAWAIIAN ISLANDS AND EARLY ERADICATION EFFORTS

Miconia is one of fifteen known Melastome species naturalized in the Hawaiian Islands and as noted in HAR §4-68-10, all species have been declared a noxious weed in the State of Hawai‘i. *Miconia* is found in the wet, windward regions of four of the major Hawaiian Islands—Hawai‘i, Maui, O‘ahu, and Kaua‘i in habitats receiving 1,800-2,000 millimeters or more of annual rainfall (Medeiros et al. 1997). Figure 7 shows the distribution of established and potential *Miconia* habitats on five of the major Hawaiian Islands.

Miconia was first introduced to the Wahiawa Botanical Garden on O‘ahu in 1961 by botanist and horticulturalist Joseph F. Rock (Medeiros et al. 1997). In 1964, a single *Miconia* was planted at the Harold L. Lyon Arboretum in Mānoa Valley. A newspaper article published in the July 15th, 1965 edition of the *Honolulu Star-Bulletin*, shows a specimen of *Miconia* growing on O‘ahu (Figure 8). In 1971, Pacific botanist, F. R. Fosberg who studied the developing infestation of *Miconia* on the high volcanic island of Tahiti, warned Hawai‘i authorities of the plant’s potential to destroy native Hawaiian forests (ibid.). Despite the warnings, between 1975-1983, *Miconia* was cultivated at the Waimea Botanical Garden on the northwestern shore of O‘ahu, however, the seasonally dry climate limited its growth and its potential to spread which led employees to destroy the plants altogether (ibid.). Naturalized seedlings were noted as early at 1975, within the Mānoa Valley vicinity, however, it was not until the 1990s that efforts to remove the few naturalized specimens were undertaken by local organizations such as the Sierra Club. In the early 1990s, after recognizing the plant’s threat, the staff at the Harold L. Lyon Arboretum destroyed the original parent plant. *Miconia* is now naturalized at several locations on the Ko‘olau Range, including Mānoa, Kalihi and Nu‘uanu valleys (see Figure 7).

On Hawai‘i Islands, *Miconia* was first reported in the early 1960s in the Hilo District at the estate of Herbert Shipman and by 1971, this species had become naturalized. A review of historical newspaper articles indicate that volunteers efforts to manually eradicate populations of *Miconia* on Hawai‘i Island were in effect as early as 1982. Prior to 1992, *Miconia* plants were being sold and has since become naturalized in many other loci on the windward side of Hawai‘i Island, including Hakalau, Onomea, Pāpa‘ikou, Hilo, Pana‘ewa, Waiākea Uka and at various locations in the Puna District. *Miconia* is also found, although less extensively, at locales in the North and South Kona Districts (see Figure 7). The *Miconia* infestation on Hawai‘i Island is considered to be the most extensive in all of Hawai‘i (Medeiros et al. 1997). *Miconia* population on Hawai‘i Island is estimated to cover some 250,000 acres, ranging from monotypic stands to single trees (Tavares and Santos 2002).

On Maui, in the early 1970s, *Miconia* was introduced at Helani Gardens, a private nursery and botanical gardens located in the windward Hāna District. During the early 1990s, when the threat of *Miconia* was realized, *Miconia* populations had already become abundant and naturalized at Helani Gardens. Concerted localized efforts to eradicate established populations at Helani Garden resulted in a more manageable situation. Despite control at Helani Gardens, between 1991-1993, five additional *Miconia* populations were identified in windward East Maui. As of 1997, ten populations of *Miconia* were known to exist on the island of Maui from near sea-level to 430 meter elevation, including Upper and Lower Nāhiku, Hāna/Olopawa, Ke‘anae, Hoalua, two sites at Huelo, Peahi, Upper Ke‘anae, and Kaupō (see Figure 7) (ibid.).

After receiving a report from a resident of the Wailua Homestead in east Kaua‘i in 1995, HDOA followed up and confirmed a population of *Miconia* that was reported to have spread from a single large tree that was transported from O‘ahu and given to a nursery on Kaua‘i. Some twenty plants were removed, however, by December of 1995, additional monitoring around the site resulted in the discovery of two *Miconia* plants with plastic pots attached to its roots. Additional populations of *Miconia* were discovered along the Wailua River and in the vicinity of the nursery as well as the Kapa‘a Homesteads. In 1996, a single plant was discovered further inland near the Wailua Reservoir (ibid.) (see Figure 7). Although *Miconia* has not been reported on Ni‘ihau, Lāna‘i, Kaho‘olawe, or Moloka‘i, the wet, windward region of east Moloka‘i contains optimal growing conditions for *Miconia* (see Figure 7). The drier conditions found on the former three islands make for less suitable *Miconia* habitat.

In the early 1990s, after being officially listed as a noxious weed, concerted efforts to manually eradicate this highly invasive plant was initiated on the island of Maui. In 1991, the Melastome Action Committee (MAC) convened and began developing an eradication plan for Maui. The Maui MAC also obtained funding to drive aggressive eradication efforts. By 1995, a second MAC was set up on Hawai‘i Island and this group effectively organized *Miconia* mapping and control efforts. On O‘ahu and Kaua‘i where *Miconia* was less widespread, eradication efforts were led primarily by HDOA, DLNR, and volunteer groups. A statewide interagency public education and involvement campaign dubbed “Operation Miconia” was launched. Wanted posters, newspaper stories, public service announcements, and *Miconia* reporting hotlines helped to create more public awareness about the plant and served as an important tool in helping officials located new *Miconia* populations (Medeiros et al. 1997). These early eradication and containment efforts utilized a combination of applied herbicides and mechanical removal. While these efforts have been successful in helping to contain *Miconia* populations, increased operational cost associated with the spread of *Miconia* into more remote regions compounded by averse policy has shifted *Miconia* management strategies (Leary et al. 2013; Medeiros et al. 1997). To enhance *Miconia m*anagement efforts, DOFAW is seeking biocontrol as a potentially viable option.

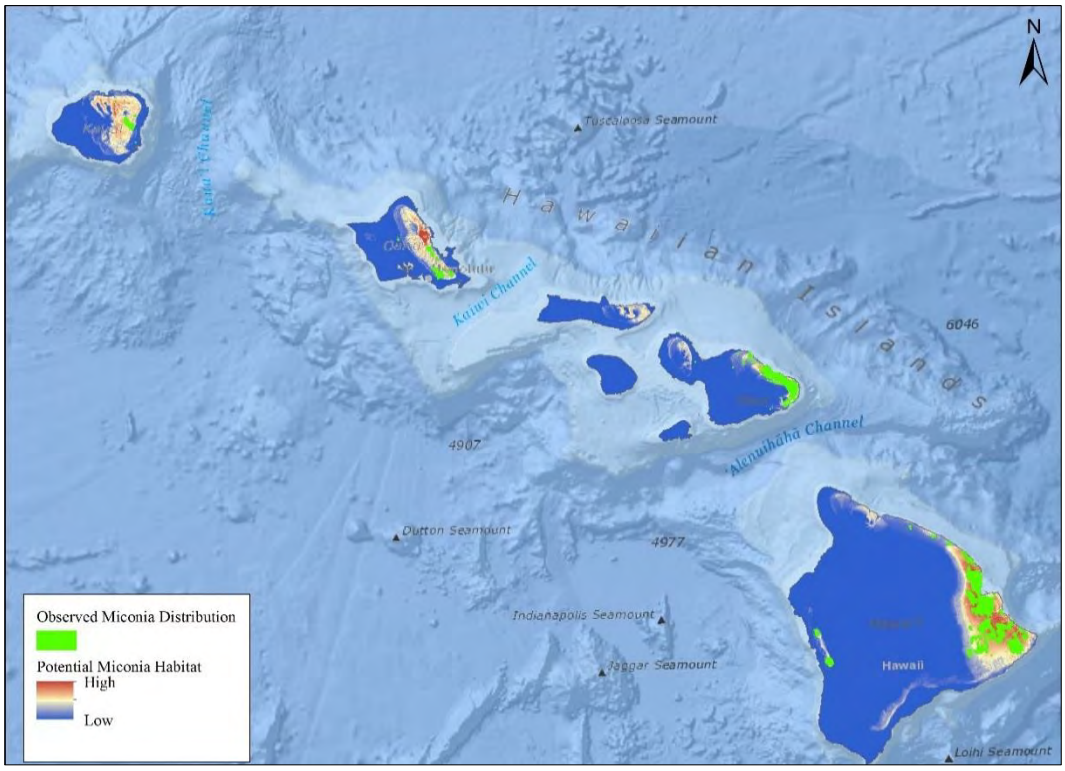

Figure 7. GIS map showing areas with confirmed *Miconia*'s infestations and potential *Miconia* habitat across the Hawaiian Islands.

Tamotsu Kubota, left, and Lindy Loo, of the Hawaii Association of Nurserymen, discuss attributes of a specimen Miconia magnifica, a rare ornamental with two-feet long reddish-maroon leaves. The two men will appear on KHVH-TV's "Aloha State Farmer" program at 8:30 a.m. Sunday to talk about a two-day nursery course to be given next Wednesday and Thursday at the East-West Center, University of Hawaii campus. A variety of topics will be covered by specialists.

Figure 8. *Miconia* shown in a 1965 HonoluluStar-Bulletinarticle (Sybert 1965:58).

A Concise Global and Pacific Overview of *Miconia* Calvescens

In its native habitat of Central and South America, *Miconia calvescens*, which is both abundant and widely distributed across the lowlands have been reportedly used on occasion as fuel (Williams 1936). Although the seeds are described as sweet and attractive to frugivorous bird and other insects, the author of this report has not identified any documented sources describing its use as food or medicine by humans. Although *Miconia* has been introduced to places in Europe and Asia it has not been deemed as an invasive species (CABI 2018). However, in parts of Australia, the Dominican Republic, and in the French Polynesian Islands of Tahiti, Raiatea and Mo'orea, *Miconia* has become a major threat to tropical native ecosystems (Meyer and Florence 1996). Prior to this plant's arrival in Hawai'i, its impacts on the tropical forest ecosystems on high volcanic islands in French Polynesia were carefully studied. Juxtaposing the long-term environmental impacts of the *Miconia* infestation on Tahiti to Hawai'i has long-served as an important assessment and projection tool as both islands share highly comparable geographical, climatic, topographic, and biotic similarities (Medeiros et al. 1997).

Miconia was introduced to the Papeari Botanical Gardens in Tahiti in 1937 as a garden ornamental and was later outplanted on the plateau of Taravao where it thrived in the moist tropical climate (ibid.). In Tahiti, *Miconia* has been named *pa'a honu* which means turtle carapace and is a local reference to the large leaf size which resembles a turtle shell (CABI 2018). In the early part of the 1970s, botanist began to raise awareness of the plant's growing infestation and warnings were put out to authorities including those in Hawai'i. After observing the infestation in Tahiti, the late Smithsonian Institution botanist, F. Raymond Fosberg warned Hawai'i authorities stating that "It is the one plant that could really destroy what's left of the native Hawaiian forest" (Altonn 1991:A-8). Nearly thirty years after its introduction to the French Polynesian islands, it has been deemed by scientist as one of the most ecologically damaging pest plants (Medeiros et al. 1997; Meyer and Florence 1996). It now dominates over two-thirds of the island of Tahiti and in some locales, grow as pure monotypic stands. *Miconia* has since spread to the surrounding islands of Raiatea and Mo'orea and to the Society archipelago (Meyer and Florence 1996). In describing this plant's impacts on the indigenous and endemic flora Meyer and Florence (ibid.:778) state that "In Tahiti, seventy to 100 native plant species including forty to fifty endemics are estimated to be directly threatened by *M. calvescens*." Additionally, Florence and Meyer (ibid.:781) explain that "dense monotypic stands of *M. calvescens* prevents not only regeneration of the native plant species but also removes habitat for other animals." Although no cultural uses of *Miconia* have been identified in the remote tropical islands of French Polynesia, it is widely recognized that the spread of *Miconia* into native forests threatens the indigenous and endemic taxa.

The extensive spread of *Miconia* throughout the French Polynesian island of Tahiti and its impacts on the native wet forest habitat is an ecological and cultural concern that is widely applicable to the Hawaiian Islands. Hawai'i's wet forest habitat, which is a culturally valued resource has maintained a significant role in perpetuating the life-ways and traditions of the Hawaiian people. Continued encroachment upon this habitat by highly invasive species such as *Miconia* poses an ecological threat that has significant cultural ramification.

Cultural Uses of Native Wet Forest Habitat in Hawai'i

The use of native wet forests plants in traditional Hawaiian culture is both extensive and well-documented (see Abbott 1992; Buck 1957; Krauss 1993). The flowers, fruits, woods, roots, and bark of many native plants found in the wet forests of the Hawaiian Islands have been and continue to be extensively used in many Hawaiian cultural practices. Although plants were held in high esteem and celebrated in traditional lore, plants were also valued as a collective whole for its ability to attract diverse wildlife, such as birds and insects. Endemic Hawaiian birds were highly valued for their colorful plumages which were extensively used in creating spectacular feathered garbs, headdresses, *lei*, and other insignia that were worn or displayed traditionally by Hawaiian nobility. The task of collecting birds was undertaken by the *po'e kia manu* (bird catchers), who held a profound understanding of avian behavior and the forest resources, including what plants to use to attract and capture the birds.

The plethora of plants found in Hawai'i's wet forest was and remains an integral component of many traditional Hawaiian cultural practices. Large trees provided a variety of hardwoods from which canoes, houses, *ki'i* (carved images), fishing accessories, and various utilitarian and recreational implements were made. Aerial roots of the climbing *'ie'ie* (*Freycinetia arborea*) were harvested and plaited together to form tightly stitched *'ie* (baskets). Ferns were collected from the forest floor and woven into *lei* or tucked into *kapa* (bark cloth) as a scenting agent. Flowers and fruits were collected for *lei*, natural dyes, and sometimes mixed together with other plants to make medicinal concoctions. Additionally, plots in the wet forests were cleared to cultivate *olonā* (*Touchardia latifolia*), an endemic plant that was purposefully grown and from which cordage of the finest quality was made. Hawaiian ethnobotanist, Beatrice Krauss notes:

> The finest cordage made by the ancient Hawaiian—in fact, the finest cordage made in the Pacific basin—was made from *olonā*. *Olonā* was cultivated in patches of two or three acres primarily in wet, upland areas. Young shoots or layered cuttings were used for planting material; the latter were obtained by bending down a branch and covering the portion touching the ground with soil so that roots emerged from it. The rooted section, with its terminal leaves, was severed and this became a rooted cutting. Planting was close to prevent side branches from growing. *Olonā* patches were kept free of weeds, especially fom [*sic*] creeping vines, which were abundant in surrounding areas; these would otherwise have choked the *olonā* plants. The stalks were ready for harvest at the end of a year or eighteen months. (Krauss 1993:27–28)

The forest itself also holds profound spiritual implications as various plants found in the wet forest were considered *kinolau* (embodiments) of named deities, many of whom took specific plant forms of the deity Kū. Such examples include but are not limited to Kūkaʻōhiʻalaka, Kūpulupulu, Kūmokuhāliʻi, and Kūalanawao (Fornander 1919–1920; Handy and Handy 1991; Kamakau 1976). While Kū is considered the activating energy associated with the forest, other deities are also recognized including Kāne, who is embodied in the sun and in freshwater; Lono who is connected to winds, storms, and fertility; and Laka who is associated with transpiration (Edith Kanakaʻole Foundation n.d.). Therefore, the Hawaiian forest, at a minimum, represents the dynamic interplay between Hawaiian deities.

These forested spaces also filled an important spiritual and utilitarian need for Hawaiian *hula* dancers, healing practitioners, and artisans, all of whom rely heavily on Hawaiʻi's forest resources (Stewart 2003). *Hula* practitioners have long valued Hawaiʻi's rich forest, which continue to be extensively used in making adornments, implements, and in furnishing the *kuahu* (altars). In describing the *kuahu*'s association with the forest, Emerson (1909:19) explained that "the wildwoods of Hawaii furnished in great abundance and variety small poles for the framework of the kuahu, the altar, that holy place of the halau, and sweet-scented leaves and flowers suitable for its decoration." In detailing the thoughtful process of greening a *kuahu*, Emerson adds:

> It was necessary to bear in mind that when one deflowered the woods of their fronds of *ie-ie* and fern or tore the trailings lengths of *maile*—albeit in honor of Laka herself—the body of the goddess was being despoiled, and the despoiling must be done with all tactful grace and etiquette.
>
> It must not be gathered from this that the occasion was made solemn and oppressive with weight of ceremony, as when a temple was erected or as when a tabu chief walked abroad, and all men lay with their mouths in the dust. On the contrary, it was a time of joy and decorous exultation, a time when in prayer-song and ascriptions of praise the poet ransacked all nature for figures and allusions to be used in caressing the deity. (Emerson 1909:16)

Other plants utilized in greening a *kuahu* included *ʻieʻie* (*Freycinetia arborea*), *halapepe* (*Pleomele sp.*), *ʻōhiʻa lehua* (*Metrosideros polymorpha*), *ʻekaha* (*Asplenium nidus*), *maʻo hau hele* (*Hibiscus brackenridgei*), *hau* (*Hibiscus tiliaceus*), *kī* (*Cordyline fruticosa*), *ʻilima* (*Sida fallax*), and *lama* (*Diospyros sandwicensis*) (Emerson 1909).

While historical literature enumerates many different types of *kahuna* (esteemed and highly specialized experts), the *kahuna* whose practice involved the extensive use of both cultivated and wild plants was the *kahuna lāʻau lapaʻau*. These *kahuna* treated the sick using highly tailored plant-based recipes that were accompanied by rituals and ceremonies. With the change in landscape and the arrival of non-native plants to the islands, Krauss (ibid) notes that many "Precontact prescriptions have been altered by addition or substitution of postcontact-introduced plants." Krauss provides a succinct summary of the meticulous preparation of traditional plant-based medicines:

> Different parts of a plant were used for medicine: roots, stems, leaves, flowers, bark, fruits, and seeds. These were prepared for use by brewing, pounding and extracting the juice or sap, pounding and making an infusion, or the part to be used was chewed and swallowed without any preparation. Plant material was pounded in special stone mortars with stone pestles made for this purpose only. In cases where leaves were used, dosages consisted of a specific number of leaves; specific handfuls of leaves; or the quantity of leaves that, when rolled together, fitted within the circle formed when the tips of the thumb and forefinger were joined. When bark was used, a strip of a designated width and length was prescribed. For berries, flowers, flower buds, and the like specific numbers determined the dosage. The "magic" numbers in prescribing dosages, times and, duration of treatment were one, three, and five; four and five; five and six; or five only, according to different sources. Pounded material was strained through or squeezed out with cleaned fabriclike sheath at the base of coconut fronds (*ʻaʻa niu*) or with the fibers of the native sedge *makaloa.* Medicinal herbs were usually administered in formulations that almost always included salt and red clay, *ʻalaea*. (Krauss 1993:101)

The adaption of cultural traditions is an important aspect of any living culture. While many artisans continue to utilize Hawai‘i’s forest plants in a more traditional manner, it is common today to see many Native Hawaiian (and non-Hawaiian) artisans incorporate or draw inspiration from native plants to create contemporary clothing, home furnishings, musical implements, accessories, art, and many other utilitarian and decorative items. The restoration and revitalization of native plant habitat is crucial to sustaining Hawaiian traditions, beliefs, cultural practices well into the future whether that be in a traditional or more contemporary manner.

3. CONSULTATION

Gathering input from community members with genealogical ties and long-standing residency or relationships to the study area is vital to the process of assessing potential cultural impacts to resources, practices, and beliefs. It is precisely these individuals that ascribe meaning and value to traditional resources and practices. Community members often possess traditional knowledge and in-depth understanding that are unavailable elsewhere in the historical or cultural record of a place. As stated in the OEQC Guidelines for Assessing Cultural Impacts, the goal of the oral interview process is to identify potential cultural resources, practices, and beliefs associated with the affected project area. It is the present authors’ further contention that the oral interviews should also be used to augment the process of assessing the significance of any identified traditional cultural properties. Thus, it is the researcher’s responsibility to use the gathered information to identify and describe potential cultural impacts and propose appropriate mitigation as necessary.

INTERVIEW METHODOLOGY

In an effort to identify individuals knowledgeable about traditional cultural practices and/or uses associated with *Miconia* or the habitat in which it thrives, a public notice was submitted to the Office of Hawaiian Affairs (OHA) for publication in their monthly newspaper, *Ka Wai Ola*. The notice was submitted via email on April 9th and was subsequently published in the May 2019 issue of *Ka Wai Ola* (2019:21) (Appendix A). As of the date of the current report, no responses have been received from the public notice. Although no responses were received as a result of the *Ka Wai Ola* publication, ASM staff contacted forty-five individuals via email and/or telephone regarding the preparation of the current CIA. These individuals were selected because they were either recognized cultural practitioners, plant experts, or Native Hawaiian organizations who utilize Hawai‘i’s forest resources for cultural purposes or were believed to have cultural knowledge about the target species or other plants found within the target species habitat. Of the forty-five individuals contacted, twenty individuals responded to our request with either brief comments, referrals, or accepted the interview request. The names and affiliation of these twenty individuals are listed in Table 1 below. Of the twenty respondents, ASM staff successfully conducted interviews with nine individuals (see summaries below). A complete list of all persons contacted for consultation is available upon request.

The interviewees were asked a series of questions regarding their background, and their experience and knowledge of the target species. Additional questions focused on any known cultural uses, traditions, or beliefs associated with any of the target species. The interviewees were then asked about their thoughts on the cultural appropriateness of using biocontrol control agents and whether they were aware of any potential cultural impacts that could result from the use of biocontrol control. The interviewees were then asked whether they had any recommendations to mitigate any identified cultural impacts as well as share any additional thoughts about the proposed action.

As part of the interview process and with the consent of the interviewees, some of the interviews were audio-recorded for note-taking purposes only (audio files not available). Where audio recordings were not permitted, ASM staff recorded notes throughout the interview process. Upon completion of the interview, ASM staff prepared an interview summary, which was emailed to the interviewees for review. The interviewees were given the opportunity to review the summary for accuracy and allowed to make any necessary edits. With the approval of the interviewees, the finalized version of the summaries is presented below.

Table 1. Persons contacted for consultation.

Name	*Affiliation, Island*	*Initial Contact Date*	*Comments*
Shalan Crysdale	The Nature Conservancy, Kaʻū Preserve, Hawaiʻi	3/6/2019	See summary below
John Repogle	Retired from The Nature Conservancy, Kaʻū Preserve, Hawaiʻi	3/6/2019	See summary below
Nohealani Kaʻawa	The Nature Conservancy, Kaʻū Preserve, Hawaiʻi	3/6/2019	See summary below
Arthur Medeiros	Auwahi Forest Restoration Project, Maui	3/7/2019	Responded via email on March 11, 2019, stating "Thank you for your valuable work supporting this essential action to attempt to slow the loss of Hawaiian biota."
Jen Lawson	Waikōloa Dry Forest Initiative, Hawaiʻi	4/3/2019	See summary below
Robert Yagi	Waikōloa Dry Forest Initiative, Hawaiʻi	4/3/2019	See summary below
Wilds Brawner	Hoʻola Ka Manakaʻā at Kaʻūpūlehu, Hawaiʻi	4/9/2019	See summary below
Sam ʻOhu Gon III	The Nature Conservancy, Oʻahu	4/22/2019	Responded to interview request but was unable to provide input on this project.
Mike DeMotta	National Tropical Botanical Gardens, Kauaʻi	4/22/2019	See summary below
Wili Garnett	Cultural practitioner, Molokaʻi	5/7/2019	Responded via email stating "I have mostly been involved with Erythrina gall wasp parasite release and monitoring, but experience watching *Tibouchina* and *Schinus* degrade watershed on many islands, including Molokai and even cultural resources at Kalaupapa."
Emily Grave	Laukahi Network, Oʻahu	5/7/2019	Responded via email stating that she was not aware of cultural uses of this plant.
Kim Starr	Starr Environmental, Maui	5/9/2019	See summary below
Forest Starr	Starr Environmental, Maui	5/9/2019	See summary below
Manaiakalani Kalua	Cultural practitioner, Hawaiʻi	5/30/2019	See summary below
Talia Porter	Honolulu Botanical Gardens, Oʻahu	6/3/2019	Responded to interview request but was unable to secure an interview.

Table 1 continues on next page

Table 2. continued.

Name	*Affiliation, Island*	*Initial Contact Date*	*Comments*
Robert Keano Kaʻupu	Cultural practitioner, Oʻahu	6/16/2019	Responded via phone that he has been interested in learning about the cultural uses of *wiliwili* but was not aware of any uses or of anyone else who used this wood for cultural purposes.
Hinaleimoana Wong-Kalu	Cultural practitioner, Oʻahu	7/16/2019	Responded to interview request but was unable to secure an interview.
Pelehonuamea Harman	Cultural practitioner, Hawaiʻi	7/31/2019	Referred ASM staff to Dennis Kanaʻe Keawe
Dennis Kanaʻe Keawe	Cultural practitioner, Hawaiʻi	8/12/2019	See summary below
Iliahi Anthony	Cultural practitioner, Hawaiʻi	8/30/2019	See summary below

End of Table 1

SHALAN CRYSDALE, JOHN REPLOGLE, AND NOHEALANI KAʻAWA

On March 6th, 2019, Lokelani Brandt and Matt Clark interviewed Shalan Crysdale, John Replogle (retired from the Nature Conservancy), and Nohea Kaʻawa of The Nature Conservancy (TNC) Kaʻū Preserve regarding DOFAW's proposed action and to gather any known cultural knowledge of *Miconia*. Shalan indicated that there are no known populations of *Miconia* in Kaʻū. While Shalan and others were aware of *Miconia* infestations on Hawaiʻi Island they were not aware of any traditional or contemporary uses of this plant.

While Shalan and John were not entirely against the use of biological control agents, they did share some of their concerns. Shalan, John, and Nohea stressed the importance of trial testing to ensure that the release of any proposed biological control agent does not adversely impact other native species as well as other valued crops. They spoke about the limitations of laboratory trial testing that may not account for all the variables that are present in the trees natural habitat. They strongly recommended that extensive trial testing be conducted prior to any proposed field release and they hope to see more post-release field monitoring to safeguard against the spread beyond the intended target species.

WILDS PIHANUI BRAWNER

Wilds Brawner, Site Manager of the non-profit organization, Hoʻōla Ka Makanaʻa at Kaʻūpūlehu Dryland Forest, was interviewed by Lokelani Brandt on April 18th, 2019. Since 2008, Wilds has worked at the 70-acre Kaʻūpūlehu Dryland Forest preserve performing a variety of duties including management and education.

When asked about his knowledge of *Miconia*, Wilds indicated that in his years of work, he has not encountered *Miconia* populations in the leewards sides of Hawaiʻi Island, but was aware of its impacts to the wet forest of Hawaiʻi Island and elsewhere. Wilds indicated that he was not aware of any known past cultural uses of this plant.

When asked about any potential cultural impacts that could result from the use of biocontrol, Wilds emphasized that utilizing biocontrol has "great potential" and that it may be a solution to help manage unwanted pests under the condition that there has been extensive research, lab and field testing, and controlled releases. He emphasized that extensive research should consider every possible factor that could potentially result in negative impacts, especially to other endemic taxa. He also stressed that public education should be a key component in this process, as it will create opportunities for the public to learn and provide input. He believes that public input can help assess the possible risks and identify steps to manage those risks. Wilds strongly recommended that all future biological control efforts integrate public input and that it should move towards a community-based resource management structure. Wilds suggested that ways to promote biocontrol are through responsible action, extensive and evidence-based testing and research, and if these pre-release efforts are successful, biocontrol "can be the silver bullet" to managing pests. He concluded that although the process has potential to control invasive species, the idea and use of the word "control," as opposed to "management," is very loaded and attaches unrealistic expectations to the effort. As with any forest, Wilds believes that with proper "management", the results will net a positive cultural impact. New forest growth produces more flowers and seed and ultimately creates more opportunities for people to interact with these forests

through place-based learning. He emphasized that when people interact and participate in caring for our "beloved" resources and when the *mo'olelo* of these resources are shared, it can then become a living cultural resource for the people.

MIKE DEMOTTA

On April 24th, 2019, Lokelani Brandt conducted an interview with Mike DeMotta, the Head Curator of the living collections for the National Tropical Botanical Gardens (NTBG) on Kaua'i. Mike manages the center's plant inventory database, which includes a large collection of native plants. He has also been tasked with developing ways to improve their native plant populations by creating spaces for a thriving living collection. Through his work, Mike has been heavily involved with native plant restoration from the coastal dry areas on Lehua Island to the pristine native forests in Limahuli Valley on Kaua'i's north shore.

When asked about any traditional cultural uses of the *Miconia*, Mike stated that he was unaware of any cultural importance or uses for any part of this plant. He went on to explain that *Miconia* is incipient on Kaua'i and has been carefully monitored and controlled by the island's invasive species committee. He explained that these early monitoring efforts have prevented mass spreading of this highly invasive plant.

When asked about whether any potential cultural impacts could result from the use of biocontrol, Mike believes that with proper research, biocontrol could preserve or rescue native forests. With his strong involvement with restoration, Mike strongly believes biocontrol will assist in opening up spaces for the regeneration of native forests and proposed that drastic measures are imperative to control or eradicate the aggressive nature of invasive species. Although he is genuinely concerned about the possibility of a collateral loss of one or two native species, Mike reasoned that the overwhelming threat to native forests from invasive species had lent to his advocacy for biocontrol. He argued that the manpower needed to control these threats are not feasible and are unrealistic. He is particularly pleased that the focus has shifted to conservation and that there is a growing awareness that we are losing pristine forests to these invasive species.

JEN LAWSON AND ROBERT YAGI

On April 26, 2019, Lokelani Brandt and Aoloa Santos met with Executive Director, Jen Lawson and Preserve Manager, Robert Yagi, of the Waikoloa Dry Forest Initiative. The Waikoloa Dry Forest Initiative manages 275 acres of dryland forest located near the Waikoloa community. When asked about any known cultural uses of *Miconia,* Jen and Robert were not aware of any known past or current uses of this plant although they were aware of the past and ongoing efforts to control this plants spread. While no specific information about *Miconia* was obtained, they did offer their insights into the proposed use of biological control to aid in management strategies.

Although Jen is a proponent of biocontrol, she explained that the proper research must be conducted and that dissemination of that research should be provided to the affected communities. She expressed that one of the main challenges will be garnering public support for the proposed action because of preconceived notions that are heavily influenced by the historical and unsuccessful application of biocontrol. Although Jen was aware of the extensive research that is conducted prior to the release of any biocontrol agent, she remarked that such research is not always effectively shared with the communities. She added that the lack of public information and transparency only exacerbates misconceptions thereby making community support difficult to establish. In light of this, Jen recommended that DOFAW and other associated agencies restructure informational public meetings to be engaging and inclusive of community input as she believes this may improve trust between the affected communities and the agencies. Additionally, she strongly advocates for a more collaborative partnership between the DOFAW and its agencies as a way to promote a more open dialogue between the agencies and community groups who work closely with some of these invasive species. Jen and Robert also recommended that more consistent post-release monitoring be conducted and that such efforts should be done in conjunction with established community groups.

FOREST AND KIM STARR

On May 31st, 2019, Lokelani Brandt and Aoloa Santos met with Forest and Kim Starr at their home in Olinda, Maui. Born and raised on Maui, Forest always enjoyed nature. He later moved to New York to attend Cornell University and in 1992 met his now wife and business partner, Kim, who is of Hawaiian descent but was *hānai* (adopted and raised) by a Japanese-Italian family. Since then they have done numerous volunteer and contract work in the conservation field. They currently co-own Starr Environmental and serve as biologists and environmental consultants for developers and federal and state agencies. Forest and Kim have extensive experience in botanical and

environmental restoration work in the Hawaiian Islands. Forest shared that they have assisted in prior biocontrol releases but they primarily focus on the early detection of introduced species.

When asked about any known cultural uses of *Miconia*, Forest and Kim stated they are not aware of any cultural uses of this plant other than its use as an ornamental. They both expressed that this plant is highly invasive in Hawai‘i because there are no natural predators. Additionally, Hawai‘i’s wet environmental conditions create the ideal environment in which this plant can thrive and maintain its invasive characteristic. Forest stated that *Miconia*, which is known to grow in the wetter regions of the islands, may impact native foliage such as the *olonā* (*Touchardia latifolia*), a plant known to be used in making traditional fibers and cordage.

Forest described much of the vegetation that dominates the islands as a “rag-tag assemblage of pantropical invasive species” and opined that this sort of global homogenization of the islands’ plant life is exacerbating the spread of really aggressive species. Adding to this, Forest expressed that changes in the environment are inevitable and noted that these changes are difficult for many to accept. Forest and Kim believe that biocontrol is a method that can help mitigate or slow the growth of species but “it never eradicates, it just reduces the numbers” and cited the example of the EGW and the panini cactus (*Opuntia ficus-indica*) which have had biocontrol agents released against them. Both Forest and Kim explained that over a course of many years they have seen limited success rates where biocontrol has resulted in complete eradication, which they shared is a common outcome.

When asked about their thoughts on the cultural appropriateness of biocontrol, Forest and Kim shared that they have witnessed the culture and traditions of these islands evolve within an inevitable changing environment. Forest emphasized that the mixed-culture of Hawai‘i has been able to co-exist with the changing environment and they have seen various cultures including Hawaiian culture utilize introduced plants in place of rare or extinct native plants in order to perpetuate their traditional cultural practices. In spite of these cultural adaptations, they feel that biocontrol can be useful in protecting native plant habitats which are both ecologically and culturally important and remain open-minded to these types of undertakings.

Based on their knowledge of the efficacy of former biocontrol efforts, Forest and Kim shared that generally, the way a biocontrol agent is introduced is not very effective and that for the most part, in order for the biocontrol to be entirely successful a large number of biocontrol agents must be introduced. Kim stated that although the purpose of biocontrol is to introduce an organism that is specific to a target plant, the efficacy is oftentimes underwhelming and as a result, there have been a few unintentional consequences. Kim shared that although biocontrol agents are introduced with good intentions, “the unknown,” meaning its potential to cause unforeseen impacts to a non-target species is the main factor that contributes to the general resistance to implement biocontrol. Additionally, Forest and Kim both stated that once a biocontrol agent is released there is very limited and often times no follow-up by the agencies that have invested in the pre-release studies. In light of this, Forest and Kim recommended that post-release monitoring should be held to the same standard as the pre-release of a biocontrol agent. Forest described that “mother nature is so crafty” and that changes are often muted or other factors become more significant than the release, therefore on-going post-release monitoring is a crucial component to this process. Forest also stated that misinformation has been detrimental to these biocontrol efforts and believes that more should be done to effectively communicate these types of undertakings to the public.

MANAIAKALANI KALUA

On June 6th, 2019, Lokelani Brandt conducted an interview with Manaiakalani “Manai” Kalua, a *kumu hula* and life-long Hawaiian cultural practitioner. Born and raised in the Hawaiian homestead community of Keaukaha, Manai has dedicated his life to *hula* and because of this, he has had extensive interactions with Hawai‘i’s native plant life, which is a fundamental element to traditional *hula* practices.

When asked about any known cultural uses for *Miconia*, Manai stated that he was not aware of any cultural uses of this plant but expressed that this plant is highly invasive and has taken over areas where he used to gather other plants for ceremonial and other cultural uses. He described collecting *‘ohe* (bamboo) in the Honoli‘i area (South Hilo District, Island of Hawai‘i), which is now overgrown with *Miconia*. He described a time when he used to collect *‘ohe* and saw a few *Miconia* plants. Later, when Manai returned to the area, he saw that someone had removed the *Miconia* but put the cuttings in a wood chipper and dispersed the wood chips back into the forest. Since then, he has observed even more *Miconia* growing in the area. He expressed that while this may have been an attempt at eliminating *Miconia*, the lack of knowledge to properly dispose of the plant has resulted in the spreading of this plant. He believes that there is still a lack of public understanding of how to properly dispose of invasive species.

Manai spoke at length about the ways in which invasive species are changing traditional cultural practices specific to *hula*. He explained that within his *hula hālau* he teaches about the proper way to harvest plants in addition to practices that will help limit the spread of invasive species. He now stresses the importance of cleaning all clothing,

equipment, and cars after every visit to the forest. He stated that invasive species are a serious problem that has major environmental and cultural implications and cited the example of Rapid ʻŌhiʻa Death (ROD), which has significantly impacted *hula* practices. He noted that culturally, *ʻōhiʻa* is an important part of *hula* adornments and rituals, since becoming aware of ROD, he no longer gathers *ʻōhiʻa* nor does he condone the gathering of this plant. He explained that not being able to utilize *ʻōhiʻa* has required him to be more creative with his cultural practices.

When asked about his thoughts on the cultural appropriateness of utilizing biocontrol, Manai explained that historically we have a long history of unsuccessfully utilizing biocontrol and cited examples including the introduction of the mongoose to control rats and the scale insect to control strawberry guava. Manai expressed concern for the idea of introducing other foreign insects which may adversely impact its intended target but whose impacts are somewhat unknown to the many other species that grow in the same habitat as the target species. He questioned, what will happen to the introduced biocontrol once the target species is eliminated, and what are the long-term impacts of utilizing biocontrol? He noted that we are still living with the repercussion of previous biocontrol choices that we still cannot manage. Although Manai is not a proponent of utilizing biocontrol, he understands that the shift to use biocontrol suggests that all other methods for controlling these invasive species have been exhausted. He was aware that utilizing biocontrol is a much slower process and stated that the government does not have the means to manually eradicate Hawaiʻi's invasive species. He stated that there are also risks associated with the manual removal of invasive species.

While Manai remains skeptical of the effectiveness of biocontrol, he believes that the government must develop stricter laws and policies to stop the introduction of invasive species. He noted that in his travels to other parts of the world, including Japan and New Zealand, their customs process is far more thorough and intensive. He believes that these countries and exemplary models where the emphasis is placed on stopping the introduction instead of trying to combat its spread. He also advocates for a more rapid response to known invasive species and cited the example of the coqui frog, which on Hawaiʻi Island is now so widespread and nearly unmanageable. He believes that rapidly responding to invasive species, especially when populations are far more contained, could be far more effective.

DENNIS KANAʻE KEAWE

On August 13, 2019, Aoloa Santos conducted an interview with Dennis "Kanaʻe" Keawe, a retired Commercial Services Consultant for Hawaiian Electric Light Company (HELCO) and former lecturer at the University of Hawaiʻi at Hilo (UH Hilo). Born and raised on Oʻahu, Kanaʻe moved to Hawaiʻi Island in November of 1974, to help his father with his coffee farm in Hōnaunau, Kona. Following his retirement from HELCO at age 55, he was asked to teach a Hawaiian studies ethnobotany course at the UH Hilo. Kanaʻe stated that when he was asked to teach the course, his botanical vocabulary and knowledge was appropriate for teaching young children and therefore acknowledged that in order to instruct at the university level, he needed to expand and develop his botanical nomenclature. Through this process, Kanaʻe learned that many varieties of Hawaiʻi's native plants "exists within the tropical belt around the world" and by having in-depth knowledge of scientific names and identifiers allowed him to effectively communicate with people well-versed in similar plants of those regions. Additionally, Kanaʻe is a renowned Hawaiian artisan and cultural practitioner endearingly referred to by many as "the all-around guy." He has been recognized for his expert-crafted oeuvres, such as *hula pahu* (drum), *kapa* (bark cloth), *iʻe kuku* (*kapa* beater), and feather crafts. As a result of his artisanship, he has been afforded opportunities and invitations to visit communities and institutions around the world, notably the Smithsonian Museum, an institution that houses a large collection of Hawaiian antiquities.

When asked about any traditional cultural uses of the *Miconia*, Kanaʻe stated that he was unaware of any cultural importance or uses for any part of this plant but shared that "the wood of the *Miconia* is hard enough to perhaps be of utilitarian purposes to be utilized to make primary kapa beaters." While no specific information about any known past or current cultural uses of this plant was shared, he did offer thoughts on the use of biocontrol. Kanaʻe expressed his support and did not foresee any major cultural impacts if extensive studies and testing is done prior to its release. He added that although there are unknown variables to this method, humans can only do so much, especially in the current state of our environment and the rapid growth of invasive species.

ILIAHI ANTHONY

On September 3rd, 2019, Lokelani Brandt interviewed Iliahi "Ili" Anthony, a *hula* dancer, *lauhala* weaver, *lei* maker, and natural dye expert. Ili is also an art teacher at Ka ʻUmeke Kāʻeo Hawaiian Immersion Public Charter School and has a background in designing furniture and exhibit spaces. Ili grew up in the community of Keaukaha and has been dancing *hula* since the age of four. As a life-long *hula* dancer for Hālau O Kekuhi, Ili explained that her knowledge of Hawaiʻi plant life comes from years of gathering foliage (primarily indigenous and endemic species) and other natural resources for their *ʻaʻahu* (costume), *lei*, and *hula* implements. Ili recalled as a child being accompanied by her *kumu hula* and family members into their gathering areas where they taught her about the Hawaiian cultural significance of the plants, gathering protocols, how to identify them in the forest, and how to sustainably gather and

prepare them to be used in the context of *hula*. She emphasized that as a small kid, she learned about these practices by watching and listening to her *kumu* and relatives and stated that when you are that young, you're not keenly aware of what it is they are teaching you, but as an adult, those teachings remain and are better understood. Ili openly stated that although she is not of Hawaiian ancestry, she has been raised by native Hawaiians and has learned about many of the traditional practices and customs. She expressed that although she chooses to remain respectful when it comes to Hawaiian issues and matters, she is willing to share her knowledge when asked and feels that she has something to offer.

Ili explained that as a *hula* dancer, she has learned to depend on other cultural practices to help her with gathering certain natural resources needed in *hula*. She described going on expeditions with her brother, who is a hunter, to gather *maile*. Ili explained that her brother knows the trails very well and is very particular about how they cut *maile*, and how much they take from any one plant. She added that although her brother is not necessarily a *lei* maker, he knows this plant and forest resources very well. She explained that she also relies on her father who is a woodcarver to help her make certain *hula* implements. Ili also described gathering with other *hula* dancers, some of whom have a background in native plants and botany, and shared that when she gathers with them, they often teach her about the names and can point out the subtleties that are not obvious to her. 'Ili believes that this demonstrates the interconnectedness of cultural practices and stated that even people who we think may not use plants, such as hunters and fishers, do often know a lot about native plant life. She stressed that as a *hula* practitioner and in terms of plant resources, she relies greatly on other practices that are not necessarily defined as *hula*.

With respect to learning about and identifying plants, whether native or non-native, Ili shared that unless someone shares that knowledge with her, then she would most likely not know about it. She expressed that when she has gone to get gathering permits from DLNR, she recalled seeing various informational posters in their office which she finds useful for learning about Hawai'i's plant life and invasive pests.

With respect to *Miconia*, Ili explained that she has encountered this plant while gathering *lauhala* in Puna but was not familiar with any cultural uses for this plant. Based on her observations and recollections, Ili believes that *Miconia* is often found in the lower elevations and made reference to the Pahoa area in the Puna District. She shared that *Miconia* is a very strong and resilient plant and wonders if there are other uses for this plant that have not been discovered?

While Ili supports the removal of invasive species, especially if they are directly impacting native plants or native plant habitat, she cautioned that some plants that have been dubbed "invasive" are utilized for various traditional and contemporary cultural purposes. Ili opined that today, people utilize various "rubbish plants" to make adornments such as *lei* and that such plants if properly arranged can be turned into something beautiful and wearable. She also noted that weedy plants such as *laukahi* (*Plantago major*) and the introduced guava (*Psidium guajava*) have become incorporated into Hawaiian *lā'au lapa'au* (plant healing) practices. While she believes that finding a cultural purpose for an invasive plant is not a strong reason to halt invasive species management efforts, she cautioned that people have come to rely on certain invasive species to perpetuate select cultural practices because they are easily accessible and abundant. Adding to this, Ili expressed that people have and will continue to adapt to living with invasive species. Ili also worries that if invasive species, particularly those that are used for cultural purposes become less abundant and available, then people will likely have to find a more readily available substitute, which could result in people gathering indigenous or endemic species. She stated that people tend to use invasive species because they are abundant and easily accessible.

Ili shared that over the years she has observed an increasing number of pests on native plants and made specific reference to *'a'ali'i* (*Dodonaea viscosa*), which now seems to be infested with spiders. She shared that as a *lei* maker, she often brings these plants into her home and disposes of her *hakina* (scrap pieces) in her yard. Although she has not seen those spiders move onto the plants at her home, Ili expressed a sense of uncertainty with gathering and possibly transporting unknown pest.

Ili also spoke about the need to improve our understanding of the ecological relationships that may exist between native and non-native species. She shared that some native plants such as *'iliahi* (sandalwood; *Santalum ellipticum*) is semi-parasitic and relies on a host plant to thrive. She added that we know that native plants have adapted to each other and wonders if native species may have adapted or are adapting to living amongst non-native species as well. She pondered on the idea of removing invasive species and the possibility of causing indirect impacts to native species that have come to rely on them for some life-giving element.

When asked about her thoughts on the cultural appropriateness of using biocontrol, Ili opined that this is a difficult question to answer and lightheartedly stated that "basically, you're introducing another culture into the culture." She asked, what things have we introduced in the past that actually worked? Ili added that she feels there have been more things in the past that have been introduced that haven't worked in comparison to those that have actually worked. Ili

stated that introducing more foreign species to the islands is a scary thought and wondered what the future would look like. She asked, will we have to continually introduce more foreign species to combat those we previously introduced? Additionally, she wondered what would take the place of these invasives once they are removed?

When asked about her thoughts and recommendations about the proposed action, Ili believes the state could do more in terms of educating the public about identifying invasive species and the ways in which everyone can help limit the spread. She stated that there is a general lack of awareness and believes that providing more information to those who are obtaining gathering permits may be one way to improve awareness. She stressed that the information needs to be presented in a reasonable manner that would not deter people from obtaining a gathering permit. Ili shared that since the events taking place on Mauna Kea, she believes there is growing alertness amongst the people about land and culture-related issues. She has noticed an increasing awareness in schools where teachers are working with students to better understand and to seek solutions to these issues. She believes that the state should improve support to the schools so that the information is more accessible to students and teachers. Ili explained that many teachers want to do more of these kinds of projects with their students but there are many challenges that hinder their ability to execute such projects, including accessibility, funding, time, and finding a good resource person that can connect them to specific places and resources. She expressed that teachers can only guide and facilitate these kinds of projects, but they are not plant experts. She believes that education can be a key component in improving public awareness. She also added that while there may be a robust amount of scientific information about the potentially positive aspects of biocontrol, it needs to be condensed and expressed in layman's terms to that the general population can actually understand and connect to what scientists are discovering. She lamented that otherwise, people won't listen or hear what is being said because they can't connect to or understand what the scientists are saying. Ili made reference to the tremendous educational efforts that were put into improving public awareness about Rapid ʻŌhiʻa Death and noted that their outreach team was doing big and small things such as community talks, stickers, hats, and being present at various local community events. She believes that more of these kinds of efforts could be undertaken for other invasive species.

Ili also shared that many scientists are not practitioners and opined that these two groups, although they may share an affinity for preserving plants, both have two completely different relationships with the resource. She believes that the relationship between scientists and practitioners should also be improved because both groups can help to elevate and improve each other's practices if they are willing to work collaboratively. While she feels that this dynamic has been changing, she thinks its especially important as we move towards the possibility of using biocontrol in native plant habitats.

4. IDENTIFICATION AND MITIGATION OF POTENTIAL CULTURAL IMPACTS

The OEQC guidelines for assessing cultural impacts identify several possible types of cultural practices and beliefs that are subject to assessment. These include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The guidelines also identify the types of potential cultural resources associated with cultural practices and beliefs that are subject to assessment, which "may include traditional cultural properties or other types of historic sites, both man made and natural, including submerged cultural resources"(Office of Environmental Quality Control (OEQC) 1997:1). The origin of the concept of traditional cultural property is found in National Register Bulletin 38 published by the U.S. Department of Interior-National Park Service (Parker and King 1998). A traditional cultural property can be generally defined as:

> …one that is eligible for inclusion in the National Register because of its association with cultural practices and beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community. (Parker and King 1998:1)

This definition also implies that any identified traditional practices and beliefs of an ethnic community, or members of that community, exceeds fifty years. "Traditional" as defined in the National Register Bulletin 38 "refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practices (ibid.). Whereas, "Culture" refers to "a system of behaviors, values, ideologies, and social arrangements" in addition to "tools and expressive elements such as graphic arts" (ibid.). The use of the term "Property" defines this category of resource as an identifiable place. Traditional cultural properties are not intangible, they must have some kind of boundary; and are subject to the same kind of evaluation as any other historic resource, with one very important exception. By definition, the significance of traditional cultural properties should be determined by the community that values them.

It is however with the definition of "Property" wherein there lies an inherent contradiction and corresponding difficulty in the process of identification and evaluation of potential Hawaiian traditional cultural properties because it is precisely the concept of boundaries that runs counter to the traditional Hawaiian belief system. The sacredness of a particular landscape feature is often cosmologically tied to the rest of the landscape as well as to other features on it. To limit a property to a specifically defined area may actually partition it from what makes it significant in the first place. However offensive the concept of boundaries may be, it is nonetheless the regulatory benchmark for defining and assessing traditional cultural properties. As the OEQC guidelines do not contain criteria for assessing the significance for traditional cultural properties, this study will adopt the state criteria for evaluating the significance of historic properties, of which traditional cultural properties are a subset. To be significant the potential historic property or traditional cultural property must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

a Be associated with events that have made an important contribution to the broad patterns of our history;

b Be associated with the lives of persons important in our past;

c Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;

d Have yielded, or is likely to yield, information important for research on prehistory or history;

e Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity.

While it is the practice of the DLNR-SHPD to consider most historic properties significant under Criterion d at a minimum, it is clear that traditional cultural properties by definition would also be significant under Criterion e. A further analytical framework for addressing the preservation and protection of customary and traditional native practices specific to Hawaiian communities resulted from the *Ka Pa'akai O Ka 'Āina* v Land Use Commission court case. The court decision established a three-part process relative to evaluating such potential impacts: first, to identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary native Hawaiian rights are exercised; second, to identify the extent to which those resources and rights will be affected or impaired; and third, specify any mitigative actions to be taken to reasonably protect native Hawaiian rights if they are found to exist.

Summary of Culture-Historical Background, Consultation

A review of the culture-historical background information reveals that *Miconia* was introduced to the Wahiawa Botanical Gardens on the island of O'ahu in 1961 as a garden ornamental. Between 1961 and the 1970s, the plant was distributed to other gardens on O'ahu including the Waimea Botanical Gardens on O'ahu's north shore and at the Harold L. Lyon Arboretum in Mānoa Valley, but was not widespread. During this time, *Miconia* was also reported at the estate of Herbert Shipman in Hilo on Hawai'i Island. By the 1970s isolated populations of *Miconia* had become naturalized on the island of O'ahu, Maui, and Hawai'i. Despite warnings given between 1975-1983 to government officials about the plant's potential to invade Hawai'i's wet forest habitat, several individual specimens were destroyed but no major efforts were undertaken to prevent the plant's spread. By the 1990s, *Miconia* had become aggressively abundant on Maui and Hawai'i islands and to eradicate and contain existing populations "Operation Miconia," a concerted statewide effort, was officially launched. Public education and awareness about the impacts of *Miconia* to Hawai'i's wet forest habitat garnered public attention and support. Despite these efforts, *Miconia* is still found on four of the major Hawaiian Islands, namely Kaua'i, O'ahu, Maui, and Hawai'i. Of the four islands, *Miconia* infestation is most extensive on Hawai'i Island and it has been estimated that this plant covers some 250,000 acres.

Identification of Cultural Impacts and Proposed Mitigation Measures

Although *Miconia* has existed in the Hawaiian Islands for more than fifty years, there are no recorded cultural uses for this plant, other than it being used as an ornamental. While horticulturalist and plant collectors are known to favor this plant for its unique qualities, there is no historical evidence to suggest that *Miconia* is crucial to any particular ethnic groups' cultural history, identity, practices, or beliefs, nor does it meet any of the significance criteria outlined above. Although *Miconia* does not meet any of the significance criteria, what is culturally significant is the wet forest habitat in which it thrives. Hawai'i's wet forest habitat could be considered significant as a traditional cultural property under Criterion e, as it contains many culturally important indigenous and endemic taxa, which are still utilized in

certain Hawaiian cultural practices. Some of these wet forest resources are also associated with certain Hawaiian cultural beliefs.

Based on the information presented in the culture-historical background and from the insights shared by the consulted parties, it is the assessment of this study that the release of the proposed biological control agent, *Euselasia chrysippe* will not result in impacts to any valued cultural, historical, or natural resources. Conversely, if no action is taken to further reduce remaining populations of *Miconia* from claiming more of Hawai'i's wet forest habitat, then impacts to this valued resource would be anticipated.

While no specific cultural impacts have been identified, the consulted parties shared valuable insight, concerns, and recommendations that could reduce the potential for any future impacts and improve public transparency regarding the effectiveness of biocontrol as a conservation management strategy. Several key themes emerged from the consultation efforts, all of which are further described below:

1) maintain stringent pre and post-release testing and monitoring;
2) improved community transparency and input;
3) active and ongoing public outreach and education;
4) improve efforts to limit the introduction of potentially harmful invasive species.

While the consulted parties did not explicitly oppose the use of biocontrol, especially to aid in the recovery of Hawai'i's native forest habitat, they all shared a sense of concern and spoke about the risks inherent in biocontrol activities. While they were all aware of the extensive studies that are conducted prior to the release of any biocontrol agent, they all spoke about the uncertainty of introducing another foreign insect to Hawai'i's fragile ecosystems. Several of the consulted parties noted that although pre-release host specificity test helps with the screening process, they shared that laboratory testing cannot account for all the variables found in nature. The generally held belief is that field release is merely another screening and testing procedure. Despite this element of uncertainty, all of the consulted parties agreed that some sort of action is necessary to limit the growth and spread of *Miconia*. Nearly all of the consulted parties stressed the importance of thorough controlled pre-release studies to safeguard against the potential for the collateral loss of other endemic taxa or economically valuable crops. Several of the consulted parties also stressed the importance of conducting on-going and consistent post-release monitoring to ensure that the biocontrol agent does not spread beyond its intended target. These individuals noted that consistent post-release monitoring will help with early detection if it is found that the proposed biocontrol agent has unintentionally spread beyond the host plant. Wild Brawner suggested the concept of integrated pest management, particularly for native plants, where natural and cultural management practices are employed concurrently. Examples of this include, timing weed removal and planting companion plants to attract active pollinators or insects that may combat other invasive insects.

In looking to future biocontrol efforts, nearly all of the consulted parties expressed the need to integrate more public input and stressed the importance of moving towards a community-based resource management structure. Based on the past public meetings held by HDOA for biocontrol, Jen Lawson felt that the public meetings held by the HDOA should be restructured so that they are engaging and inclusive of community input as she believes this may improve trust between the affected communities and the agencies. Jen Lawson and Iliahi Anthony believe that supporting biocontrol research must be clearly and effectively communicated to the public using various media forms. Iliahi Anthony noted that education and outreach are key components to improve the public's understanding of biocontrol and empowering them with the knowledge and tools to help limit the spread of invasive species. Both Jen Lawson and Iliahi Anthony expressed that improving the public's understanding of the risk and benefits of biocontrol may help to build public transparency and hopefully resolve some of the misconceptions associated with biocontrol. Jen Lawson encourages the responsible agencies to consider partnering with conservation-focused non-profit organizations and community groups, especially during the field release monitoring phase as these groups are working directly with these target species daily. As noted by Kim and Forest Starr, the conventional biocontrol release methods that have been used in the past typically yields results that are underwhelming. Perhaps, the additional support from non-profit organizations could potentially improve the efficacy of biocontrol.

All of the consulted parties spoke about the many misconceptions associated with biocontrol, many of which are based on failed historical examples. While testing and screening procedures have improved significantly since the late 19th century, many people today remain resistant and skeptical to implement biocontrol. It is the author's contention and as described by some of the consulted parties that this widely held belief stems from the agencies' lack of public outreach and education. In light of this, it is imperative that DLNR, DOFAW, and HDOA make serious efforts to participate in public outreach events and to educate the public so that these misconceptions, some of which are rooted in a historical context, can be better understood. Public outreach and education efforts should also demonstrate the potential effectiveness of biocontrol as a conservation management strategy. Iliahi Anthony spoke about the

effectiveness of the Rapid ʻŌhiʻa Death (ROD) community outreach efforts and believes that this could be an exemplary model. Iliahi Anthony noted that the ROD outreach team has been actively disseminating information using various media forms.

While combatting existing populations of invasive species is a critical step in managing Hawaiʻi's natural resources, it was noted by Manaiakalani Kalua that the State of Hawaiʻi must also ramp up their efforts to prevent the arrival and introduction of unwanted pest species. Manaiakalani Kalua believes that current policies and laws must be revised and strengthened. Both Manaiakalani Kalua and Iliahi Anthony noted that in their travels to other countries their customs entry process is far more rigorous and thorough. Manaiakalani Kalua believes that the State should look to other countries such as New Zealand and Japan as models to prevent the arrival of unwanted pests.

In summary, the recommendations provided above are intended to ensure that the release of *E. chrysippe* as a biocontrol agent for *Miconia* considers the culture-historical context and the concerns and thoughts shared by the consulted parties. While none of the consulted parties explicitly opposed the use of biocontrol, the concerns, and recommendations offered above are intended to support the State of Hawaiʻi in being mindful of the cultural, social, and environmental uniqueness of Hawaiʻi. Conducting background research, consulting with community members, and taking steps towards mitigating any potential cultural impacts is done so in the spirit and practice of *Aloha ʻĀina*, a contemporary movement founded on traditional practices and beliefs that emphasize the intimate relationship that exists between Native Hawaiians and the *ʻāina* (land). If DLNR, DOFAW, and HDOA assume ownership of their right and responsibility to release a biocontrol agent, we recommend it be done so in that same spirit and practice. Attention to and implementation of the above-described issues and measures will help to ensure that no such resources, practices, or beliefs will be adversely affected by the proposed release of *E. chrysippe*.

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APPENDIX A.
KA WAI OLA PUBLIC NOTICE

PUBLIC NOTICE

ASM Affiliates is preparing a Cultural Impact Assessment (CIA) in advance of a proposed statewide release of four (4) biological control (biocontrol) agents for four target invasive species. In brief, DOFAW is seeking to conduct a statewide field release of four (4) separate biocontrol agents on four target species:

- introduction of a wasp parasitoid *(Aprostocetus nitens)* to further control the erythrina gall wasp (*Quadradstichus erythrinae)*, which has been impacting the native *wiliwili (Erythrina sandwicensis)*;
- introduction of a small beetle *(Syphraea uberabensis)* to control weedy melastomes *(Tibouchina spp.)*;
- introduction of a thrips insect *(Pseudophilothrips ichini)* to control Christmas berry *(Schinus terebinthifolia)*;
- introduction of a butterfly *(Euselasia chrysippe)* to control miconia *(Miconia calvescens)*.

We are seeking consultation with any community members that might have knowledge of traditional cultural uses or who are involved in any ongoing cultural practices associated with the target species (i.e. *wiliwili*, melastones, Christmas berry, and miconia). If you have and can share any such information please contact Lokelani Brandt lbrandt@asmaffiliates.com, or Aoloa Santos asantos@asmaffiliates.com, phone (808) 969-6066, mailing address ASM Affiliates 507A E. Lanikaula Street, Hilo, HI 96720.

(Ka Wai Ola 2019:21)

ATTACHMENT 3

Biology and Host Range of *Euselasia chrysippe*

Euselasia chrysippe (Lepidoptera: Riodinidae), the golden sombermark butterfly, is proposed for environmental release in Hawaii for biological control of the noxious weed *Miconia calvescens* (Melastomataceae). Native to Central and South America, miconia is considered one of Hawai'i's most invasive plants. With its exceptionally large leaves, it shades and outcompetes other species, effectively forming a monoculture. Uncontrolled growth can overwhelm highly diverse native wet forest ecosystems that are home to critically endangered species and essential to our freshwater resources. Despite major efforts using chemical control, this species continues to proliferate, particularly on Maui and Hawai'i Islands, and long-term management of *M. calvescens* will depend on the use of biocontrol (Ashe 2017). To date only one biocontrol agent has been released against miconia, the leaf spot pathogen *Colletotrichum gloeosporioides*, with only minor impacts in Hawaii (Seixas et al. 2007).

Figure 1. Euselasia chrysippe adults emerge from pupation

Euselasia chrysippe is a natural herbivore of miconia in the plant's native range in Costa Rica. Among the leaf-feeding natural enemies of miconia, *E. chrysippe* was found the most promising for biocontrol because its larvae feed together in groups, causing more damage to miconia leaves. This gregarious behavior also may improve its defense against natural enemies of lepidopteran species already present in Hawai'i. Extensive testing has shown *E. chrysippe* to be host-specific to miconia and other closely related members of the Melastomataceae family, all of which are non-native weeds in Hawai'i.

Release of *E. chrysippe* is proposed on all islands where miconia has established. Spread of the insect from initial release sites will occur both through natural dispersal and via artificial redistribution by land managers. It is expected that *E. chrysippe* will range statewide in all areas where miconia exists within a few years of release. Feeding by *E. chrysippe* is expected to reduce foliage and suppress vigor of miconia trees, allowing other species to persist and compete, to the long-term benefit of Hawai'i's forests and watersheds. State and federal land management agencies will monitor the effectiveness of the biocontrol.

Biology of *Euselasia chrysippe*

Euselasia chrysippe (Bates 1866) is a butterfly in the family Riodinidae whose native range extends from southern Mexico to Colombia, at elevations from sea level to 1,500m (Nishida 2010). In Costa Rica, it is found on the Caribbean and Pacific slopes in primary and secondary rain forests (Allen 2012; Nishida 2010). Caterpillars and eggs of *E. chrysippe* have been collected only from plants in the family Melastomataceae, specifically several species within the genus *Miconia* and *Conostegia rufescens* (Nishida 2010). Caterpillars feed together in large groups, causing defoliation of otherwise healthy leaves.

Figure 2. Larval cohort emerged from egg cluster

Under lab rearing, *E. chrysippe* eggs take approximately one month to hatch, and development of larvae and pupae to emergence of adult butterflies takes roughly another month. Both male and female adults have been shown to live for longer than a month (Nishida 2010). The caterpillars of each cohort develop through six instars, ultimately consuming the

equivalent of one full *M. calvescens* leaf (Johnson 2010). As with all known members of the tribe Euselasiini, *E. chrysippe* caterpillars hatch, feed, rest, molt, and pupate together in sibling cohorts of up to 100 individuals (Allen 2010; Nishida 2010). This gregarious behavior is thought to optimize feeding on tough leaves. In addition, remaining as a large group provides a defense against predation and may contribute to low parasitism rates in their home range (Allen 2010).

Figure 3. Caterpillars feed gregariously

Natural Enemies: A factor commonly affecting lepidopteran insects introduced for weed biocontrol in Hawai‘i is parasitism by various insects previously introduced accidentally, or purposefully for biocontrol of lepidopteran pests. Reported parasitoids of the genus *Euselasia* include species of Chalcididae, Ichneumonidae, Trichogrammatidae (all in Hymenoptera), and Tachinidae (Diptera) (Nishida 2010). Fortunately, the known parasites of *E. chrysippe* do not occur in Hawaii: one egg parasitoid (*Encarsia* cf. *porteri* (Hymenoptera: Ahelinidae)) and two genera of solitary tachinid parasitoids that attack large larvae and emerge from pupae have been recorded in Costa Rica (Nishida 2010). Species in the subfamily Riodininae do not share the usual parasitoids of Lepidoptera (Hanson et al. 2010), and no members of this family are native or have been introduced to Hawai‘i (Nishida 2002), which further reduces the chance that a specialized parasite of *E. chrysippe* currently exists here.

Generalist predators, however, might significantly impact the immature stages of *E. chrysippe*, which remain exposed on plants throughout their development. In particular, the long development time for eggs means that stage is vulnerable for an extended period. In Costa Rica, *E. chrysippe* eggs were preyed upon by ants, and larvae by hemipteran predators and vespid wasps (Allen 2012).

Effect on Target Weed: *Euselasia chrysippe* was selected as a biocontrol for miconia in Hawai‘i because its gregariously feeding larvae can cause substantial damage to leaves. In Costa Rica its eggs and larvae are found on a wide range of sizes of *Miconia* trees, from saplings less than 1m tall to large mature trees. When reared on potted plants, a cohort of 60–80 larvae will consume several hundred square centimeters of leaf tissue – equivalent to the area of one average-sized leaf (Puliafico et al. 2015). Damage is typically distributed across several leaves because larvae move to new feeding areas between meals. Small larvae feed on the under surface of leaves, creating windowing damage, while the later stages feed through the whole leaf lamina. Damage also includes removal of portions of uneaten leaves, presumably to reduce detection by natural enemies (Figure 4).

Although extensive defoliation by *E. chrysippe* is not observed in Costa Rica, its populations are presumed to be limited by natural enemies there. If introduced to Hawai‘i, population growth is expected to be less constrained by enemies, allowing numbers of *E. chrysippe* to increase to levels sufficiently high to cause substantial defoliation. Damage is unlikely to be severe enough to kill miconia trees, but repeated partial defoliations may reduce growth and reproduction of trees and enhance light levels for plants competing with miconia. Future releases of other candidate biocontrol

Figure 4. Euselasia chrysippe larvae defoliating Miconia calvescens

agents will aim to impact seed production, population densities, and/or seedling establishment and survival (Johnson 2010).

Host Range of *Euselasia chrysippe*

Recorded host plants for the genus *Euselasia* include members of the families Euphorbiaceae, Clusiaceae, Myrtaceae, Melastomataceae, Sapotaceae, and Vochysiaceae; however, caterpillars and eggs of *E. chrysippe* have been collected only from Melastomataceae, specifically *Miconia calvescens, M. impetiolaris, M. trinervia, M. elata, M. appendiculata, M. donaena, M. longifolia,* and *Conostegia rufescens* (DeVries 1997; DeVries et al. 1992; Janzen and Hallwachs 2009; Nishida 2010). No-choice host tests conducted by Nishida (2010) found that larvae collected from *M. impetiolaris* would feed on *Conostegia xalapensis* and *M. calvescens* (Melastomataceae) but exhibited no feeding on two *Eucalyptus* spp., *Eugenia truncata*, and *Psidium guajava* (all Myrtaceae), or *Clusia flava* (Clusiaceae).

Host specificity tests with larvae of *E. chrysippe* were conducted from 2012-2014 in laboratories in Hawai‘i, at the Hawai‘i Volcanoes National Park Quarantine Facility, and in Costa Rica, at La Selva Biological Station. Larvae for tests were collected as eggs from several sites in Costa Rica on two of its host plants, *Miconia calvescens* and *Miconia impetiolaris*. An emphasis was placed on testing plants in the order Myrtales, specifically on species within the families Melastomataceae, Myrtaceae, Combretaceae, Lythraceae, and Onagraceae. Relationships within the Melastomataceae were based on Clausing and Renner (2001). In addition, species from more distantly related taxa but with economic, cultural, and/or ecological significance in Hawai‘i were selected based on input from the U.S. Fish and Wildlife Service, consultations with members of the agricultural community, and expert sources on native Hawaiian plants. In total, 73 species of plants from 19 families were examined for suitability as hosts for *E. chrysippe* (Table 1). No-choice tests, with cohorts of 5-10 larvae exposed to leaves of each plant species for 3 days in 90-mm petri dishes, were replicated 4-5 times. Further tests of a subset of melastomes were conducted over longer periods, on potted plants and in petris with leaves replaced every few days, to determine if any are suitable for complete development of *E. chrysippe*.

Results of host specificity studies showed that among the 73 species tested, *E. chrysippe* larvae feed and survive primarily on *Miconia calvescens* and a few close relatives within the tribe Miconieae (Figures 5 and 6). Very low levels of feeding occurred on a few plants in families outside of Melastomataceae, but in all cases, survival of the larvae past the 3-day mark on species in these families was extremely low, and none developed into larger larvae. Among plants occurring in Hawai‘i, only two species other than *M. calvescens* experienced substantial levels of feeding: the melastomes *Clidemia hirta* and *Tetrazygia bicolor*, which have recently been found through genetic analyses to be better placed within the genus *Miconia* (Michelangeli et al. 2020). No Melastomataceae are native to Hawai‘i, and nine of the 15 species naturalized in Hawai‘i have been declared state noxious weeds (Medeiros et al. 1997).

Studies have clearly demonstrated that *E. chrysippe* is host-specific to a narrow subset of Melastomataceae. Results of the host specificity studies are summarized below (Figures 5-7). Laboratory tests are consistent with field observations of *E. chrysippe* in Costa Rica, where eggs and larvae have been collected only from species of *Miconia* and *Conostegia rufescens*, a plant in the same tribe (Nishida 2010). A similar pattern of specificity holds for other species within the genus *Euselasia*. Across numerous studies in various parts of tropical America, *Euselasia* have been found to be narrowly host-specific, with each species specializing within a family of plants (Nishida 2010).

Table 1. Plant species exposed to *Euselasia chrysippe* larvae in no-choice petri tests

Order Family Tribe	Test Plant Species	Common Name(s)	Native Range*	Present in Hawaii?
Myrtales				
Melastomataceae				
Miconieae	*Clidemia dentata*		SCA	
	Clidemia discolor		SCA	
	Clidemia epiphytica		SCA	
	Clidemia hirta	clidemia, Koster's curse	SCA	yes
	Conostegia subcrustulata		SCA	
	Conostegia xalapensis		SCA	
	Henriettea turberculosa		SCA	
	Leandra granatensis		SCA	
	Leandra longicoma		SCA	
	Miconia affinis		SCA	
	Miconia argentea		SCA	
	Miconia barbinervis		SCA	
	Miconia calvescens	miconia	SCA	yes
	Miconia cremadena		SCA	
	Miconia elata		SCA	
	Miconia gracilis		SCA	
	Miconia impetiolaris		SCA	
	Miconia longifolia		SCA	
	Miconia multispicata		SCA	
	Miconia nervosa		SCA	
	Miconia prasina		SCA	
	Miconia theizans		SCA	
	Tetrazygia bicolor		NA/SCA	yes
Bertolonieae	*Triolena hirsuta*		SCA	
Blakeeae	*Blakea litoralis*		SCA	
	Topobea maurofernandeziana		SCA	
Dissochaeteae	*Medinilla cummingii*		IM	yes
	Medinilla magnifica	showy medinilla	AU/IM	yes
Melastomeae	*Arthrostemma ciliatum*	pinkfringe	SCA	yes
	Dissotis rotundifolia	pink lady, rockrose	AF	yes
	Heterocentron subtriplinervium	pearlflower	SCA	yes
	Melastoma sanguineum	fox-tongued melastome	IM	yes
	Melastoma septemnervium	Asian melastome	IM	yes
	Pterolepis glomerata	false meadowbeauty	SCA	yes
	Tibouchina herbacea	cane tibouchina	SCA	yes
	Tibouchina longifolia	long leaf glory tree	SCA	yes
	Tibouchina urvilleana	princess flower, glorybush	SCA	yes
Combretaceae	*Terminalia catappa*	false kamani	AU/IM	yes
Lythraceae	*Cuphea ignea*	cigar flower	SCA	yes
	Lythrum maritimum	pukamole	SCA	yes

* HI =Hawaii, SCA =South & Central America, NA =North America, AU =Australia, AF =Africa, IM =Indomalayan, COS =Cosmopolitan

Order Family Tribe	Test Plant Species	Common Name(s)	Native Range*	Present in Hawaii?
Myrtaceae	*Eucalyptus deglupta*	rainbow eucalyptus	IM	yes
	Eucalyptus globulus	blue gum	AU	yes
	Eugenia uniflora	Surinam cherry, pitanga	SCA	yes
	Lophostemon confertus	brushbox, Brisbane box	AU	yes
	Melaleuca leucadendra	weeping paperbark	AU/IM	yes
	Metrosideros macropus	lehua mamo	HI	yes
	Metrosideros polymorpha	'ohi'a lehua	HI	yes
	Plinia cauliflora	jaboticaba	SCA	yes
	Psidium cattleianum	strawberry guava	SCA	yes
	Psidium friedrichsthalianum	Costa Rican guava, cas	SCA	yes
	Psidium guajava	common guava	SCA	yes
	Rhodomyrtus tomentosa	downy myrtle, rose myrtle	IM	yes
	Syzygium cumini	Java plum	IM	yes
	Syzygium malaccense	mountain apple,	AU/IM	yes
Onagraceae	*Epilobium ciliatum*	willowherb	NA/SCA/IM	yes
	Fuchsia magellanica	hardy fuchsia	SCA	yes
	Oenothera laciniata	cutleaf evening primrose	NA	yes
Geraniales				
Geraniaceae	*Geranium homeanum*	Australasian geranium	AU	yes
Brassicales				
Caricaeae	*Carica papaya*	papaya	SCA	yes
Malvales				
Malvaceae	*Hibiscus rosa-sinensis*	hibiscus	IM	yes
	Theobroma cacao	cacao	SCA	yes
Sapindales				
Anacardiaceae	*Mangifera indica*	mango	IM	yes
Rutaceae	*Citrus* x *sinensis*	lemon	IM	yes
Sapindaceae	*Dodonaea viscosa*	a'ali'i	COS/HI	yes
Rosales				
Moraceae	*Artocarpus altilis*	ulu, breadfruit	IM	yes
Fabales				
Fabaceae	*Acacia koa*	koa	HI	yes
	Sophora chrysophylla	mamane	HI	yes
Gentianales				
Rubiaceae	*Coffea arabica*	coffee	AF	yes
Lamiales				
Scrophulariaceae	*Myoporum sandwicense*	naio	HI	yes
Proteales				
Proteaceae	*Macadamia integrifolia*	macadamia	AU	yes
Alismatales				
Araceae	*Anthurium*	anthurium	SCA	yes
Laurales				
Lauraceae	*Persea americana*	avocado	SCA	yes
Cyatheales				
Dicksoniaceae	*Cibotium glaucum*	hapu'u	HI	yes

* HI =Hawaii, SCA =South & Central America, NA =North America, AU =Australia, AF =Africa, IM =Indomalayan, COS =Cosmopolitan

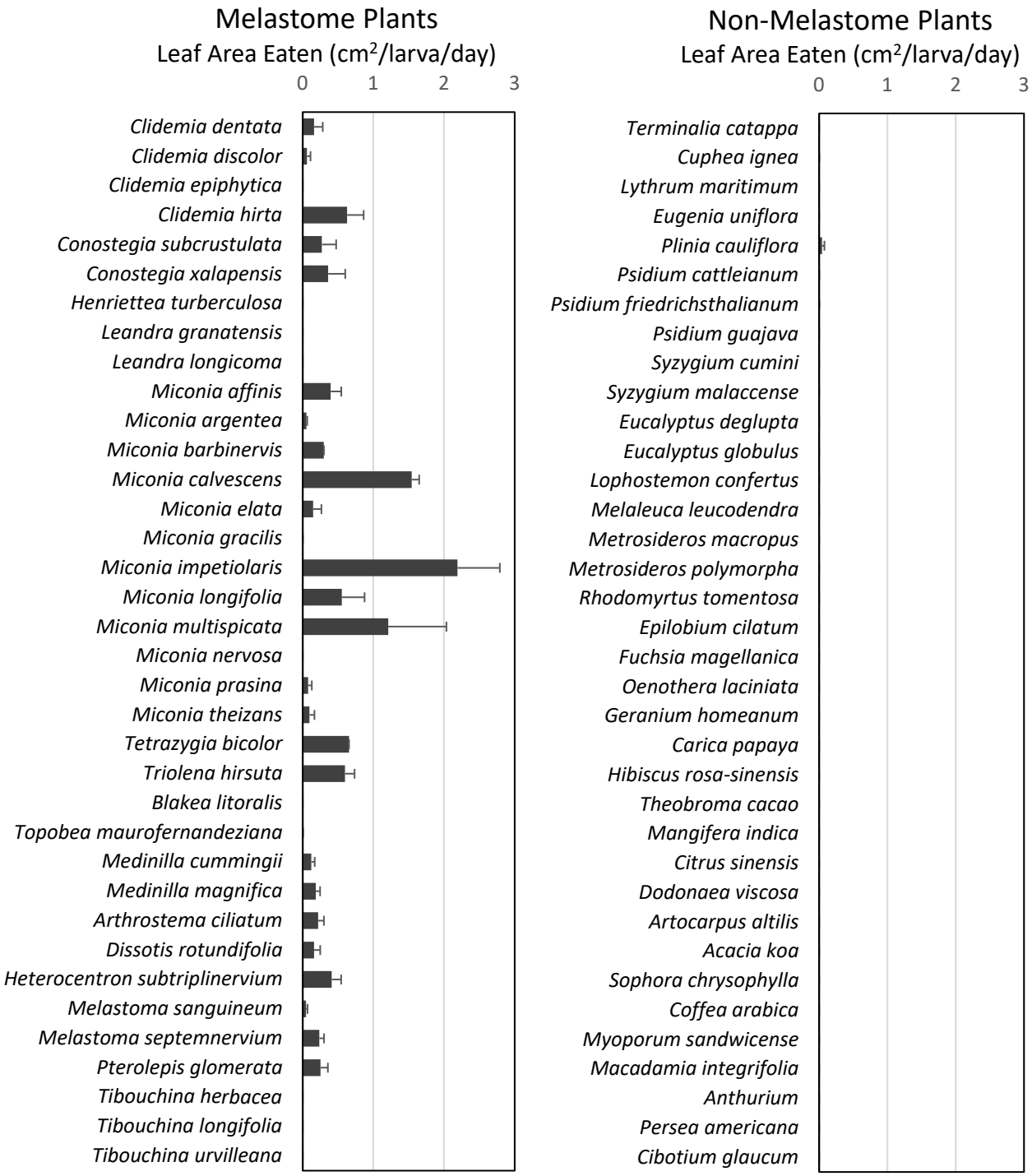

Figure 5. Average feeding damage by mid-sized larvae (instars 3-5) of *Euselasia chrysippe* on plant species in Costa Rica and Hawaii exposed as fresh leaves for 3 days in 90 mm petri dishes in 2012-2014, measured from photos before and after exposure (bar = standard error). Species on left, in the family Melastomataceae, are grouped according to genetic relatedness, and non-melastomes on right are listed in order of genetic distance from Melastomataceae.

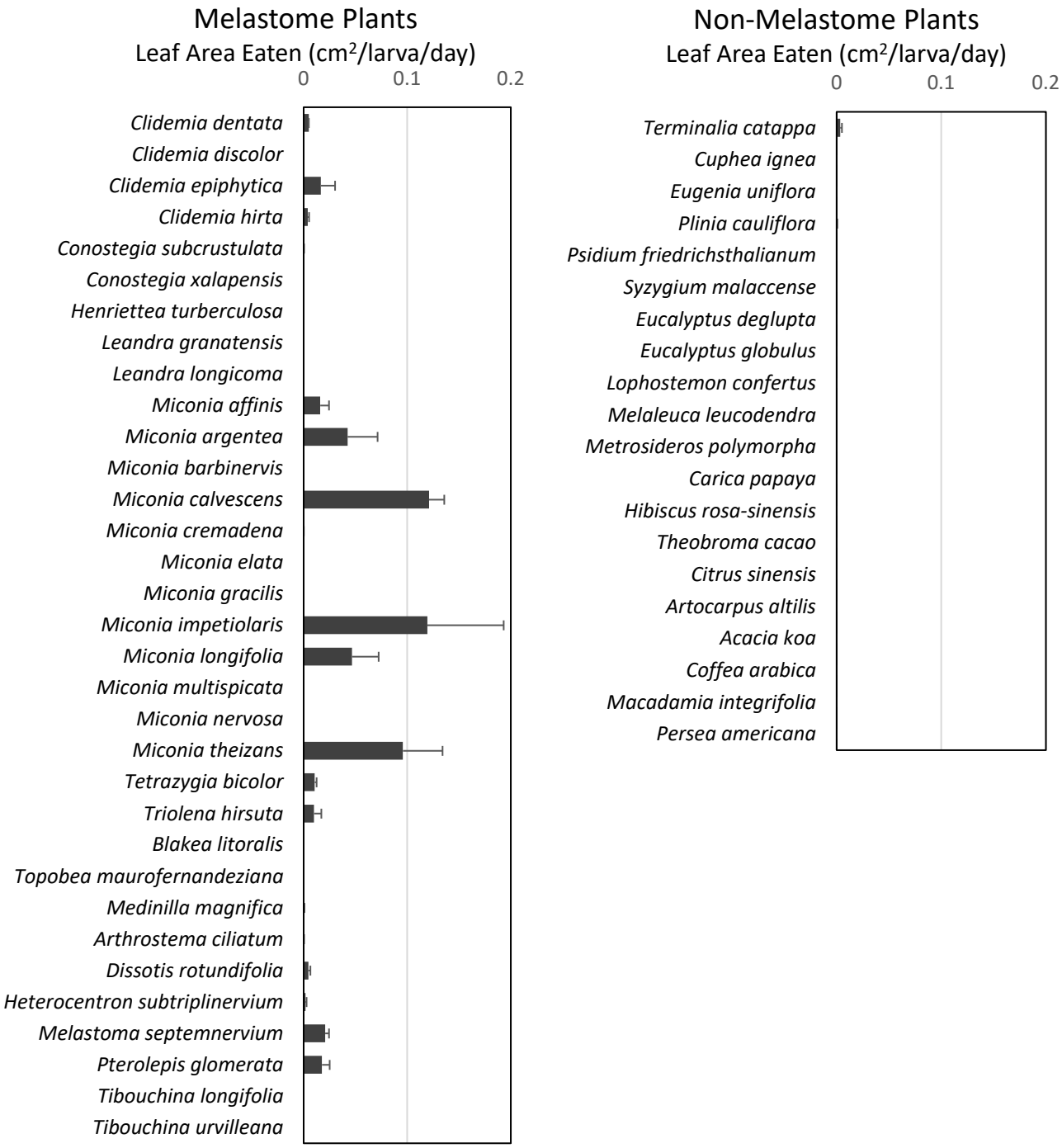

Figure 6. Average feeding damage by small larvae (instars 1-2) of *Euselasia chrysippe* on plant species in Costa Rica and Hawaii exposed as fresh leaves for 3 days in 90 mm petri dishes in 2012-2014, measured from photos before and after testing (bar = standard error). Species in Melastomataceae on left are grouped according to genetic relatedness, and non-melastomes on right are listed in order of genetic distance from Melastomataceae.

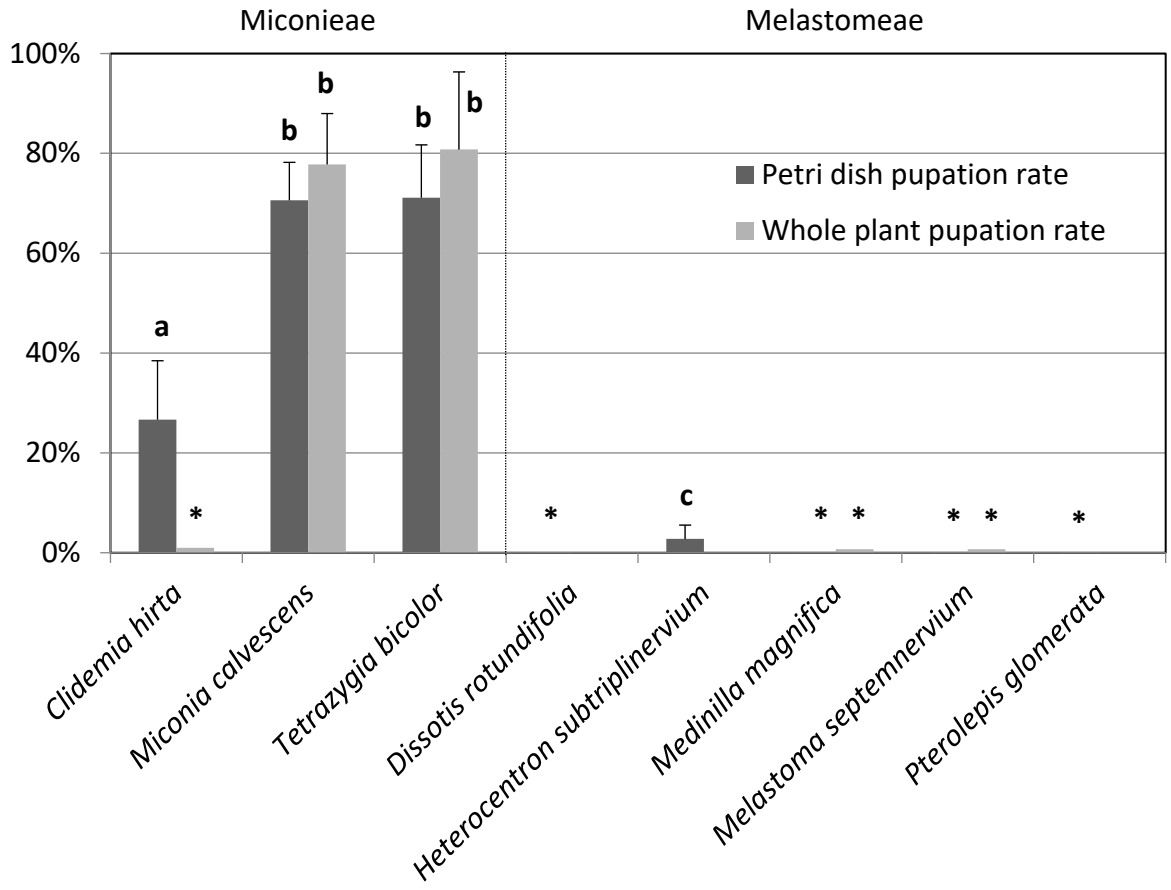

Figure 7. Survival of *E. chrysippe* larvae to pupation (percent average ± standard error) when exposed continuously to leaves in Petri dishes (dark gray) and whole plants (light gray) of test plant species in the tribes Miconieae and Melastomeae (family: Melastomataceae). Results with different letters (a,b,c) are statistically different. Results with an asterisk (*) had negligible survival and were not tested in the statistical model.

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United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection & Quarantine
4700 River Road
Riverdale, MD 20737

Permit to Move Live Plant Pests, Noxious Weeds, and Soil

Importation

Regulated by 7 CFR 330

This permit was generated electronically via the ePermits system

PERMITTEE NAME:	Matthew Johnson	**PERMIT NUMBER:**	P526P-20-02009
ORGANIZATION:	USDA Forest Service	**APPLICATION NUMBER:**	P526-190826-015
ADDRESS:	Hawaii Volcanoes National Park Quarantine Facility Kilauea Research Station, Building 34 Volcano, HI 96718	**FACILITY NUMBER:**	22
MAILING ADDRESS:	P.O. Box 236 Volcano, HI 96785	**HAND CARRY:**	No
		DATE ISSUED:	04/21/2020
PHONE:	808-967-7122		
FAX:	808-967-7158	**EXPIRES:**	**04/21/2023**
DESTINATION:	HI		
DESIGNATED PORTS:	HI, Honolulu		

Under the conditions specified, this permit authorizes the following:

Regulated Article	Life Stage(s)	Intended Use	Shipment Origins	Originally Collected	Culture Designation
Allorhogas clidemiae	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	
Allorhogas granivorus	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	
Anthonomus monostigma	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	
Diclidophlebia lucens	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	
Euselasia bettina	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	
Euselasia chrysippe	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	
Syphraea uberabensis	Any	Research - Lab	Central America, South America	Originally Collected from Outside the U.S. and Territories	

SPECIAL INSTRUCTIONS TO INSPECTORS

See permit conditions below

Permit Number P526P-20-02009

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS. Robert Pfannenstiel	DATE 04/21/2020

DHS CBP INSPECTORS - SHIPMENT BY BONDED CARRIER
1) Confirm that the carrier of the shipment imported under this USDA PPQ 526 permit is commercially bonded.
2) Confirm that the imported shipment has a valid USDA PPQ Form 599 Red/White label attached to the exterior for routing to a USDA APHIS PPQ Inspection Station or other "Designated Port" as stated on the Permit. A valid label will have the permit number, expiration date, label number, and address of a USDA APHIS PPQ Plant Inspection Station/Designated Port. PLEASE NOTE: In the event of a shipment of bulk container with discrete units, a single PPQ Form 599 Red/White label may be used.
3) Validate the permit in ePermits using the CBP search feature.
4) If a valid PPQ Form 599 Red/White label is not attached to the exterior of the package or the label has been covered or is otherwise not legible, then forward to the nearest USDA APHIS PPQ Plant Inspection Station.
5) If the address on the airway bill does not match the address on the PPQ Form 599 Red/White label then forward the package to the nearest USDA APHIS PPQ Plant Inspection Station/designated port shown on the PPQ Form 599 label. All costs associated with rerouting misaddressed packages will be assumed by the permit holder.

APHIS PPQ INSPECTORS at PIS -High-Risk Invertebrates
Follow the instructions in the Plant Inspection Station Manual for High-Risk Invertebrates Red and White Labeled Packages (must be opened in a sleeved cage; see procedures for handling on page 3-7-39). For questions or concerns, contact the USDA APHIS PPQ Pest Permit Branch in Riverdale, MD, at 301-851-2046, toll free 866-524-5421.

PERMIT GUIDANCE

1) Receipt or use of foreign isolates or samples from countries under sanctions requires specific permission from the U.S. Department of Treasury; please refer to https://www.treasury.gov/resource-center/sanctions/Programs/Pages/Programs.aspx
2) This permit does not authorize movement or release into the environment of genetically engineered organisms produced with the regulated organisms described in this permit. Importation, interstate movement, and environmental release of genetically engineered plant pests require a different permit issued under regulations at 7 CFR part 340. Any unauthorized interstate movement or environmental release, including accidental release, of a regulated GE organism would be a violation of those regulations. Additional guidance and contact information for APHIS Biotechnology Regulatory Services, can be found at: https://www.aphis.usda.gov/aphis/ourfocus/biotechnology.
3) If an animal pathogen is identified in your shipment, to ensure appropriate safeguarding, please refer to http://www.aphis.usda.gov/import_export/animals/animal_import/animal_imports_anproducts.shtml
4) If a human pathogen is identified, please refer to the CDC Etiologic Agent Import Permit Program at http://www.cdc.gov/od/eaipp/
5) This permit does not fulfill the requirements of other federal or state regulatory authorities. Please contact the appropriate agencies, such as the U.S. Environmental Protection Agency, the U.S. Fish and

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Wildlife Service, the U.S. Food and Drug Administration, the Centers for Disease Control and Prevention, the APHIS Veterinary Services unit, the APHIS Biotechnology Regulatory Services, or your State's Department of Agriculture to ensure proper permitting.
6) If you are considering renewal of this permit, an application should be submitted at least 90 days prior to the expiration date of this permit to ensure continued coverage. Permits requiring containment facilities may take a longer period of time to process.

PERMIT CONDITIONS

USDA-APHIS issues this permit to Matthew Johnson, USDA Forest Service, Hawaii Valcanoes National Park, Quarantine Facility, Kilauea Research Station, Volcano, HI 96718. This permit authorizes the importation of any life stages of the various taxa shown under Regulated Article above, collected in/from Central and South American countries, and observed to feed on or be associated with Miconia calvescens,(the target/host plant), to the permit holder Dr. Matthew Johnson, USDA Forest Service, Hawaii Volcanoes National Park, to be received into the USDA APHIS approved containment facility at that address (CF #22).

The imported material may contain various host plant parts of Miconia calvescens, including roots, leaves and stems.

This permit authorizes the possession and rearing of any species imported under this permit for research in the USDA APHIS inspected containment facility (Facility #22) at USDA Forest Service, Hawaii Volcanoes National Park, Kilauea Research Station, Quarantine Facility, Building 34, Volcano, HI 96718, subject to the conditions below.

1.
- This permit is issued by the United States Department of Agriculture's Animal and Plant Health Inspection Service (APHIS). It conveys APHIS regulations and requirements for the material(s) listed on this permit. It does not reduce or eliminate your legal duty and responsibility to comply with all other applicable Federal and State regulatory requirements.
- The permit number or a copy of the permit must accompany the shipment.
- You must be an individual at least 18 years old, or legal entity such as partnership, corporation, association, or joint venture.
- You are legally responsible for complying with all permit requirements and permit conditions.
- The regulated material and shipping container(s) are subject to inspection by officials of Custom and Border Protection (CBP) and APHIS. CBP or APHIS officials may require the shipment to be treated, seized, re-exported, or destroyed (in part or whole). You will be responsible for expenses.

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Robert Pfannenstiel	04/21/2020

- If you violate any applicable laws associated with this permit, you may face substantial civil or criminal penalties. We may cancel all current permits and deny future permit applications.
- Without prior notice and during reasonable hours, authorized Federal and State Regulators must be allowed to inspect the conditions associated with the regulated materials/organisms authorized under this permit.

2. The permit holder must:

- maintain a valid PPQ526 permit so long as the regulated materials/organisms are alive or viable,
- not assign or transfer this permit to other persons without APHIS PPQ authorization,
- maintain an official permanent work assignment, residence, or affiliation at the address on this permit,
- notify the Pest Permit Staff as soon as possible of any change in the permit holder's work assignment, residence, or affiliation,
- notify the Pest Permit Staff of the receipt of unauthorized and/or misdirected shipments of regulated materials/organisms,
- adequately mitigate environmental impacts resulting from unauthorized release of regulated materials/organisms and notify the Pest Permit staff immediately if one occurs,
- notify the Pest Permit Staff if the facility is damaged/destroyed or if you wish to decommission the facility,
- destroy all regulated materials/organisms prior to departure from the organization unless other arrangements are confirmed by the Pest Permit Staff.

Notifications to the Pest Permit Staff must be made via 866-524-5421 or pest.permits@usda.gov within one business day of the event triggering a notification.

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3. All packages for transport must minimally consist of both inner/primary and outer/secondary packages securely sealed so that both are effective barriers to escape or unauthorized dissemination of the listed materials/organisms. The inner/primary package(s) will contain all regulated materials/organisms and must be cushioned and sealed in such a way that it remains sealed during shock, impact, and pressure changes that may occur. The outer/secondary shipping container must be rigid and strong enough to withstand typical shipping conditions (dropping, stacking, impact from other freight, etc.) without opening.
4. After PPQ issues this 526 permit, you will need to request Red/White labels (PPQ Form 599) at least 5 days in advance of your shipping date. If you applied for your permit online using ePermits, you may request the labels using the My Shipments/Labels feature. Otherwise, send your request to Redandwhitelabelrequest@usda.gov. All email requests must come from the permit holder or designee. If requested by the designee, the permit holder must be copied on all requests. Specify the approved port as listed on the permit and the total number of labels needed. You may request additional labels the same way.
   Packages without labels on the exterior may be refused entry.

   Review label instructions at:
   https://www.aphis.usda.gov/aphis/ourfocus/planthealth/import-information/permits/plant-pests/or ganisms-shipping-requirements

   You are responsible for instructing your shipper to carefully follow these instructions. You are responsible for each import shipping label issued under this permit.
5. Upon receipt, open the package only in the approved containment facility identified above. Depending on the organism(s) or developmental stage, it may be necessary to open the package inside a cage (glove box or sleeve cage) or use other appropriate means that must prevent the organisms from escaping.
6. After separation of organisms regulated under this permit, along with any necessary host organisms and host plant parts, all other foreign biological material and substrate, including soil, and foreign plant material, if any, must be properly disposed of or destroyed immediately.

   Only authorized/permitted organisms may be retained as live organisms, plus any hosts and plant parts as needed for continued rearing and culture of the regulated organisms until transfer to lab-sourced material. Upon completion of isolations/transfers from imported material (i.e., soil, hosts) these imported materials must likewise be properly disposed of or destroyed immediately, as described above.

   Only secondary containers and packing materials suitable for re-use (such as coolers and icepacks) may be reused, and only after sterilization by autoclave, or with bleach or alcohol, etc., as per protocols established in the SOP's for this facility.

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 Robert Pfannenstiel	04/21/2020

7. This permit authorizes the importation and possession of live organisms of only those taxa/species listed under "Regulated Article" above, and not authorized under this permit are live cultures of other taxonomic groups from other hosts, or are from other source countries/continents, or received by way of any other permit, except as described below.

   In addition, this permit authorizes continued possession/continued curation of only the live organisms (identified and unidentified) cultured or stored by the permit holder which were imported as authorized on previous permits, of which this is a "renewal". All other such live regulated organisms must be kept under separate USDA APHIS permit, or devitalized.

8. The regulated organisms authorized for import under this permit are to be maintained only in the laboratory area approved for containment at the address indicated under the "Authorizations" above on this permit (CF 22). Any distribution or other removal of live organisms regulated under this permit from the designated area of Containment Facility Forest Service requires a separate prior authorization from APHIS PPQ.

   This permit does not authorize field release, interstate transport, field research, greenhouse work, or any other activities with the regulated organisms authorized for import under this permit outside of the containment facility.

9. All operations must be consistent with information submitted in association with this Containment Facility (CF #22) including the most recent Standard Operating Procedures (SOP's) submitted for the Facility, and any information submitted in association with the inspection of this Containment Facility. This includes, minimally, maintenance of restricted access to unauthorized persons of building and or approved containment areas (key, key card or code), and/or restricted access to unauthorized persons of growth chambers and other equipment (for example by lock) where organisms will be kept, as well as proper/prescribed maintenance of the Autoclave and/or other equipment used to devitalize or sterilize waste.

   The permit holder must insure that all persons working with these regulated organisms
   a) are trained in the importance of approved containment practices;
   b) follow the Standard Operating Procedures (SOP) established for the facility and filed with the USDA APHIS Pest Permit Evaluation Unit at the time of facility inspection; and
   c) are informed of these permit conditions and understand the requirement to adhere to these conditions and the SOP.

   The permit holder shall document such training or familiarization with these permit conditions and the SOP's for the facility, by having copies of both dated and signed/initialed by all persons handing the regulated articles, and have such documentation made available to USDA APHIS upon request.

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.	DATE
Robert Pfannenstiel	04/21/2020

10. A separate authorization from USDA APHIS (a new PPQ 526 permit) is required for possession/maintenance of live regulated organisms received under this permit beyond the expiration of this permit. Otherwise, all regulated organisms received under this permit must be devitalized prior to expiration of this permit.

END OF PERMIT CONDITIONS

Permit Number P526P-20-02009

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.	DATE
Robert Pfannenstiel	04/21/2020

M. TRACY JOHNSON

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Education

Ph.D., 1995, Entomology, North Carolina State University
Thesis: The role of natural enemies in ecology and evolution of *Heliothis virescens* on transgenic plants.
M.S., 1990, Entomology, North Carolina State University
Thesis: Combined effects of genetically engineered host plant resistance and natural enemies on *Heliothis* populations in tobacco.
A.B., 1984, Biology, University of California - Berkeley

Work Experience

Research Entomologist, Aug 2000-Present, USDA Forest Service, PSW, Institute of Pacific Islands Forestry
Biological control of weeds in Hawaiian forests, Insect ecology, Post-release monitoring of biocontrol, Non-target impacts of biocontrol, Plant-herbivore-enemy interactions
Junior Researcher, Mar-Aug 2000, Department of Zoology, University of Hawaii – Manoa
Examining population dynamics of the agricultural pest *Nezara viridula* under sublethal biological control by an introduced parasitoid.
Junior Researcher, Dec 1997-Feb 2000, Dept. Entomology, University of Hawaii - Manoa
Quantifying the off-target effects of biological control on the native Hawaiian koa bug, and surveying parasitism of an alien leafhopper invading native forests.
Fulbright Fellow, Oct 1996-Sep 1997, Internatl Centre of Insect Physiology and Ecology, Kenya
Assessing risk of African maize stemborers evolving resistance to transgenic maize expressing toxins of *Bacillus thuringiensis*.
Technician, May 1984 – Dec 1986, Biological Control of Weeds Lab, USDA-ARS, Albany CA
Field studies of native thistles and insects to measure nontarget impact of weevil introduced for biocontrol of weedy thistles; quarantine study of insects shipped from Greece in search for biocontrol agents against thistles.

Recent Publications

Alfaro-Alpízar MA, Koster SJC, Johnson MT, and Badenes-Pérez FR. 2020. Description, biology, and impact of the fruit-feeding moth, *Mompha luteofascia* sp. n. (Lepidoptera: Momphidae), on *Miconia calvescens* (Melastomataceae) in Costa Rica. *Annals of the Entomological Society of America* 113: 30-39.

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Hughes, R.F., M.T. Johnson and A. Uowolo. 2013. The invasive alien tree *Falcataria moluccana*: Its impacts and management. Pp 218-223 *in* Wu, Y., T. Johnson, S. Sing, S. Raghu, G. Wheeler, P. Pratt, K. Warner, T. Center, J. Goolsby and R. Reardon (eds), Proceedings of the XIII International Symposium on Biological Control of Weeds.

Conant, P., J.N. Garcia, M.T. Johnson, W.T. Nagamine, C.K. Hirayama, G.P. Markin and R.L. Hill. 2013. Releases of natural enemies in Hawaii since 1980 for classical biological control of weeds. Pp. 230-242 *in* Wu, Y., T. Johnson, S. Sing, S. Raghu, G. Wheeler, P. Pratt, K. Warner, T. Center, J. Goolsby and R. Reardon (eds), Proceedings of the XIII International Symposium on Biological Control of Weeds.

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Reichert, E., M.T. Johnson, E. Chacón, R.S. Anderson, and T.A. Wheeler. 2010. Biology and host preferences of *Cryptorhynchus melastomae* (Coleoptera: Curculionidae), a possible biocontrol agent for *Miconia calvescens* (Melastomataceae) in Hawaii. *Environmental Entomology* 39: 1848-1857.

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RESTRICTED ANIMAL LIST (Part A) §4-71-6.5

SCIENTIFIC NAME	COMMON NAME
FAMILY Noctuidae	
Antiblemma acclinalis	biocontrol agent, Koster's curse
Cucullia verbasci	biocontrol agent, common mullein
FAMILY Notodontidae	
Cyanotricha necyria	biocontrol agent, banana poka
FAMILY Oecophoridae	
Agonopterix ulicetella	biocontrol agent, gorse
FAMILY Pyralidae	
Ephestia kuehniella	moth, Mediterranean flour
Galleria mellonella	moth, greater wax
Pempelia genistella	biocontrol agent, gorse
FAMILY Riodinidae	
Euselasia chrysippe	biocontrol, Miconia
FAMILY Scythrididae	
Scythris gallicella	biocontrol agent, gorse
FAMILY Sesiidae	
Melittia oedipus	biocontrol agent, ivy gourd
Pennisetia marginata	biocontrol agent, blackberry
FAMILY Tortricidae	
Cryptophlebia ombrodelta	moth, litchi fruit
ORDER Thysanoptera	
FAMILY Thripidae	
Scolothrips sexmaculatus	thrips, sixspotted
Sericothrips staphylinus	biocontrol agent, gorse
CLASS Crustacea	
ORDER Decapoda	
FAMILY Alpheidae	
Athanas (all species in genus)	shrimp, anemone