State of Hawaii
Department of Agriculture
Agricultural Loan Division

December 5, 2023

Department of Agriculture
Honolulu, Hawaii

Subject: **Loan Presentation**

APPLICANT:

Diamond B Ranch, LLC
103 A Maha Rd.
Makawao, HI 96768

Brendan L. Balthazar (Co-Borrower)
103 A Maha Rd.
Makawao, HI 96768

CLASSIFICATION & ELIGIBILITY:

Diamond B Ranch, LLC is a limited liability company registered with the Hawaii Department of Commerce & Consumer Affairs (DCCA) on December 29, 2014. Brendan L. Balthazar is the sole member-manager and 100% owner of the company. Mr. Balthazar meets the eligibility requirements as a qualified farmer defined in Chapter 155 of the Hawaii Revised Statutes (HRS) §155-1 and general eligibility requirements cited in subsection §155-10. He is a U.S. citizen, and life-long Hawaii resident and has been ranching for more than 50 years.

COMMODITY: Cattle, Sheep, Goats

CREDIT HISTORY: SEE EXHIBIT A (CONFIDENTIAL)

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OTHER STATE AGRICULTURAL LOANS:

Mr. Balthazar has two (2) previous loans with the State Agricultural Loan Division (SALD) that were paid in full:

Emergency Loan DD-6078, was approved on 7/26/2001, for $250,000 to aid the ranch from the severe impacts of drought affecting the island of Maui.

Operational loan DC-6316, was approved on 1/30/2012, for $150,000 for fencing, labor, water lines, troughs, water tanks, and operating capital.

LOAN REQUEST & PURPOSE:

Amount	Class D - Emergency Axis Deer Loan
$350,000	Operating and Improvement
$350,000	Total Class D Request

The emergency deer loan program was enacted to provide relief for ranchers and farmers for funding to mitigate the damaging effects from the axis deer population explosion. This request will allow the Diamond B Ranch and Mr. Brendan Balthazar to prepare and install perimeter fencing to control the axis deer encroachment and prevent further damage to pasture and grazing areas. A portion of the funds will be used to provide operating funds to clear land and install water infrastructure. The ranch intends to use its own equipment including excavators to clear the invasive trees and brush from new leaseholds noted below:

In 2023, Diamond B Ranch acquired two (2) leasehold parcels totaling 167.299-acres from the Hawaii Department of Agriculture (HDOA) as part of the ACT-90 land transfer from the Department of Land and Natural Resources (DLNR). Mr. Balthazar received HDOA board approval for a 35-year lease by the Agricultural Resource Management (ARM) division for the following:

- State leasehold No. S-3151 for 35-years and identified as TMK: 2-2-004: 066, consisting of 146.319-acres of land in Keokea, Kula, Makawao, Island Maui, Hawaii.

- State leasehold No. S-3152 for 35-years and identified as TMK: 2-2-004: 029, consisting of 20.980-acres of land at Keokea, Kula, Makawao, Island Maui, Hawaii.

TERMS:

Amount:	$350,000 (Class D)
Term:	(20) Twenty years
Interest rate:	3.00%, fixed
Repayment:	Annual principal and interest payment of $23,526 until maturity.

SECURITY:

The Class-D will be secured by the following:

- First leasehold mortgage on State leasehold No. S-3151 for 35-years and identified as TMK: 2-2-004: 066, consisting of 149.319-acres of land in Keokea, Kula, Makawao, Island Maui, Hawaii.
- First leasehold mortgage on State leasehold No. S-3152 for 35-years and identified as TMK: 2-2-004: 029, consisting of 20.980-acres of land at Keokea, Kula, Makawao, Island Maui, Hawaii.
- A first position UCC blanket security interest in the Diamond B Ranch LLC, accounts receivable, livestock, and farm equipment. The equipment is valued at $1,530,100 and the livestock at $417,000.

GUARANTORS:

None

FINANCIAL CONDITION:

SEE EXHIBIT A (CONFIDENTIAL)

REPAYMENT ABILITY:

SEE EXHIBIT A (CONFIDENTIAL)

INSURANCE:

Evidence of liability insurance in the amount of $1 million.

BACKGROUND/ MANAGEMENT ABILITY:

Known as the last paniolo (cowboy) of Makawao, Brendan Balthazar started Diamond B Ranch in 1968 after retiring from Maui's Department of Fire and Public Safety as an engineer with nearly 37 years of service. He started his

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ranch with just one cow and through hard work and dedication expanded his operation to where it is today. Currently, his animal herd consists of hundreds of cows, goats, sheep, and includes 30 bulls, 6 horses, and 5 ranch dogs. Cattle breed is an Angus cross with Simmental which is preferred by the buyers. Calves are typically weaned for 8 to 9 months and shipped at 300 to 450 lbs. to a Texas buyer. Other livestock include Boer goats which are typically weened for 3 months and Hair sheep.

Most of the pastures are leased and strategically situated along the slopes of Haleakala. Locations include Kaupo, Halehaku, Kula, and Haiku. To minimize the potential impacts of drought, his strategy is to have pastures at various locations. Mr. Balthazar works 7 days a week to care for his animals and improve the parcels by clearing brush, removing invasive trees/plants, adding lime to improve soil pH, applying fertilizer, planting grass, and adding improvements such as corrals, fencing, and water systems at each site.

Mr. Balthazar's residence serves as the ranch headquarters with a corral, equipment, and storage area. He has ample equipment to operate his ranch including hauling vehicles to transport heavy equipment for pasture work and cattle to the dock for shipment to the mainland.

Brendan Balthazar's experience and devotion to ranching is undeniable. As an active member of the Maui Cattlemen's Association (MCA) and Board member of the Hawaii Farm Bureau, he is respected throughout the industry and community as well. MCA was formed to provide a premium product that's local, forage-fed, and hormone and antibiotic-free.

Brendan Balthazar is a dedicated and seasoned rancher. Proceeds from this request will allow him to protect grazing areas from the axis deer and allow him to restore pasture lands for his cattle. The borrower has an excellent repayment record with the SALD of servicing all debt obligations as agreed.

Benefits to the State include supporting cattle production, which is a key contributor to the local economy. Based on cash receipts, beef is currently ranked as one of Hawaii's top agricultural commodities. Moreover, ranching represents an

important aspect of Maui's cultural heritage as the cattle industry dating back to 1793.

TURNDOWNS: Brendan Balthazar's loan request was denied by Bank of Hawaii and Maui County FCU based on:

- Does not offer type of loan using cattle as collateral.
- Inadequate collateral.

RECOMMENDATIONS: The loan is recommended for approval based on the applicant's ranching experience, collateral, ample cash flow, and strong personal financial management.

Date

11/17/2023

Recommended by:

Wayne Takamine
Business Loan Officer I

Date

11/17/23

Reviewed by:

Dean M. Matsukawa
Acting Agricultural Loan Administrator

Date

11/18/23

Approved for submission:

Sharon Hurd
Chairperson, Board of Agriculture

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State of Hawaii
Department of Agriculture
Agricultural Loan Division

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject: **Loan Presentation**

APPLICANT:

Daniel "Kaipo" Sheen
83-5584 Middle Keei Road
Captain Cook, HI 96704

Kona Controls Inc. (Co-borrower)
DBA Makapu'eo Farms
83-5584 Middle Keei Road
Captain Cook, HI 96704

CLASSIFICATION & ELIGIBILITY

The applicants meet the qualification requirements under Hawaii Revised Statutes Chapter 155, as a Qualified Farmers. Mr. Sheen has been farming full time 18 years as sole proprietor and is a life-long Hawaii resident. He owns 100% of the shares of Kona Controls Inc. The company registered with Commerce and Consumer Affairs on March 22, 2012, with the stated purpose of coffee farming. The company's primary business is orchard management consisting of growing, harvesting and marketing of crops. Daniel Sheen serves as President/Vice-President and Director. Naneki Astronomo, manager of Menehune Coffee serves as Treasurer.

COMMODITY:

Coffee, Macadamia

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CREDIT HISTORY: SEE EXHIBIT A (CONFIDENTIAL)

OTHER STATE AGRICULTURAL LOANS: None

LOAN REQUEST & PURPOSE:

Amount	Class A
$450,000	Purchase farm leasehold property

This loan request will enable the applicant to purchase an 8-acre Kamehameha School leasehold property that he has managed since 2008. The seller was awarded a new 35-year lease with the lease term expiring in September 2058. The applicants were able to negotiate a lower sales price recognizing the years of improvements they made to the farm.

TERMS: Class A- Direct Farm Ownership Loan

Amount:	$450,000
Term:	30 years
Interest rate:	7.25% per annum, fixed
Repayment:	Monthly principal and interest payments of $3,070 until maturity.

SECURITY: The Class- A will be secured as follows:

1) First position leasehold mortgage on the 8.93-acre parcel located at 83-5331 Manako Road in Captain Cook, identified as TMK (3) 8-3-008-036. The property is owned by Bishop Estate/ Kamehameha Schools

2) A Blanket Financing Statement and Security Agreement on all crops, accounts, inventory, farm equipment, tools, and coffee equipment.

Shown below is the loan – to-value (LTV) ratio for the proposed loan:

Loan to value Ratio = $450,000 (SALD proposed) / $620,000 (Appraised value) = 72.58%

The 8.93-acre leasehold farm is located on the west facing mountain slope of Honaunau off of Manoko Road. There is a slight grade ranging from 2% to 10%. This parcel has approximately 2 acres established of Kona Typica orchard. The farm has moderately deep soil and Mr. Sheen's revitalization effort in the macadamia orchard and coffee can be seen in the volume of production.

Manoko is in the rain shadow and soil web records indicate the farm with an annual mean precipitation of 20 to 50 inches. The soil is well draining silty loam with a bedrock 10 inches deep.

The property was appraised for $620,000 on October 13, 2023, by Certified Residential Appraiser Collen McDonald license # CRA-849 of Colleen McDonald Appraisals, Inc. The LTV ratio of 72.58% meets the program's required ratio of 85% for Class A Loans.

The value of the crops and inventory were not factored into the calculation above as they are short-term in nature. The equipment value although significant was also left out of the calculation as the property has sufficient value to meet our LTV requirements and due to the term of the loan.

GUARANTORS: None

FINANCIAL CONDITION: SEE EXHIBIT A (CONFIDENTIAL)

REPAYMENT ABILITY: SEE EXHIBIT A (CONFIDENTIAL)

All

INSURANCE: Hazard Insurance on the dwelling with SALD named as the mortgagee.

BACKGROUND/ MANAGEMENT ABILITY:

Mr. Sheen is a 4th generation coffee farmer and has been operating his family's 5-acre farm selling green coffee beans in Kona since 2005. He expanded the operation by partnering with several coffee farms and buying coffee cherry from other farms. When coffee berry borer arrived, he watched as the quality of purchased coffee declined. Farms that had previously had high-quality cherry now had quality that varied from bag to bag. To attract higher quality cherry and pay fairly, he introduced a sliding scale based on the quality of cherry delivered. Even with that he found it difficult to maintain his quality standards. Over the next few years, he tried many things to bring up the quality of beans, which resulted in him eventually managing the farms from which coffee cherry was being purchased.

Mr. Sheen was able to onboard several farms by paying the landowners residuals based on the volume of coffee produced on their property. In these agreements he manages the coffee plants creating uniformity in the product. He now operates over 100 acres of coffee, employing 10 workers full time, and producing an estimated 300,000 pounds of raw coffee cherry annually.

Mr. Sheen's focus on quality continues beyond the field using the Hawaii Department of Agriculture's (HDOA) coffee certification with an aim of prime grade. His international wholesale buyers have come to expect the HDOA certification. The main customers are international and national wholesale buyers. He also sells a portion of the crop to Menehune Coffee Shop.

The leasehold farm consists of 8.93 acres with a residence located in Honaunau. He began managing this property in 2008. In that time, he planted 2 acres in coffee and revitalized the 5-acre macadamia nut orchard. The property has a geodesic dome home of 692 square foot built in 1981 connected by a hall to an expansion that includes 2 rooms and an additional bath for a total of 3 bed and 2 baths. The home is in good condition with a new roof and new water heater. The farm is well-kept with coffee in production.

Most of the trees were flushed with ripening green cherry. The macadamia on the front 5 acres is well laid out with the ability to navigate amongst the rows easily. Mr. Sheen installed irrigation throughout and a pig-fence around the perimeter.

SUMMARY:

Mr. Sheen is a hardworking and experienced farmer. He has persisted through the introduction of pests and adapted his management in stride. In his years as a Kona coffee farmer, he has established positive relationships with many smaller farmers and maintained a high standard of product. In 2014, Makapueo Farms was awarded Farmer of the Year from the US Department of Agriculture for excellent work with soil, water, and energy efficient management. Kona Controls Inc. is well managed and together with the personal financial strength of Mr. Sheen provides strong support for the loan.

The property is in good condition with a thoughtful layout and improvements to increase productivity. Mr. Sheen installed the fencing and irrigation preemptively as pig pressure increases in Honaunau. The farm is near his "home" farm where he processes all the coffee cherry to green bean before he sells to his many markets. His market demand is higher than his current supply. By keeping the farm property, he will be able to maintain current volumes and make further improvements for increased yields. The house on the property provides additional value as a unit for farm labor. The proposed loan will be well secured by the real-estate.

TURNDOWNS:

American Savings Bank and American Agricultural Lenders denied credit based on the following:

- Does not lend on leasehold
- Inadequate collateral
- Insufficient income

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RECOMMENDATIONS: Approval of this request is recommended based on Mr. Sheen's farming experience, the historical performance of the farm, good financial strength and the collateral offered.

Loan approval is subject to receipt of State Tax Clearance and Kamehameha Schools Bishop Estate consent of the lease assignment.

Date: 11/14/23

Recommended by:

Jillian C. Scheibe
Agricultural Loan Officer I

Date: 11/17/23

Reviewed and concurred by:

Dean M. Matsukawa
Acting Agricultural Loan Administrator

Date: 11/18/23

Approved for submission:

Sharon Hurd
Chairperson, Board of Agriculture

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
ANIMAL INDUSTRY DIVISION
AQUACULTURE DEVELOPMENT PROGRAM
1428 SOUTH KING STREET
HONOLULU, HAWAII 96814

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject: Request for Approval of Proposed Memorandum of Agreement ("MOA") Between the Department of Agriculture ("HDOA") and the Department of Land and Natural Resources ("DLNR") Regarding the Transfer of Revenues, Less Management Expenses, to the Aquaculture Development Special Fund, Managed by Department of Agriculture.

Background:

DLNR is responsible for the issuing and administration for leasing of state ocean water pursuant to the provisions in Sections 171-53 and 59(b), and Chapter 190D of Hawaii Revised Statutes ("HRS"). In addition, Section 190D-33, HRS mandates the revenues obtained from the leasing of state marine waters pursuant to Chapter 190D to be deposited into the special land and development fund to be used for planning, research, and development of the aquaculture industry.

DLNR reports that, at the present time, there is only one aquaculture lease managed by the DLNR Land Division ("LD") - General Lease No. S-5721 to Keahole Point Fish LLC, who leases 90 acres of submerged lands offshore of Kalaoa, North Kona for a base rent of $40,000.00 per year or 1% of gross revenue, whichever is greater (lessee paid an additional $14,862.00 in percentage rent for the most recent accounting period).

Aquaculture Development Program (ADP) and DLNR LD are amenable to the transfer of certain revenues collected from this and future mariculture leases, less the cost of issuing, managing, and administering the leases, from DLNR's special fund to ADP's special fund in accordance with Section I 90D-33, HRS. To this end, HDOA and DLNR seek to execute a MOA, a draft of which, approved by the Board of Land and Natural Resources ("BLNR") on September 22, 2023, is attached as Exhibit A. Under the proposed MOA, 20% of the total revenues collected under aquaculture or Chapter 190D, HRS, ocean leases issued by the BLNR will be transferred to the general fund trust holding account to contribute to the payment of the Office of Hawaiian Affairs' share of ceded lands revenues. DLNR LD will then retain 25% of the total revenues collected, plus any third-party costs incurred in managing the leases (such as appraisal, survey, or mapping costs). ADP will receive the balance of the revenue on a periodic basis. For reference, attached as Exhibit B is the DLNR Land Division's submittal of the MOA to the BLNR – approved September 22, 2023.

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Recommendation

It is recommended that the Board approve the proposed Memorandum of Agreement between Hawaii Department of Agriculture and Department of Land and Natural Resources pertaining to the periodic transfer of transfer of revenues collected from the leases described under Chapters 171 and 190D, HRS, and further subject to the review and approval by the Department of the Attorney General.

TODD LOW
Program Manager,
Aquaculture & Livestock Support Services

CONCURRED:

ISAAC M. MAEDA, DVM
Administrator,
Division of Animal Industry

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

EXHIBIT A

DRAFT DLNR HDOA MEMORANDUM OF AGREEMENT

MEMORANDUM OF AGREEMENT BETWEEN THE
STATE OF HAWAII, DEPARTMENT OF AGRICULTURE, AND
THE STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES

REGARDING THE MANAGEMENT OF CURRENT AND FUTURE
AQUACULTURE AND OCEAN LEASES

THIS MEMORANDUM OF AGREEMENT(hereinafter referred to as "Agreement") is made and entered into on this ___ day of _____, 20___, by and between the State of Hawaii, Department of Land and Natural Resources ("DLNR") whose address is P.O. Box 621, Honolulu, Hawaii 96809-0621 and the State of Hawaii, Department of Agriculture ("DOA"), on behalf of the Aquaculture Development Program ("ADP"), whose address is 1177 Alakea Street #400, Honolulu, Hawaii 96813, (collectively "Parties").

RECITALS

WHEREAS ADP, under DOA, the agency that oversees the development of aquaculture industries in the State, anticipates applications for additional aquaculture and ocean leases being submitted in the near future. Under Section 141-52, Hawaii Revised Statutes ("HRS"), ADP is tasked with, among other things, the development and expansion of the aquaculture industry and coordination of development projects to investigate and solve biological and technical problems involved in raising certain species with commercial potential;

WHEREAS pursuant to Section 190D-33, HRS, revenues obtained from the leasing of state marine waters pursuant to Chapter 190D, HRS, shall be deposited into the Special Land and Development Fund to be used for planning, research, and development of the aquaculture industry;

WHEREAS ADP, through DOA, and DLNR are amenable to the transfer of certain revenues collected from mariculture leases, less the cost of issuing, managing and administering the leases,[1] from DLNR's special fund to ADP in accordance with Section 190D-33, HRS;

WHEREAS in the past, DLNR has transferred to ADP about $200,000.00 for its aquaculture program; and

[1] The parties determined that it would be reasonable and equitable for DLNR to retain a 25% management fee to cover the costs of issuing and managing the leases that include, among other tasks, billing, collections and monitoring of insurance and bonding requirements, plus any third-party costs incurred, such as appraisal or ocean surveying and mapping costs.

WHEREAS ADP will report the amount and usage of the transferred funds further described below in its annual report to the Legislature on the implementation of Chapter 190D, HRS, regarding ocean and submerged lands leasing.

NOW, THEREFORE, the parties hereto agree as follows:

1. Term. The term of this Agreement shall begin on the Effective Date of this Agreement and shall terminate on December 31, 2024. For the purposes of this Agreement, "Effective Date" shall mean the date of execution of this agreement.

2. Revenue Apportionment. Any revenue collected from the aquaculture and ocean leases issued pursuant to Chapter 190D, HRS, shall be apportioned in the following manner:

   A. 20% to the Office of Hawaiian Affairs.

   B. 25% to the DLNR's Special Land and Development Fund, plus any third-party costs incurred in managing the leases (such as appraisal, survey, or mapping costs).

   C. 55% or the net remaining amount of revenues, whichever is less to ADP through the DOA via journal voucher transfer.

   D. DLNR shall use its best efforts to transfer the revenue described in item 2.C above within four (4) calendar months following collection of the revenues.[2]

3. Amendment. This Agreement may not be amended or modified except by written agreement executed by all Parties.

4. Termination. Either party may terminate all or a portion of this Agreement upon not less than thirty days' written notice to the other party.

5. Renewal. This Agreement shall automatically renew every year for successive one-year terms. If either Party decides not to renew the Agreement, the Party shall provide written notice to the other party no later than thirty (30) days prior to the end of the calendar year.

6. Entire Agreement. This Agreement, along with all attachments, contains the

[2] The parties recognize processing payments and transfers such as journal vouchers involve other departments or offices such as the fiscal/accounting offices at the Departments of Land and Natural Resources and the Accounting and General Services.

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entire agreement of the Parties and supersedes any other agreements or understandings, oral or written between the Parties concerning the subject matter of this Agreement.

7. Severability. If any provision of this Agreement, or the application thereof, to any person or circumstance is invalid, illegal, or unenforceable to any extent, the remainder of this Agreement and the application thereof to other persons or circumstances will not be affected.

8. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, and said counterparts will together constitute one and the same agreement and shall be binding on each of the Parties not withstanding that all of the Parties are not signatory to the original or the same counterpart. The submission of a signature page by facsimile transmission, or similar electronic submission facility (e.g., e-mail) shall be deemed to constitute an "original" signature page for all purposes (other than recordation), and facsimile or electronic copies shall be deemed to constitute duplicate originals.

IN WITNESS WHEREOF, the DOA on behalf of ADP, and the DLNR have executed this Memorandum of Agreement as of the date first above written.

Approved by the Board of Agriculture
At its meeting held on

_____

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AQUACULTURE DEVELOPMENT
PROGRAM

_____
Its Chairperson

Approved by the Board of Land
And Natural Resources at its
Meeting held on

September 22, 2023, Item D-5

STATE OF HAWAII
DEPARTMENT OF LAND AND
NATURAL RESOURCES

_____
Its Chairperson

APPROVED AS TO FORM:

_____
Deputy Attorney General

Dated: _____

APPROVED AS TO FORM:

_____
Deputy Attorney General

Dated: October 19, 2023

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EXHIBIT B

DLNR LAND DIVISION SUBMITTAL TO BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Land Division
Honolulu, Hawaii 96813

September 22, 2023

Board of Land and Natural Resources
State of Hawaii
Honolulu, Hawaii

Statewide

Authorize Chairperson to Negotiate, Approve and Execute a Memorandum of Agreement Between the Department of Land and Natural Resources and the Department of Agriculture Regarding the Management of Statewide Ocean Leases Issued under Chapters 171 and 190D, Hawaii Revised Statutes, and Transfer of Revenues, Less Management Expenses, to the Aquaculture Development Program Managed by the Department of Agriculture.

BACKGROUND:

Leasing of State ocean water is processed pursuant to the provisions in Sections 171-53 and 59(b), and Chapter 190D of Hawaii Revised Statutes ("HRS"). In addition, Section 190D-33, HRS mandates the revenues obtained from the leasing of state marine waters pursuant to Chapter 190D to be deposited into the special land and development fund to be used for planning, research, and development of the aquaculture industry.

At the present time, there is only one aquaculture lease managed by the Land Division ("LD") – General Lease No. S-5721 To Keahole Point Fish LLC, who leases 90 acres of submerged lands offshore of Kalaoa, North Kona for a base rent of $40,000.00 per year or 1% of gross revenue, whichever is greater (lessee paid an additional $14,862.00 in percentage rent for the most recent accounting period). However, the Aquaculture Development Program ("ADP") under the Department of Agriculture ("DOA"), which is the agency that oversees the development of aquaculture industries in the State, anticipates applications for additional aquaculture leases being submitted in the near future. ADP and LD are amenable to the transfer of certain revenues collected from mariculture leases, less the cost of issuing, managing and administering the leases, from DLNR's special fund to ADP in accordance with Section 190D-33, HRS.

To this end, the parties seek to execute a Memorandum of Agreement ("MOA"), a draft of which is attached as **Exhibit A**. Under the proposed MOA, 20% of the total revenues collected under aquaculture or Chapter 190D, HRS, ocean leases issued by the Board will be transferred to the general fund trust holding account to contribute to the payment of the

APPROVED BY THE BOARD OF
LAND AND NATURAL RESOURCES
AT ITS MEETING HELD ON
September 22, 2023 HH

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Office of Hawaiian Affairs' share of ceded lands revenues. LD will then retain 25% of the total revenues collected, plus any third-party costs incurred in managing the leases (such as appraisal, survey or mapping costs). ADP will receive the balance of the revenue on a periodic basis.

RECOMMENDATION: That the Board authorize the Chairperson to negotiate, approve and execute the Memorandum of Agreement substantially in the form attached as Exhibit A between the Department of Land and Natural Resources and the Department of Agriculture regarding the management of aquaculture and ocean leases issued pursuant to Chapters 171 and 190D, HRS, and transfer of revenues collected from the leases described above, and further subject to the review and approval by the Department of the Attorney General.

Respectfully Submitted,

Barry Cheung

Barry Cheung
District Land Agent

APPROVED FOR SUBMITTAL:

Dawn N.S. Chang, Chairperson KAM RT

MEMORANDUM OF AGREEMENT BETWEEN THE
STATE OF HAWAII, DEPARTMENT OF AGRICULTURE, AND
THE STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES

REGARDING THE MANAGEMENT OF CURRENT AND FUTURE
AQUACULTURE AND OCEAN LEASES

THIS MEMORANDUM OF AGREEMENT(hereinafter referred to as "Agreement") is made and entered into on this ___ day of _____, 20___, by and between the State of Hawaii, Department of Land and Natural Resources ("DLNR") whose address is P.O. Box 621, Honolulu, Hawaii 96809-0621 and the State of Hawaii, Department of Agriculture ("DOA"), on behalf of the Aquaculture Development Program ("ADP"), whose address is 1177 Alakea Street #400, Honolulu, Hawaii 96813, (collectively "Parties").

RECITALS

WHEREAS ADP, under DOA, the agency that oversees the development of aquaculture industries in the State, anticipates applications for additional aquaculture and ocean leases being submitted in the near future. Under Section 141-52, Hawaii Revised Statutes ("HRS"), ADP is tasked with, among other things, the development and expansion of the aquaculture industry and coordination of development projects to investigate and solve biological and technical problems involved in raising certain species with commercial potential;

WHEREAS pursuant to Section 190D-33, HRS, revenues obtained from the leasing of state marine waters pursuant to Chapter 190D, HRS, shall be deposited into the Special Land and Development Fund to be used for planning, research, and development of the aquaculture industry;

WHEREAS ADP, through DOA, and DLNR are amenable to the transfer of certain revenues collected from mariculture leases, less the cost of issuing, managing and administering the leases,[1] from DLNR's special fund to ADP in accordance with Section 190D-33, HRS;

WHEREAS in the past, DLNR has transferred to ADP about $200,000.00 for its aquaculture program; and

[1] The parties determined that it would be reasonable and equitable for DLNR to retain a 25% management fee to cover the costs of issuing and managing the leases that include, among other tasks, billing, collections and monitoring of insurance and bonding requirements, plus any third-party costs incurred, such as appraisal or ocean surveying and mapping costs.

EXHIBIT A

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WHEREAS ADP will report the amount and usage of the transferred funds further described below in its annual report to the Legislature on the implementation of Chapter 190D, HRS, regarding ocean and submerged lands leasing.

NOW, THEREFORE, the parties hereto agree as follows:

1. Term. The term of this Agreement shall begin on the Effective Date of this Agreement and shall terminate on December 31, 2024. For the purposes of this Agreement, "Effective Date" shall mean the date of execution of this agreement.

2. Revenue Apportionment. Any revenue collected from the aquaculture and ocean leases issued pursuant to Chapter 190D, HRS, shall be apportioned in the following manner:

   A. 20% to the Office of Hawaiian Affairs.

   B. 25% to the DLNR's Special Land and Development Fund, plus any third-party costs incurred in managing the leases (such as appraisal, survey, or mapping costs).

   C. 55% or the net remaining amount of revenues, whichever is less to ADP through the DOA via journal voucher transfer.

   D. DLNR shall use its best efforts to transfer the revenue described in item 2.C above within four (4) calendar months following collection of the revenues.[2]

3. Amendment. This Agreement may not be amended or modified except by written agreement executed by all Parties.

4. Termination. Either party may terminate all or a portion of this Agreement upon not less than thirty days' written notice to the other party.

5. Renewal. This Agreement shall automatically renew every year for successive one-year terms. If either Party decides not to renew the Agreement, the Party shall provide written notice to the other party no later than thirty (30) days prior to the end of the calendar year.

6. Entire Agreement. This Agreement, along with all attachments, contains the

[2] The parties recognize processing payments and transfers such as journal vouchers involve other departments or offices such as the fiscal/accounting offices at the Departments of Land and Natural Resources and the Accounting and General Services.

entire agreement of the Parties and supersedes any other agreements or understandings, oral or written between the Parties concerning the subject matter of this Agreement.

7. Severability. If any provision of this Agreement, or the application thereof, to any person or circumstance is invalid, illegal, or unenforceable to any extent, the remainder of this Agreement and the application thereof to other persons or circumstances will not be affected.

8. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, and said counterparts will together constitute one and the same agreement and shall be binding on each of the Parties not withstanding that all of the Parties are not signatory to the original or the same counterpart. The submission of a signature page by facsimile transmission, or similar electronic submission facility (e.g., e-mail) shall be deemed to constitute an "original" signature page for all purposes (other than recordation), and facsimile or electronic copies shall be deemed to constitute duplicate originals.

IN WITNESS WHEREOF, the DOA on behalf of ADP, and the DLNR have executed this Memorandum of Agreement as of the date first above written.

BTD

DLH

Approved by the Board of Agriculture
At its meeting held on

_____

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AQUACULTURE DEVELOPMENT
PROGRAM

_____
Its Chairperson

Approved by the Board of Land
And Natural Resources at its
Meeting held on

_____

STATE OF HAWAII
DEPARTMENT OF LAND AND
NATURAL RESOURCES

_____
Its Chairperson

APPROVED AS TO FORM:

_____
Deputy Attorney General

Dated: _____

APPROVED AS TO FORM:

_____
Deputy Attorney General

Dated: _____

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
HONOLULU, HAWAII

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject:	REQUEST FOR CONSENT TO ASSIGNMENT OF GENERAL LEASE NO. S-6016; MARY CHANG XU, LESSEE/ASSIGNOR, TO FIRST RATE PLANTATION, INC., ASSIGNEE; TMK: (1) 5-6-006:044, KAHUKU AGRICULTURAL PARK, LOT 16, KOOLAULOA, KAHUKU, ISLAND OF OAHU, HAWAII
Authority:	Sections 166-7 and 166-9, Hawaii Revised Statutes (HRS), and Sections 4-153-33(a)(6)(B), Hawaii Administrative Rules (HAR)
Lessee/Assignor:	Mary Chang Xu
Assignee:	First Rate Plantation, Inc.
Land Area:	10.263 gross acres
Tax Map Key:	(1) 5-6-006:044 (see Exhibit "A")
Land Status:	Encumbered by Governor's Executive Order No. 3867, dated April 26, 2001, to the Department of Agriculture for agricultural park purposes
Annual Rental:	$3,280.00 per year until reopening on 4/1/2024
Character of Use:	Diversified Agriculture
Lease Term:	45 years, April 1, 1999 through March 31, 2044
Consideration:	$160,000.00

REMARKS:

In 1999, General Lease No. S-6016 was awarded to Mary Chang Xu by the Board of Agriculture. Ms. Xu cultivates bananas, taro, and various vegetables and fruits, and markets the produce to customers including Times Supermarket, Don Quijote, and Armstrong Produce. Due to declining health, Ms. Xu is physically unable to farm. The lessee requests to assign General Lease No. S-6016 to First Rate Plantation, Inc. owned and operated by Vanessa Portus, pursuant to Sections 4-153-33(a)(6)(B), HAR.

C-1

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Vanessa Portus grew up on a farm and worked on her family's vegetable farm. Ms. Portus founded and operated First Rate Plantation, LLC in 2012, producing and selling fresh herbs grown on a 35-acre farm in West Oahu direct to stores and produce distributors nationwide and in Canada. In 2015, as the company grew, she established First Rate Plantation, Inc. Ms. Portus would like to expand the operation by growing basil, galangal, turmeric, betel leaf, rosemary, papaya, and other herbs on the subject farm lot. First Rate Plantation, Inc. qualifies as an agricultural corporation with at least 75 percent of its corporate members who qualify as bona fide farmers with more than two years of full-time farming experience and meets eligibility requirements for Agricultural Parks pursuant to Sections 4-153-1 and 13, HAR.

The Assignee has agreed to pay the Lessee/Assignor a consideration of $160,000.00 for the assignment of leasehold interest. The sale includes an inventory of mature trees and plants. In accordance with Paragraph 17. Assignments of lease, lease interest, etc., any net proceeds are subject to a premium percentage charge benefitting the Lessor. In this case, calculations in accordance with this provision net $48,000.00 to the Lessor (see attached Exhibit "B").

RECOMMENDATION:

That the Board of Agriculture approve the assignment of General Lease No. S-6016 from Mary Chang Xu, Lessee/Assignor, to First Rate Plantation, Inc., Assignee, and the consideration of $160,000.00. All documents shall be subject to review and approval as to form by the Department of the Attorney General, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully Submitted,

BRIAN KAU, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

Attachments – Exhibits "A" and "B"

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

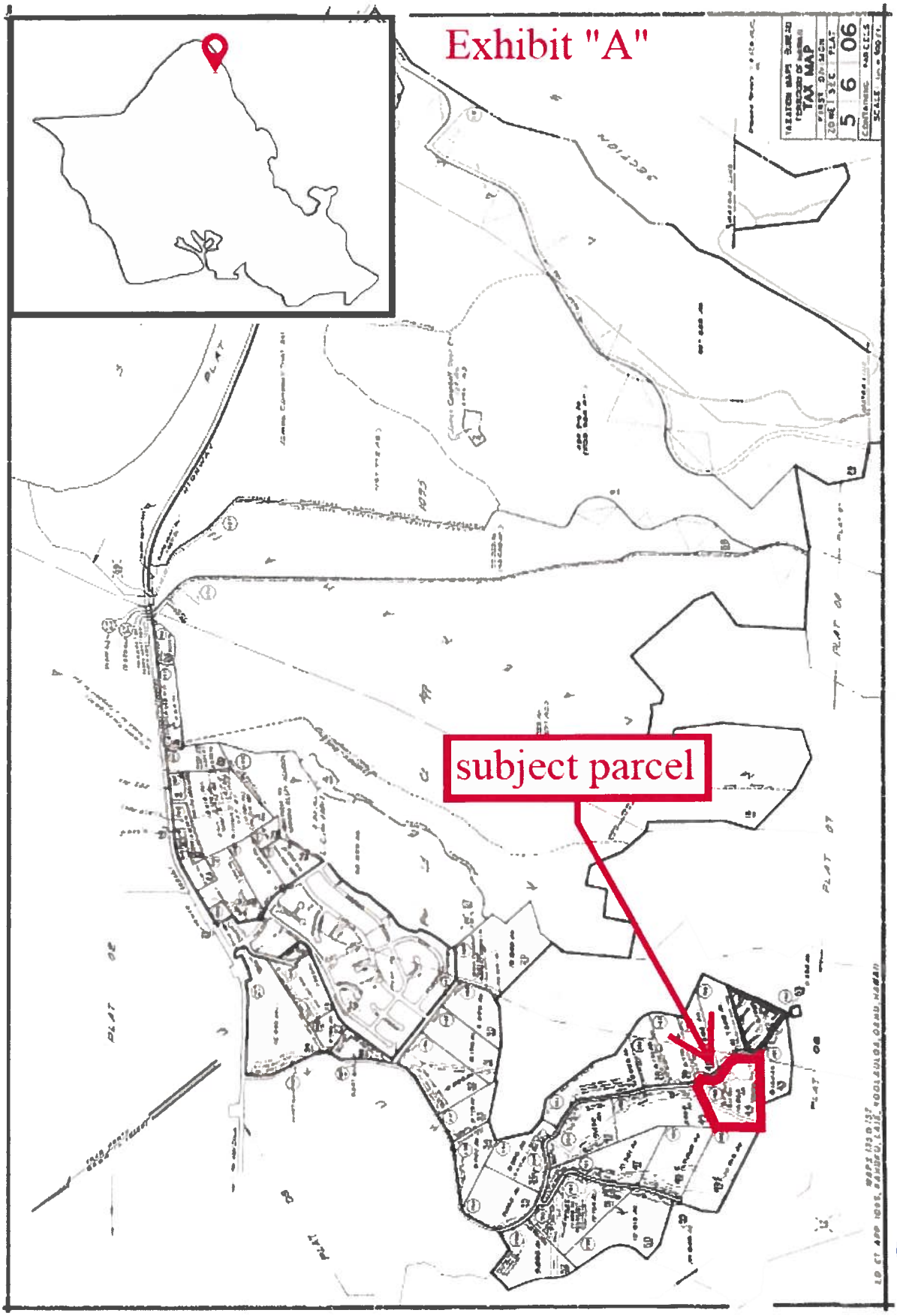

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EXHIBIT "B"

ASSIGNMENT OF LEASE CALCULATIONS FOR

GENERAL LEASE NO. S-6016

Adjusted Depreciation Cost of Improvements or Renovations

Actual Cost:	$0.00
CCI (most recent):	n/a
CCI (base):	n/a
Expired Term:	296
Whole Term:	540

1. Adjusted Cost of Improvements or Renovations:

Actual Cost x CCI (most recent)/CCI (Base)

CCI (recent) n/a

CCI (base) n/a

CCIR/CCIB

Actual Cost x CCI(R)/CCI(B) =

$0.00 0.00 $0.00

2. Depreciation:

Adjust. Cost Impr./Whole Term x Expired Term =

$0.00 540 296 $0.00

3. Adjusted Depreciated Cost of Improvements:

Adjust cost - Depreciated cost =

$ - $ - $ -

1. TOTAL NET CONSIDERATION		$ 160,000.00
2. Adj Cost of Imp/Renov	$ -	
	$ -	$ -
3. Adj. cost of Trade Fixtures	$ -	
	$ -	
4. Excess		$ 160,000.00
5. Premium	Percentage: 30%	$ 48,000.00

Total Consideration:	$ 160,000.00
Less: Inventory	$ -
Net Consideration:	$ 160,000.00

Photos

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STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
HONOLULU, HAWAII

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject:	REQUEST FOR CONSENT TO ASSIGNMENT OF GENERAL LEASE NO. S-6017; PRASONG HSU AND SUNNY HSU, LESSEE/ASSIGNOR, TO FIRST RATE PLANTATION, INC., ASSIGNEE; TMK: (1) 5-6-006:045, KAHUKU AGRICULTURAL PARK, LOT 17, KOOLAULOA, KAHUKU, ISLAND OF OAHU, HAWAII
Authority:	Sections 166-7 and 166-9, Hawaii Revised Statutes (HRS), and Sections 4-153-33(a)(6)(B), Hawaii Administrative Rules (HAR)
Lessee/Assignor:	Prasong Hsu and Sunny Hsu
Assignee:	First Rate Plantation, Inc.
Land Area:	11.254 gross acres
Tax Map Key:	(1) 5-6-006:045 (see Exhibit "A")
Land Status:	Encumbered by Governor's Executive Order No. 3867, dated April 26, 2001, to the Department of Agriculture for agricultural park purposes
Annual Rental:	$3,920.00 per year until reopening on 4/1/2024
Character of Use:	Diversified Agriculture
Lease Term:	45 years, April 1, 1999 through March 31, 2044
Consideration:	$250,000.00

REMARKS:

In 1999, General Lease No. S-6017 was awarded to Prasong Hsu and Sunny Hsu by the Board of Agriculture. Mr. and Mrs. Hsu cultivate various vegetables and fruits, and market the produce to customers including Times Supermarket, Don Quijote, and Armstrong Produce. Due to declining health and being their father's sole caregiver, Mr. and Mrs. Hsu are physically

C-6

unable to farm. The lessee requests to assign General Lease No. S-6017 to First Rate Plantation, Inc. owned and operated by Vanessa Portus, pursuant to Sections 4-153-33(a)(6)(B), HAR.

Vanessa Portus grew up on a farm and worked on her family's vegetable farm. Ms. Portus founded and operated First Rate Plantation, LLC in 2012, producing and selling fresh herbs grown on a 35-acre farm in West Oahu direct to stores and produce distributors nationwide and in Canada. In 2015, as the company grew, she established First Rate Plantation, Inc. Ms. Portus would like to expand the operation by growing basil, galangal, turmeric, betel leaf, rosemary, papaya, and other herbs on the subject farm lot. First Rate Plantation, Inc. qualifies as an agricultural corporation with at least 75 percent of its corporate members who qualify as bona fide farmers with more than two years of full-time farming experience and meets eligibility requirements for Agricultural Parks pursuant to Sections 4-153-1 and 13, HAR.

The Assignee has agreed to pay the Lessee/Assignor a consideration of $250,000.00 for the assignment of leasehold interest. The sale includes an inventory of mature trees and plants. In accordance with Paragraph 17. Assignments of lease, lease interest, etc., any net proceeds are subject to a premium percentage charge benefitting the Lessor. In this case, calculations in accordance with this provision net $63,000.00 to the Lessor (see attached Exhibit "B").

RECOMMENDATION:

That the Board of Agriculture approve the assignment of General Lease No. S-6017 from Prasong Hsu and Sunny Hsu, Lessee/Assignor, to First Rate Plantation, Inc., Assignee, and the consideration of $250,000.00. All documents shall be subject to review and approval as to form by the Department of the Attorney General, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully Submitted,

BRIAN KAU, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

Attachments – Exhibits "A" and "B"

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

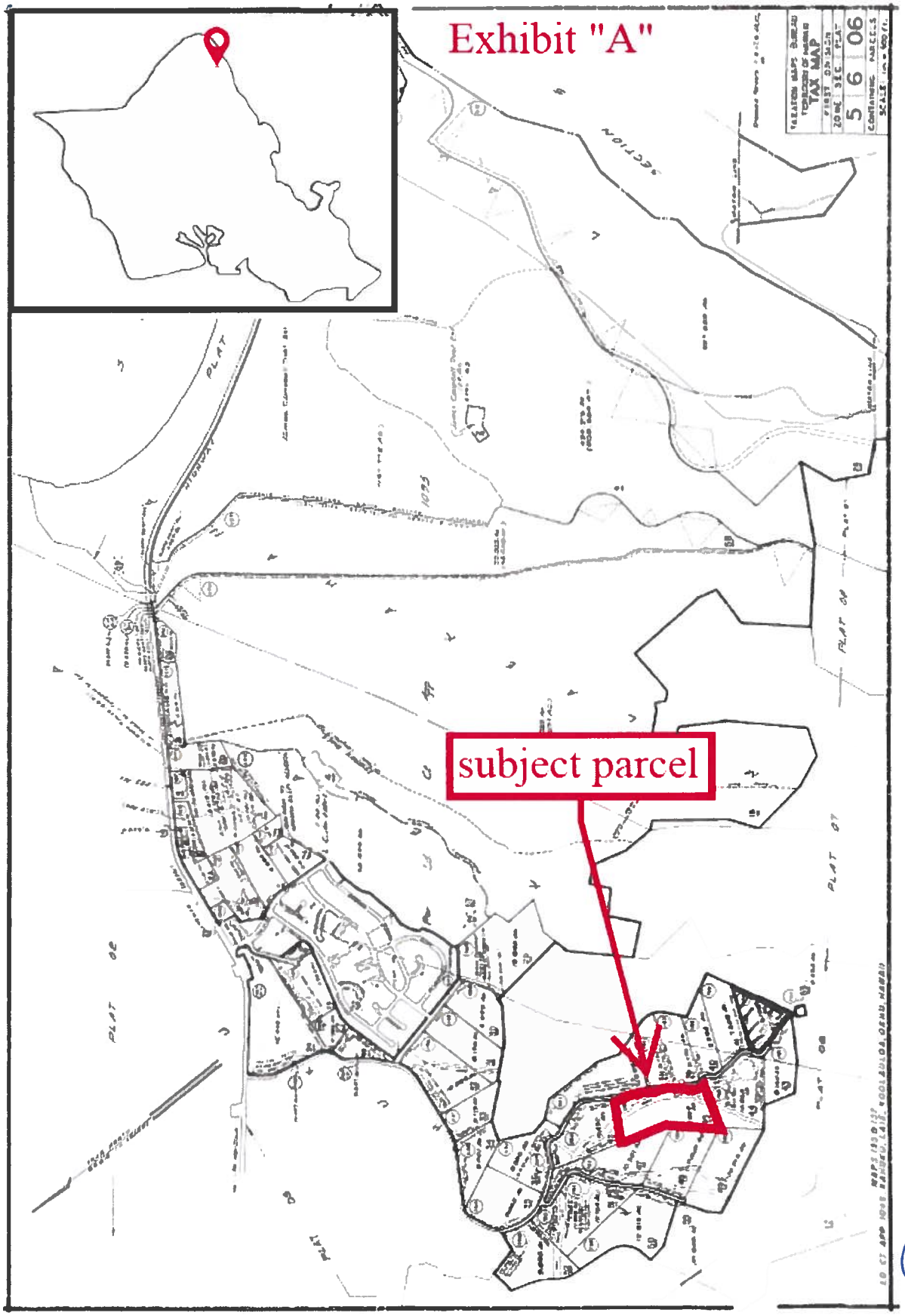
Exhibit "A"
subject parcel

EXHIBIT "B"
ASSIGNMENT OF LEASE CALCULATIONS FOR
GENERAL LEASE NO. S-6017

Adjusted Depreciation Cost of Improvements or Renovations

Actual Cost:	$0.00
CCI (most recent):	n/a
CCI (base):	n/a
Expired Term:	296
Whole Term:	540

1. Adjusted Cost of Improvements or Renovations:

Actual Cost x CCI (most recent)/CCI (Base)

CCI (recent)	n/a
CCI (base)	n/a
CCIR/CCIB	

Actual Cost x CCI(R)/CCI(B) =

$0.00	0.00	$0.00	

2. Depreciation:

Adjust. Cost Impr./Whole Term x Expired Term =

$0.00	540	296	$0.00

3. Adjusted Depreciated Cost of Improvements:

Adjust cost - Depreciated cost =

$ -	$ -	$ -

1. TOTAL NET CONSIDERATION		$ 210,000.00
2. Adj Cost of Imp/Renov	$ -	
		$
	$ -	-
3. Adj. cost of Trade Fixtures	$ -	
	$ -	
4. Excess		$ 210,000.00
5. Premium	Percentage: 30%	$ 63,000.00

Total Consideration:	$	250,000.00
Less: Inventory	$	40,000.00
Net Consideration:	$	210,000.00

Photos

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STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
HONOLULU, HAWAII

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject:	REQUEST FOR CONSENT TO ASSIGNMENT OF GENERAL LEASE NO. S-6018; YOU SOUKASEUM AND PRASONG HSU, LESSEE/ASSIGNOR, TO FIRST RATE PLANTATION, INC., ASSIGNEE; TMK: (1) 5-6-006:046, KAHUKU AGRICULTURAL PARK, LOT 18, KOOLAULOA, KAHUKU, ISLAND OF OAHU, HAWAII
Authority:	Sections 166-7 and 166-9, Hawaii Revised Statutes (HRS), and Sections 4-153-33(a)(6)(B), Hawaii Administrative Rules (HAR)
Lessee/Assignor:	You Soukaseum and Prasong Hsu
Assignee:	First Rate Plantation, Inc.
Land Area:	9.430 gross acres
Tax Map Key:	(1) 5-6-006:046 (see Exhibit "A")
Land Status:	Encumbered by Governor's Executive Order No. 3867, dated April 26, 2001, to the Department of Agriculture for agricultural park purposes
Annual Rental:	$3,450.00 per year until reopening on 4/1/2024
Character of Use:	Diversified Agriculture
Lease Term:	45 years, April 1, 1999 through March 31, 2044
Consideration:	$160,000.00

REMARKS:

In 1999, General Lease No. S-6018 was awarded to You Soukaseum by the Board of Agriculture. In 2011, the lease was assigned to You Soukeseum and Prasong Hsu. Mr. Soukaseum and Mr. Hsu cultivate mango and various vegetables and fruits, and market the produce to customers including Times Supermarket, Don Quijote, and Armstrong Produce. Due to physical and mental disabilities, Mr. Soukaseum can no longer farm. Mr. Hsu is also physically unable to farm and cares for Mr. Soukaseum full-time. The lessee requests to assign

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General Lease No. S-6018 to First Rate Plantation, Inc. owned and operated by Vanessa Portus, pursuant to Sections 4-153-33(a)(6)(B), HAR.

Vanessa Portus grew up on a farm and worked on her family's vegetable farm. Ms. Portus founded and operated First Rate Plantation, LLC in 2012, producing and selling fresh herbs grown on a 35-acre farm in West Oahu direct to stores and produce distributors nationwide and in Canada. In 2015, as the company grew, she established First Rate Plantation, Inc. Ms. Portus would like to expand the operation by growing basil, galangal, turmeric, betel leaf, rosemary, papaya, and other herbs on the subject farm lot. First Rate Plantation, Inc. qualifies as an agricultural corporation with at least 75 percent of its corporate members who qualify as bona fide farmers with more than two years of full-time farming experience and meets eligibility requirements for Agricultural Parks pursuant to Sections 4-153-1 and 13, HAR.

The Assignee has agreed to pay the Lessee/Assignor a consideration of $160,000.00 for the assignment of leasehold interest. The sale includes an inventory of mature trees and plants. In accordance with Paragraph 17. Assignments of lease, lease interest, etc., any net proceeds are subject to a premium percentage charge benefitting the Lessor. In this case, calculations in accordance with this provision net $18,750.00 to the Lessor (see attached Exhibit "B").

RECOMMENDATION:

That the Board of Agriculture approve the assignment of General Lease No. S-6018 from You Soukaseum and Prasong Hsu, Lessee/Assignor, to First Rate Plantation, Inc., Assignee, and the consideration of $160,000.00. All documents shall be subject to review and approval as to form by the Department of the Attorney General, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully Submitted,

BRIAN KAU, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

Attachments – Exhibits "A" and "B"

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

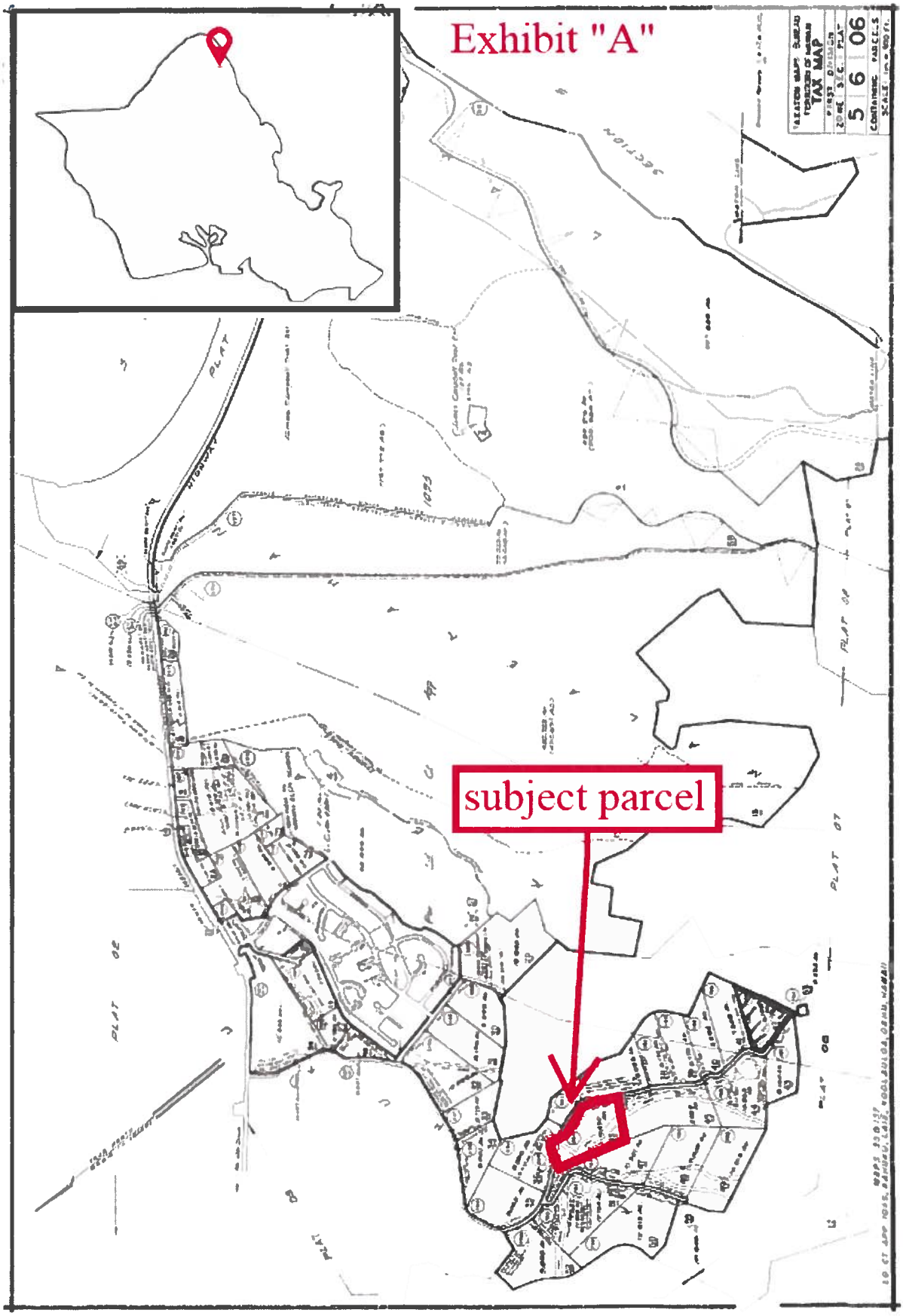
Exhibit "A"
TAX MAP
5 6 06
subject parcel

EXHIBIT "B"

ASSIGNMENT OF LEASE CALCULATIONS FOR

GENERAL LEASE NO. S-6018

Adjusted Depreciation Cost of Improvements or Renovations

Actual Cost:	$0.00
CCI (most recent):	n/a
CCI (base):	n/a
Expired Term:	296
Whole Term:	540

1. Adjusted Cost of Improvements or Renovations:

Actual Cost x CCI (most recent)/CCI (Base)

CCI (recent)	n/a
CCI (base)	n/a
CCIR/CCIB	

Actual Cost x CCI(R)/CCI(B) =

$0.00	0.00	$0.00

2. Depreciation:

Adjust. Cost Impr./Whole Term x Expired Term =

$0.00	540	296	$0.00

3. Adjusted Depreciated Cost of Improvements:

Adjust cost - Depreciated cost =

$ -	$ -	$ -

1. TOTAL NET CONSIDERATION		$ 62,500.00
2. Adj Cost of Imp/Renov	$ -	
	$ -	$ -
3. Adj. cost of Trade Fixtures	$ -	
	$ -	
4. Excess		$ 62,500.00
5. Premium	Percentage: 30%	$ 18,750.00

Total Consideration:	$ 160,000.00
Less: Inventory	$ 97,500.00
Net Consideration:	$ 62,500.00

Photos

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STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
HONOLULU, HAWAII

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject:	REQUEST APPROVE: (1) CONSENT TO ASSIGNMENT OF GENERAL LEASE NO. S-5380; THOMAS AKI, LESSEE/ASSIGNOR, TO ROCK HILL FARM, LLC, ASSIGNEE; (2) EXTENSION OF LEASE; AND (3) AMENDMENT OF LEASE; TMK: (1) DIV/4-1-009:266, KOOLAUPOKO, WAIMANALO, ISLAND OF OAHU
Authority:	Sections 166E-5 and 6, Hawaii Revised Statutes (HRS) and Sections 4-158-2(a)(9), 4-158-9, 10, 11 and 12, 4-158-18(1), and 4-158-19(a)(4)(B), Hawaii Administrative Rules (HAR)
Lessee/Assignor:	Thomas Aki
Assignee:	Rock Hill Farm LLC
Land Area:	31.170 gross acres
Tax Map Key:	(1) 4-1-009:266 (see Exhibit "A")
Land Status:	Encumbered by Governor's Executive Order No. 4535 to the Department of Agriculture for Non-Agricultural Park Lands purposes
Rental:	$2,120.00 per year
Lease Term:	35 years, January 1, 1995 to December 31, 2030
Character of Use:	Pasture purposes
Consideration:	$400,000.00

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REMARKS:

General Lease No. S-5380 (the Lease) was awarded to Robert and Theresia Lee in 1995 for pasture purposes by the Board of Land and Natural Resources (BLNR). In 2017, the Lease was set aside and transferred to the Department of Agriculture by Governor's Executive Order No. 4535.

In 2015 the BLNR approved the assignment of lease to Thomas Aki and Elizabeth Lee, and they invested a tremendous amount of time, effort and finances clearing the land and hauling debris. Mr. Aki and Ms. Lee parted ways in 2019, and General Lease No. S-5380 was assigned solely to Thomas Aki. Subsequently, Mr. Aki suffered economic hardship operating and managing the sheep business alone. Mr. Aki requests to assign the lease to Rock Hill Farm LLC, owned and operated by Leon Broughton and Alice Broughton, pursuant to Section 4-158-19(a)(4)(B), HAR and the Lease.

Leon Broughton was born on a sheep farm in New Zealand. In 1962, he and his brother established their own sheep business by adding two more sheep farms. Alice Broughton owned and operated a horse and cattle ranch since 1970, and in 1996 she joined Mr. Broughton in the sheep business. Mr. and Mrs. Broughton sold their sheep farms in New Zealand and plan to utilize the proceeds to fund and invest in a sheep farm on Oahu. The sheep will be marketed to local consumers and distributors.

Pursuant to Section 4-158-1 and 27, HAR, Rock Hill Farm LLC qualifies as an agricultural company with at least 75 percent of its members qualifying as Bona Fide farmers and meeting residency eligibility requirements.

The Assignee has agreed to pay the Lessee/Assignor a consideration of $400,000.00 for the assignment of the leasehold interest. The sale includes an inventory of sheep and improvements on the premises. In accordance with Paragraph 13. Assignments, etc. of the Lease, any net proceeds are subject to a Premium Percentage charge benefiting the Lessor. Calculations in accordance with this provision net $14,173.00 to the Lessor (see Exhibit "B").

Mr. Aki also requests to extend the term of the lease for an additional thirty (30) years to the maximum 65-year term pursuant to Section 166E-5, HRS, and Sections 4-158-9, 10, 11, and 12, HAR. The lease term may be extended commencing January 1, 2031 through December 31, 2060. The requirements of the above referenced sections state, in pertinent parts, the following:

- The holder of an encumbrance shall be satisfactorily performing in full compliance with the terms and conditions of the existing lease.
- The holder of the encumbrance shall not be in arrears in the payment of taxes, rents, or other obligations owed to the State or any county.
- The holder of an encumbrance's agricultural activity or farming operation shall be fully and economically viable as specified in section 4-158-11.

All extensions shall require the determination of the base rent and additional rents. The rental value shall be based on the appraisal conducted by a disinterested appraiser or appraisers contracted by the administrator.

The current "Character of Use" of the Lease is pasture purposes. Pasture, as defined in the Lease, "means the conduct of livestock operation consisting of keeping cattle, primarily, and others, in a minor role, such as horses and sheep where animals graze the land for feed produced thereon." So that Mr. and Mrs. Broughton may raise sheep, staff requests approval to amend the definition of Pasture in Lease to include raising sheep as a primary operation.

RECOMMENDATION:

That the Board of Agriculture (1) consent to the assignment of General Lease No. S-5380 from Thomas Aki, Lessee/Assignor, to Rock Hill Farm LLC, Assignee and accept the consideration of $400,000.00; (2) approve the extension of General Lease No. S-5380 to expire on December 31, 2060; and (3) approve the amendment of the definition of Pasture in General Lease No. S-5380 to include raising sheep. All documents shall be subject to review and approval as to form by the Department of the Attorney General, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully Submitted,

BRIAN KAU, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

Attachments – Exhibits "A" & "B"

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

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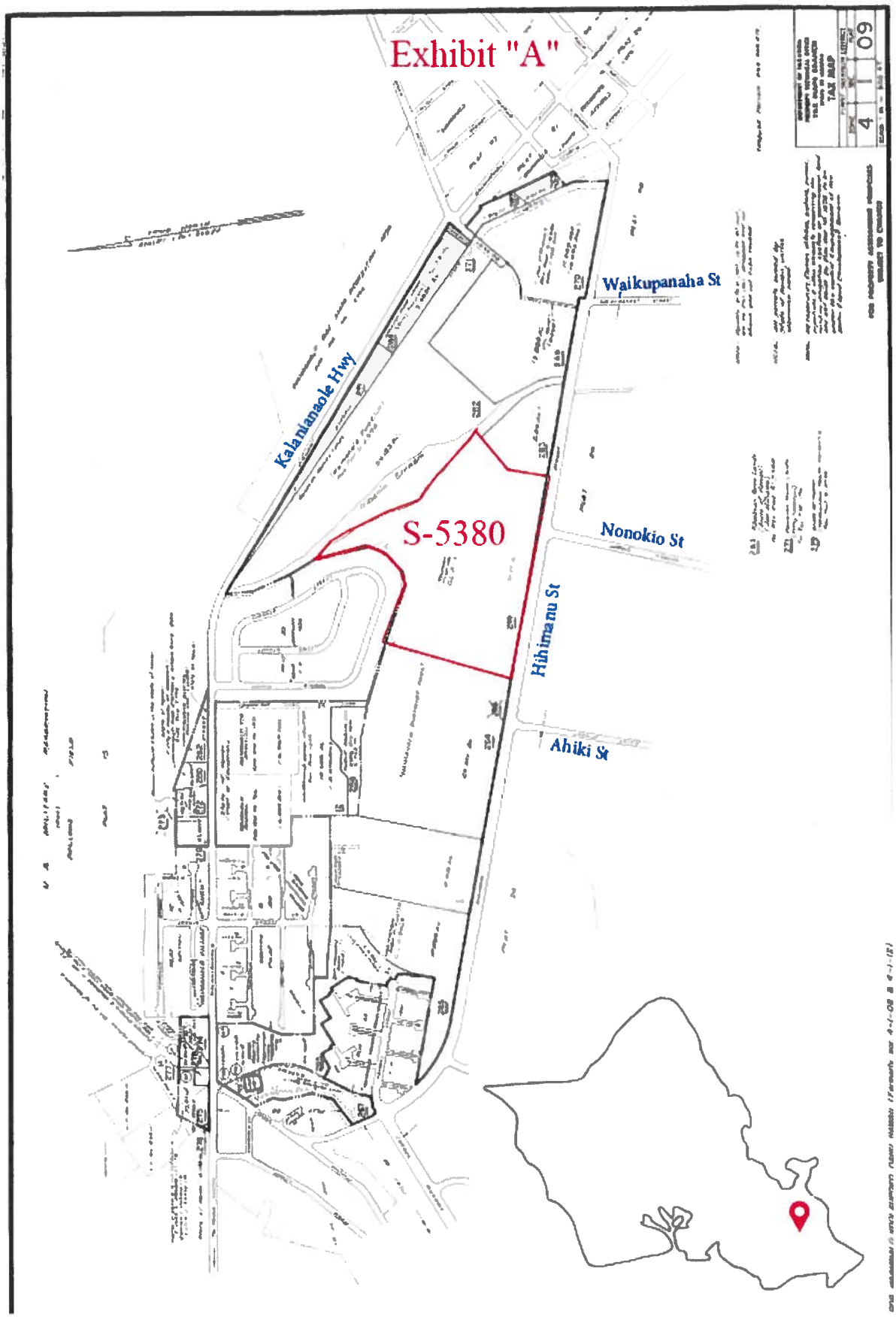
Exhibit "A"
Waikupanaha St
Kalanianaole Hwy
S-5380
Nonokio St
Hihimanu St
Ahiki St

EXHIBIT "B"

ASSIGNMENT OF LEASE CALCULATIONS FOR

GENERAL LEASE NO. S-5380

Adjusted Depreciation Cost of Improvements or Renovations

Actual Cost:	$393,100.00
CCI (most recent):	13497.97
CCI (base):	11213
Expired Term:	347
Whole Term:	420

1. Adjusted Cost of Improvements or Renovations:

Actual Cost x CCI (most recent)/CCI (Base)

CCI (recent)	13497.97
CCI (base)	11213
CCIR/CCIB	1.20

Actual Cost x CCI(R)/CCI(B) =

$ 393,100.00	1.20	$ 473,205.39

2. Depreciation:

Adjust. Cost Impr./Whole Term x Expired Term =

$ 473,205.39	420	347	$ 390,958.00

3. Adjusted Depreciated Cost of Improvements:

Adjust cost - Depreciated cost =

$ 473,205.39	$ 390,958.00	$ 82,247.39

1. TOTAL NET CONSIDERATION		$ 365,700.00
2. Adj Cost of Imp/Renov	$ 473,205.39	
	$ 390,958.00	$ 82,247.39
3. Adj. cost of Trade Fixtures	$ -	
	$ -	
4. Excess		$ 283,452.61
5. Premium	Percentage: 5%	$ 14,173.00

Total Consideration:	$ 400,000.00
Less Inventory:	$ 34,300.00
Net Consideration:	$ 365,700.00

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Photos

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
HONOLULU, HAWAII

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject:	REQUEST TO APPROVE RENTAL OFFSET, GENERAL LEASE NO. S-3145 AND S-3146; DEAN H. NONAKA AND NICOL U. NONAKA, LESSEE; TMK (4) 1-9-002:001 AND TMK (4) 1-9-002:020, HANAPEPE, ISLAND OF KAUAI, HAWAII
Authority:	Section 166E-6, Hawaii Revised Statutes (HRS), and Section 4-158-2(a)(3), Hawaii Administrative Rules (HAR)
Lessee:	Dean H. Nonaka and Nicol U. Nonaka
Land Area:	S-3145 – 2.396 acres S-3146 – 0.93 acres
Tax Map Key:	S-3145 - (4) 1-9-002:001 (Exhibit "A") S-3146 - (4) 1-9-002:020 (Exhibit "A")
Lease Term:	35 years, 8/1/2021 through 7/31/2056
Land Status:	Encumbered by Governor's Executive Order No. 4259, dated January 9, 2009, to the Department of Agriculture for agriculture purposes
Annual Base Rental:	S-3145- $3,502.00 per year S-3146- $1,505.00 per year
Character of Use:	Diversified agriculture

BACKGROUND:

In 2009, Governor's Executive Order No. 4259 transferred the subject land parcels to the Department of Agriculture (DOA) for management purposes. The Agricultural Resource Management Division requested and received the Board's approval to dispose of the parcels and by way of sealed bids the subject property was awarded to the successful bidder, Dean and Nicol Nonaka. Thirty-five (35) year leases were issued for each parcel commencing August 1, 2021 through July 31, 2056.

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C-23

Dean and Nicol Nonaka submitted expense receipts for equipment and services rendered. They removed about seventy non-working vehicles from both parcels and had them professionally disposed of. In addition to removing numerous abandoned vehicles, the Lessee also worked with local law enforcement to remove homeless encampments in the area. The Lessee continues to clear the land in anticipation of planting fruit trees. Their expenses clearing and preparing the land for planting have exceeded the amount totaling two years of rental offset for both leases.

Pursuant to 4-158-2(a)(3), HAR, and the Lease, the Board may permit the Lessee to offset the cost of land clearance and improvements against not more than two (2) years of base annual rental. The Lessee is requesting rental offsets of two years of base annual lease rent as follows:

General Lease No. S-3145: $7,004.00
General Lease No. S-3144: $3,010.00

RECOMMENDATIONS:

Staff recommends that the Board of Agriculture approve the Lessee's request for a rental offset of up to two years of base annual lease rent from 8/1/2021 through 7/31/2023, in accordance with the terms and conditions of General Lease No. S-3145 and S-3146 and Section 4-158-2(a)(3), HAR, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

All related documents are subject to the review and approval as to form by the Department of the Attorney General, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully submitted,

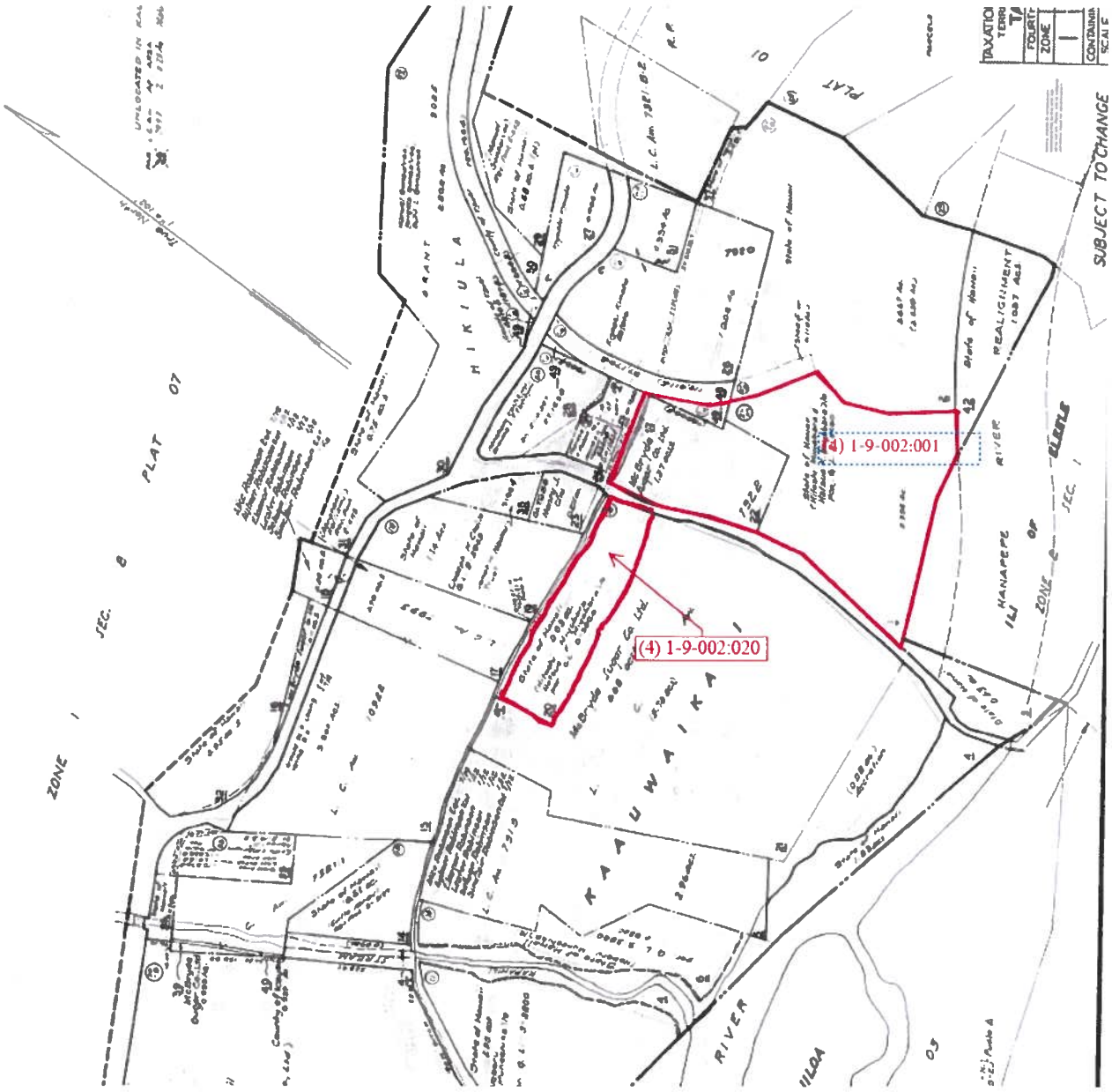
BRIAN KAU, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

Attachments - Exhibit "A"

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

Exhibit "A"



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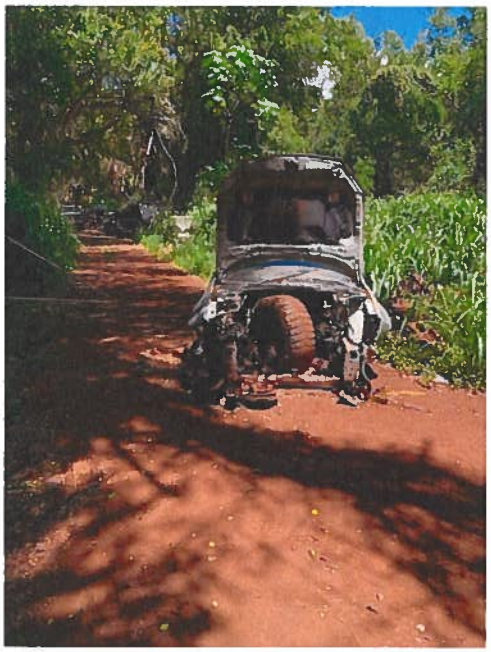
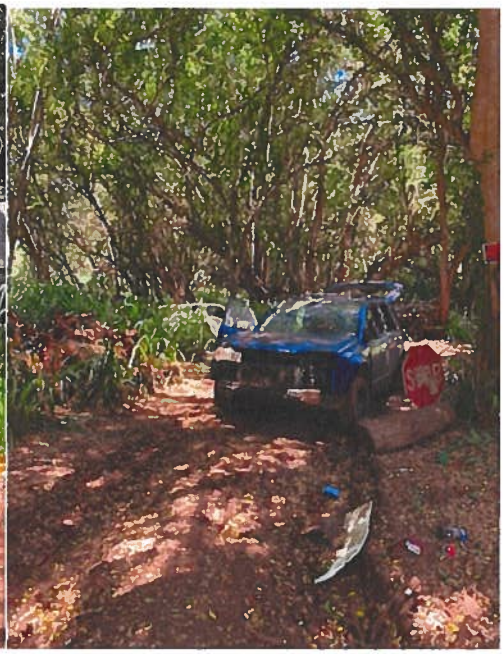
BEFORE PHOTOS





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C-26

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
HONOLULU, HAWAII

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject: REQUEST TO APPROVE RIGHT-OF-ENTRY FOR UNITED STATES DEPARTMENT OF AGRICULTURE (USDA), WILDLIFE SERVICES TO STUDY BOVINE TUBERCULOSIS RISK FROM WILDLIFE; LESSEE: VACANT; TMK: (2) 5-2-001:011, LOT NO. 2, MOLOKAI AGRICULTURAL PARK, HOOLEHUA, ISLAND OF MOLOKAI, HAWAII

Authority: Section 166-3 and166E, Hawaii Revised Statutes (HRS), and Sections 4-153-3(b)(3), and 4-158-2(a)(8), Hawaii Administrative Rules (HAR)

Lessee: Vacant

Land Area: Approximately 25.304 acres

Tax Map Key: (2) 5-2-001:011 (Exhibit "A")

Land Status: Encumbered by Governor's Executive Order No. 3696 to the Department of Agriculture for agricultural park land purposes in 1996

Lease Term: NA

Character of Use: NA

BACKGROUND:

The USDA, Animal and Plant Health Inspection Services (APHIS), Wildlife Services has initiated a study to determine the risk of transmission of Bovine Tuberculosis (bTB) among livestock and wildlife on the island of Molokai. The USDA will collect data for the study by installing cameras at predetermined locations across Molokai to index populations and behaviors of axis deer and wild pigs. One of the locations will be at or near the Molokai Agricultural Park on a HDOA lot. Only authorized individuals will have access to the camera to periodically retrieve data and perform maintenance as needed.

The term of this bTB study shall commence upon BOA approval of this request for a right-of-entry agreement (ROE) for a term of 24 months, unless sooner terminated pursuant to the terms set forth in the ROE.

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In addition, staff is requesting that the Board delegate to the Chairperson the authority to approve alternate sites at the Molokai Agricultural Park and other HDOA lots on Molokai for installation of a camera and to extend the term of the ROE, if necessary.

RECOMMENDATIONS:

That the Board of Agriculture approve the following:

(1) The issuance of a Right-of-Entry agreement for the USDA/APHIS/Wildlife Services study regarding Bovine Tuberculosis Risk from Wildlife; and

(2) Delegation of authority to the Chairperson to (a) approve alternate sites at the Molokai Agricultural Park and other HDOA leased lots on Molokai for the study and (b) to extend the term of the ROE, if necessary.

All documents are subject to approval as to form by the Office of the Attorney General, and such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully submitted,

BRIAN KAU, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

Attachment - Exhibit "A"

APPROVED FOR SUBMISSION:

Sharon Hurd
Chairperson, Board of Agriculture

Exhibit "A"

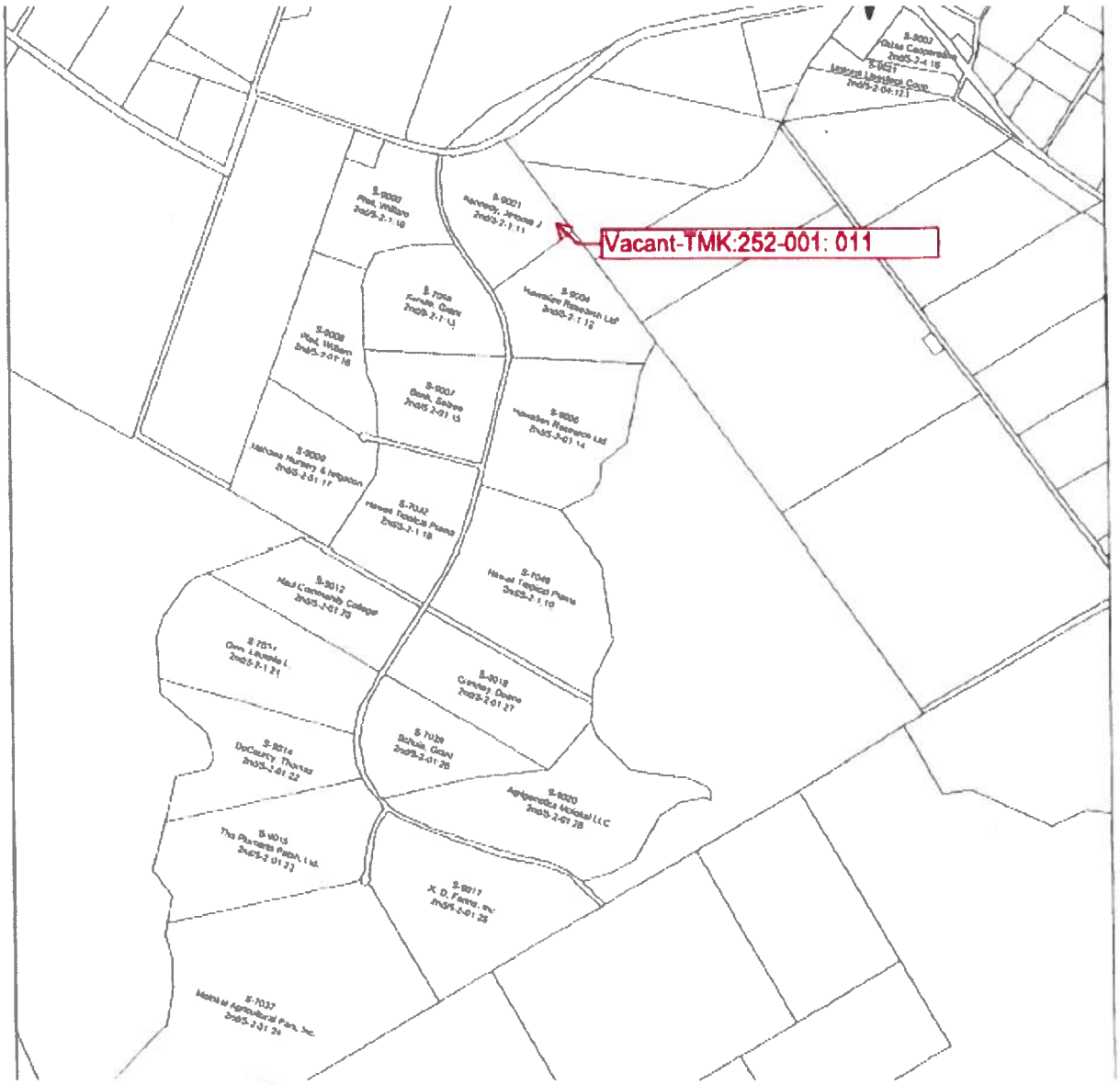

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Exhibit "B"

State of Hawaii
Department of Agriculture
Plant Industry Division
Plant Quarantine Branch
Honolulu, Hawaii

December 5, 2023

Board of Agriculture
Honolulu, Hawaii

Subject: Request to: (1) Approve for Future Placement on the List of Restricted Animals (Part A), the Currently Unlisted Wasp, *Aprostocetus nitens* (Hymenoptera: Eulophidae), as a Biocontrol Agent of *Quadrastichus erythrinae* (Hymenoptera: Eulophidae), by the Hawai'i Department of Agriculture, Plant Pest Control Branch (HDOA-PPC);

(2) Authorize the Chairperson to Schedule Public Hearings and Appoint One or More Hearings Officers in Connection With the Proposed Amendments to Chapter 4-71, Hawaii Administrative Rules.

(3) Provided the Wasp, *Aprostocetus nitens,* is Placed on the List of Restricted Animals (Part A), Allow the Import and Field Release from the HDOA-PPC Insect Containment Facility [Laboratory Quarantine] of the Wasp, *Aprostocetus nitens*, by Permit, for Biocontrol of *Quadrastichus erythrinae* by HDOA-PPC; and

(4) Provided the Wasp, *Aprostocetus nitens,* is Placed on the List of Restricted Animals (Part A), Establish Permit Conditions for the Import and Field Release of the Wasp *Aprostocetus nitens* as a Biocontrol Agent of *Quadrastichus erythrinae* by HDOA-PPC.

I. Summary Description of the Request

PQB NOTES: *The Plant Quarantine Branch (PQB) submittal for requests for import or possession permits, distinguishes information provided by the applicant, Darcy Oishi, 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 3 through page 8 of the submittal was taken directly from the applicant's application. For instance, the statements on pages 7 through 8 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, environmental assessment, advisory review, and proposed permit conditions, are identified as sections II, IV, VI, and VII of the submittal, which start at pages 3, 9, 12, and 13 respectively.

COMMODITY: Various field releases of the wasp, *Aprostocetus nitens* (Hymenoptera: Eulophidae: Tetrastichinae), currently held in Laboratory Quarantine

PERSON RESPONSIBLE FOR THE ORGANISM:
Darcy Oishi, Acting Manager
HDOA-PPC
1428 South King Street
Honolulu, Hawaii 96814

CATEGORY: *Aprostocetus nitens* is currently an unlisted animal. Animals not found on any list are considered prohibited until placed on a list. Section 150A-5.5(b), Hawaii Revised Statutes (HRS), allows articles quarantined in the biocontrol containment facilities of the department or of other government agencies engaged in joint projects with the Department to be released upon issuance of a permit approved by the Board.

PQB NOTES: *The applicant is requesting that the Board place Aprostocetus nitens on the List of Restricted Animals (Part A) and allow import and field release into the environment from HDOA-PPC's Insect Containment Facility [laboratory quarantine] for the biological control of Quadrastichus erythrinae. Aprostocetus nitens was originally brought into the HDOA-PPC Insect Containment Facility from Kenya, South Africa, and Tanzania in 2005 and 2006 for biocontrol research and host range testing. The applicant is not currently requesting a special permit at this time.*

In December 2019, a Draft Environmental Assessment (DEA) was submitted to the Office of Environmental Quality Control (OEQC) [now known as the Environmental Review Program] with an Anticipated Finding of No Significant Impact (AFNSI). The draft was published in OEQC's Environmental Notice on December 23, 2019 (See Attachment 2). The final EA with a Finding of No Significant Impact (FONSI) was published in the Environmental Notice on February 8, 2023.

II. Procedural Background

HDOA-PPC has requested that one of the lists in Chapter 4-71, Hawai'i Administrative Rules (HAR), be amended to include the wasp, *Aprostocetus nitens.* 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 or Conditionally Approved Lists may enter the State of Hawai'i 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), 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 place a species on a list has no legal effect until the rule has been changed. This procedure is solely for administrative ease in preparation for amendments to the various lists.

Provided the Board approves HDOA-PPC's 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, 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 HDOA, with support from the Hawai'i Department of Land and Natural Resources (DLNR) and the University of Hawai'i (UH), proposes the import and field release of a eulophid parasitoid wasp to complement *Eurytoma erythrinae* for biocontrol of the erythrina gall wasp (EGW), *Quadrastichus erythrinae*, an invasive pest species that has attacked and quickly killed hundreds of *Erythrina* spp. trees in Hawai'i including the endemic wiliwili, *Erythrina sandwicensis*.

Aprostocetus nitens, a tiny stingless wasp native to South Africa, Kenya, and Tanzania, has been selected and evaluated as a new biological control agent targeting the invasive pest EGW in Hawai'i. It is a host-specific parasitoid wasp intended for

statewide field release as a natural enemy of EGW which has been devastating wiliwili and related *Erythrina* species. This release will complement the success of *Eurytoma erythrinae* (Hymenoptera: Eurytomidae), a parasitoid wasp approved by the Board of Agriculture and field-released statewide in 2008 for control of EGW and will improve the survival success of wiliwili, an ecologically and culturally important native Hawaiian tree species.

DISCUSSION:

1. **Person Responsible:**

Darcy Oishi, Acting Manager
HDOA-PPC
1428 South King Street
Honolulu, Hawai'i 96814

2. **Safeguard Facility and Practices:**

The *Aprostocetus nitens* colony is currently held in quarantine at the HDOA-PPC Insect Containment Facility (ICF) at 1428 South King St., Honolulu, HI 96814 in accordance with Hawai'i Revised Statutes 150A-5.5. The *Aprostocetus nitens* colony originates from insects collected in Kenya, Tanzania, and South Africa by HDOA-PPC, UH, [other]and collaborators between 2005 and 2006. The field-collected insects were shipped and safeguarded under United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection & Quarantine Permit to Move Live Plant Pests, Noxious Weeds, and Soil Permit Numbers P526P-20-03513 and 73874 (Attachment 3) and moved directly into the HDOA-PPC ICF, for rearing and screening to eliminate associated natural enemies. Juliana Yalemar, HDOA-PPC Insectary Entomologist, will positively identify the insects and determine them to be free of natural enemies in preparation for field release into the environment.

3. **Method of Disposition:**

If this permit request is approved, the *Aprostocetus nitens* colony will be removed from the HDOA-PPC Insect Containment Facility and transferred to the HDOA-PPC Insect Rearing Facility (Insectary) for mass rearing. Approximately 100 to 200 adults will be removed from the HDOA-PPC Insectary to be released by HDOA-PPC staff at sites throughout the State, beginning with O'ahu, Hawai'i, and Maui Islands. HDOA-PPC staff will hand-carry newly emerged adult *A. nitens,* contained in secure vials, on interisland flights from O'ahu to Hawai'i, Maui, and Kaua'i release sites. Releases will occur on the same day HDOA-PPC staff arrive on the designated island. Adult *A. nitens* individuals will be continuously released on EGW-infested *Erythrina* trees and will continue statewide until such time that it

is determined to be established at intended *Erythrina* field sites. HDOA-PPC expects to rear and release thousands of individuals of this wasp until the species is established. Once *A. nitens* colonies are deemed established in the State, partner agencies including Department of Land and Natural Resources, Division of Forestry and Wildlife, University of Hawai'i, and others, will assist in liberating additional individuals at locations where HDOA-PPC needs assistance.

Post-release monitoring will be conducted at all release sites statewide by HDOA-PPC and agency partners.

If this permit request is not approved by the Board of Agriculture, the Plant Pest Control Branch will temporarily maintain colonies within the Insect Containment Facility to see if any international partners may be interested in *A. nitens.* If there is an international partner interested, then a federal permit shall be obtained for transfer. All stocks will then be disposed of by autoclave and the USDA permit will be canceled.

4. Abstract of Organism:

Aprostocetus nitens Prinsloo & Kelly (Hymenoptera: Eulophidae) is a natural enemy of the invasive *Quadrastichus erythrinae* (erythrina gall wasp = EGW). *A. nitens* has been evaluated in the HDOA-PPC ICF between 2005 and 2019 where it has been found to be host specific to EGW in Hawai'i. *A. nitens* larvae feed exclusively on immature larval and pupal life stages of EGW. Adult *A. nitens* feed on flower nectar. *A. nitens* is host specific to *Quadrastichus erythrinae*; there are no native species in the genus *Quadrastichus* in Hawai'i. There are also no parasitoid wasps that similarly utilize *Erythrina sandwicensis* in Hawai'i. *A. nitens* do not bite or sting humans or animals. No adverse effects are anticipated on the environment, humans, or other animals.

Taxonomy:
Aprostocetus nitens Prinsloo & Kelly, 2009 is a parasitoid wasp (Hymenoptera), classified in the family Eulophidae, subfamily Tetrastichinae.

Most species of Eulophidae are primary parasitoids of hidden larvae (e.g. leaf-mining and gall-forming orders such as Lepidoptera, Hymenoptera, Diptera, Hemiptera: Coccoidea, Thysanoptera, etc.). Some species are hyperparasitoids. Tetrastichinae is one of the two largest Eulophidae subfamilies (about 1650 species in 90 genera) with species covering all geographic areas (Reina & La Salle 2003). *Aprostocetus* is the largest Tetrastichinae genus with over 700 species described worldwide (Noyes 2001, 2019). Many species of the subgenus *Aprostocetus* are primary parasitoids of hosts in plant galls (Reina & La Salle 2003).

Description of Adults:

Aprostocetus nitens was first collected in South Africa in 1980 (Prinsloo & Kelly 2009), but it remained an unnamed species to science. *A. nitens* was first described as a new species by Prinsloo and Kelly in 2009, after it was collected in Kenya, Tanzania, and South Africa during exploratory surveys for natural enemies of the erythrina gall wasp, *Q. erythrinae*. This species is quite small (1.1–1.7 mm long), and shiny black in color with a dark metallic green tinge and yellow gaster (abdomen), antennae, and legs. The wings are transparent with brown venation. See Prinsloo and Kelly (2009) for full description (Attachment 4).

Distribution:
A. nitens is native to Africa where it has been recorded from Kenya, South Africa, and Tanzania. This species was recently described in 2009 and is not known from elsewhere in the world.

Life History:
A life history study conducted in the HDOA-PPC ICF showed that *A. nitens* adult females are synovigenic which means they can produce fertile eggs upon emerging from pupation and throughout their lifespan, laying an average of 139 eggs. Females lay eggs in galled tissues caused by EGW on *Erythrina* trees. Larvae of *A. nitens* feed exclusively on immature stages of EGW infesting *Erythrina* species of trees. Each *A. nitens* larva can complete development on a single EGW larva or pupa.

The entire life cycle for *A. nitens* from egg to adult takes approximately 20 days. This species can survive 4 days without food and lives for an average of 120 days (Yalemar et al. 2016).

Habitat/Ecology:
A. nitens is tolerant of warm and moderate temperatures and is not expected to be restricted in range by temperatures in Hawai'i. In its native range in Africa, *A. nitens* was collected in the same localities as its target host, *Quadrastichus erythrinae* and *Eurytoma erythrinae*, the first biocontrol agent released in Hawai'i *against Q. erythrinae.* Thus, *A. nitens* is expected to fare well in the range of Hawai'i['s] temperatures and environments where the target host and native *Erythrina sandwicensis* exist.

Natural Enemies:
There is no information in literature regarding the natural enemies of *A. nitens* in its native range. This species was first described to science in 2009 (Prinsloo & Kelly 2009), after collections during biocontrol exploration for natural enemies of EGW in Kenya, South Africa, and Tanzania in 2005 & 2006.

Effect on Target Pest:
A. nitens was selected as a complementary biological control agent of EGW due to its host specificity to EGW and the non-competitive effects it will have with the first-

released biological agent, *Eurytoma erythrinae.* Larvae of *A. nitens* are specific to gall-forming *Quadrastichus* species of African *Erythrina* trees, as exhibited during field observations during exploration, examination of unidentified museum material, and years of testing within HDOA's Insect Containment Facility.

Unlike *E. erythrinae*, which requires multiple immature EGW individuals to develop, *A. nitens* completes its development on a single immature EGW. Eggs of *A. nitens* are oviposited inside galls, and larvae will start to feed on the developing EGW as soon as it emerges. One larva will attach itself to an EGW and suck the liquid out of the pest killing it in the process.

5. Potential Effects on the Environment and Health:

Host specificity studies were performed at the HDOA Insect Containment Facility. The results of no-choise starvation tests and multi-choice testing indicated the host range of *Aprostocetus nitens* is restricted to *Quadrastichus erythrinae*, the invasive and devastating pest to endemic Hawaiian wiliwili (*Erythrina sandwicensis*) trees and other *Erythrina* spp. In Hawai'i.

The objective of the host specificity trials conducted was to determine if *A. Nitens* would attack any non-target gall-forming insects. This method followed host specificity testing methods conducted for *Eurytoma erythrinae* (Yalemar et al., 2016; Attachment 4). The seven species tested included one Hawaiian endemic psyllid (*Pariaconus* sp.) on 'ōhi'a lehua (*Metrosideros polymorpha*); four beneficial species previously liberated for weed biological control: a scale insect (*Tectococcus ovatus*) on leaves and shoots of strawberry guava (*Psidium cattleianum*), lantana gall fly (*Eutreta xanthochaeta*) on the stems of *Lantana camara*, Hamakua pamakani gall fly (*Procecidochares alani*) on the stems of *Ageratina riparia*, and Maui pamakani gall fly (*Procecidochares utilis*) on the stems of *Ageratina adenophora*; and two immigrant wasps: banyan leaf-galling wasp (*Josephiella microcarpae*) and a eucalyptus gall wasp (*Ophelimus* sp.) on eucalyptus leaves.

Host specificity assays consisted of two types of tests. Choice tests, which approximate choices of host the parasitoid would be presented within the field, and no-choice tests to determine whether *A. nitens* (the agent) would feed on non-target hosts in the absence of its intended host. In a choice test, the agent is allowed to choose plants infested by either the target (EGW) or a non-target gall-forming insect for oviposition and development. In the no-choice test, the agent is given only the option of using a non-target gall-former as host. At the end of each test, the mature agents are removed, and the plant is held in a cage to await the emergence of any offspring from the agents exposed to the galls. After 1 month, galls from each test plant are dissected and examined under a microscope to determine whether parasitism has taken place (Yalemar et al. 2016). Results of the host specificity trials indicate that *A. nitens* is host specific and has no preference for any of the seven non-target gall-forming species studied. In addition, even if *A.*

nitens were to parasitize these non-target species, it would be unable to produce any offspring because none of these species was shown to be suitable for supporting this species' development.

Field observations in *A. nitens'* natural habitat in Africa and quarantine studies in Hawai'i (HDOA-PPC ICF) strongly indicate that the proposed release of this Erythrina gall wasp biocontrol agent will not have any undesirable, negative, non-target effects on the natural environment of the Hawaiian Islands. Environmental impacts associated with the No Action Alternative of not issuing permits for release are those resulting from the continued damage to the endemic wiliwili tree and other species in the genus *Erythrina* caused by EGW and environmental damage caused by other methods (such as systemic pesticides) employed to control EGW in affected trees. The proposed release and establishment of *A. nitens* is expected to supplement the success of *E. erythrinae* in suppressing infestations of Erythrina gall wasp, effectively reducing these impacts further.

References:

Noyes, J.S. 2001. Taxapad 2001. Chalcidoidea. Electronic Publication (CD-ROM). Dicky S. Yu, Bentall Centre, Vancouver, Canada.

Noyes, J.S. 2013. Universal Chalcidoidea Database. World Wide Web electronic publication. http://www.nhm.ac.uk/chalcidoids

Prinsloo, G.H. and J.A. Kelly. 2009. The tetrastichine wasps (Hymenoptera: Chalcidoidea: Eulophidae) associated with galls on *Erythrina* species (Fabaceae) in South Africa, with the description of five new species. *Zootaxa* 2083: 27–45.

Reina P. and J. La Salle J. 2003. Key to the World Genera of Eulophidae Parasitoids (Hymenoptera) of Leafmining Agromyzidae (Diptera). https://keys.lucidcentral.org/keys/v3/eulophidae_parasitoids/

Yalemar, J., R. Bautista, and W. Nagamine. 2016. Host Specificity and Biological Studies for *Aprostocetus nitens* (Hymenoptera: Eulophidae), Another Potential Biological Control Agent of the Erythrina Gall Wasp, *Quadrastichus erythrinae* Kim (Hymenoptera: Eulophidae). Unpublished report.

IV. 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, 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 at a facility located at the Hawaii Department of Agriculture (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 the field-release of *Aprostocetus nitens* for research and biocontrol of *Quadrastichus erythrinae* (EGW) 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.

HDOA-PPC submitted a Draft EA prepared by HDOA and DLNR with an Anticipated Finding of No Significant Impact. The Draft EA was published in the Office of Environmental Quality Control's Environmental Notice on December 23, 2019. From this date, the Draft EA was open to a public comment period of 30 days. All comments received during the open public comment period are included within the Final Evironmental Assessment (Attachment 4).

The final EA including host specificity testing results, possible environmental impacts, cultural impacts, and the Finding of No Significant Impact (FONSI) was published in the Environmental Notice, on February 8, 2023 (FONSI transmittal letter is presented as Attachment 4).

V. <u>Advisory Subcommittee Review:</u> 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 wasp, *Aprostocetus nitens* Prinsloo & Kelly, 2009 (Hymenoptera: Eulophidae) on the List of Restricted Animals (Part A) as a biocontrol agent for the invasive *Quadrastichus erythrinae* (Hymenoptera: Eulophidae).

<u>Dr. Daniel Rubinoff:</u> Recommends Approval.

Dr. Mark Wright: Recommends Approval.

Comments: "The quarantine screening shows that this species will not pose any risks to native species in Hawaii."

Dr. Francis Howarth: Recommends Approval.

Comments: "I approve with reservations. The host specificity testing seems limited; only a few non-target species tested and most (e.g. Diptera) were inappropriate. Also, as I have commented many times, there needs to be a more specific description on post-release monitoring. What methods will be used? How much money, personnel, and effort are expressly committed to monitoring? Good grief, without appropriate monitoring, we will never know what we are doing right or wrong – and thus cannot improve methods used in biocontrol. The vague statement that monitoring will be done is highly suspect. There also needs to be an appropriate review of the results of monitoring. I recommend review by the advisory committee, and I would very much like to see the annual reports.

PQB NOTES: *HDOA's Plant Pest Control Branch has made their work plan for monitoring of A. nitens releases available. The work plan is attached as Attachment 6.*

Permit condition no. 15. 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, and shall include the following:
a. Amount of the restricted article(s) released 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 *Quadrastichus erythrinae*; and
d. Effect of the restricted article(s) on native plant and animal species"

Dr. Peter Follett: Recommends Approval.

Comments: "This biocontrol agent of erythrina gall wasp appears to be host specific and therefore will have no adverse effects on the Hawaii environment and may provide indispensable mortality against the pest. The absence of a publication on the host specificity testing is concerning as this means the research has not undergone peer-review by experts in the field. Seven gall-forming nontargets were tested with apparently no successful attack or development. Hopefully, the target host was included in all replicates of nontarget testing to demonstrate *A. nitens* competence, i.e., to show that wasps used in each test were healthy and the environmental conditions suitable for successful parasitism. Nevertheless, erythrina gall wasp is an important pest of a native tree and biocontrol is the best option for pest management."

PQB NOTES*: *Subsequently, *Dr. Follett read the environmental assessment including Figure 11, which shows erythrina gall wasp parasitism along with each non-target species. Dr. Follett further commented that the environmental assessment looked very good and that he fully supports this project.*

2. Provided *Aprostocetus nitens* is placed on the List of Restricted Animals (Part A), I recommend Approval___/___Disapproval to allow the importation and field release of *Aprostocetus nitens*, by permit, for biological control of *Quadrastichus erythrinae* by the HDOA-PPC.

Dr. Daniel Rubinoff: Recommends Approval.

Comments: "Can / Should Molokai be added as a release site?"

Dr. Mark Wright: Recommends Approval.

Comments: "The quarantine screening shows host specificity on erythrina gall wasp, and also strongly suggests that *A. nitens* will provide improved suppression of galls on inflorescences and infructescences of *Erythrina*. This should result in increased seed set and hopefully improved opportunity for recruitment of endemic *Erythrina*."

Dr. Francis Howarth: Recommends Approval.

Comments: "See above."

Dr. Peter Follett: Recommends Approval.

3. Provided *Aprostocetus nitens* is placed on the List of Restricted Animals (Part A), I recommend Approval___/___Disapproval to establish permit conditions for the importation and field release from containment of *Aprostocetus nitens* as a biocontrol agent of *Quadrastichus erythrinae* by the HDOA-PPC.

Dr. Daniel Rubinoff: Recommends Approval.

Comments: "Applicants appear to have done their homework. Non-target impacts have been evaluated and this would be a valuable addition to erythrina gall wasp control programs."

Dr. Mark Wright: Recommends Approval.

Dr. Francis Howarth: Recommends Approval.

Comments: "See above."

Dr. Peter Follett: Recommends Approval.

VI. Advisory Committee Review

This request was submitted to the Advisory Committee on Plants and Animals (Committee) at its meeting on November 17, 2023, held in person and virtually via Zoom. PQB Entomologist Christopher Kishimoto provided a synopsis of the request.

Committee member Joshua Fisher asked once the draft Environmental Assessment (EA) with an Anticipated Finding of No Significant Impact was first published in 2019, why it took 2-3 years to publish the Final EA with a FONSI. The applicant, Mr. Darcy Oishi, replied that he needed to get some additional paperwork in order and also needed to start work on the federal EA process. The two processes go hand in hand and a federal permit will not be issued until a state permit has been issued first. Mr. Oishi also said that there was a change in the federal permit application process and system he had to learn it.

Committee member Thomas Eisen asked Mr. Oishi what the timeline was before the *Aprostocetus nitens* would be released for biocontrol. Mr. Oishi said the timeline for field release of *A. nitens* was dependent on two things: (1) the completion of the public hearings that are necessary to get *A. nitens* placed on PQB's List of Restricted Animals (Part A); and (2) the issuance of the federal permit which requires a federal EA and FONSI.

Committee Chairperson Rob Hauff questioned Mr. Kishimoto about permit condition nos. 7 through 11 and possibly permit condition no. 12. Those permit conditions address imports but the *A. nitens* that will be released only needed to be carried from HDOA's quarantine facility to its insectary facility next door. Mr. Kishimoto told Mr. Hauff he was correct. However, PQB decided to include imports of *A. nitens* into the permit conditions in the event more insects needed to be imported.

Committee Chairperson Hauff asked if the Committee had any more questions for Mr. Kishimoto or Mr. Oishi. Hearing none, he asked if there was any testimony from the public.

Hearing no public testimony requests, Chairperson Hauff asked for a motion to recommend approval. Committee member Sam Gon moved to recommend approval as presented. Committee member Gracelda Simmons seconded the motion.

Chairperson Hauff asked if there was any further discussion. Hearing none, he asked each Committee member for their recommendation.

Vote: Approved 6/0 (Hauff, Simmons, Eisen, Mizuno, Gon, and Fisher)

VII. Proposed Permit Conditions

1. The restricted article(s), *Aprostocetus nitens*, 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 Hawai'i, except as approved by the Board or upon determination of establishment in the field by the Hawaii Department of Agriculture (HDOA) Plant Pest Control Branch (PPC).

2. The permittee, HDOA PPC, 1428 South King St., Honolulu, HI 96814, shall be responsible and accountable for all restricted article(s) until their final disposition.

3. The restricted article(s) shall be safeguarded and maintained at the U.S. Department of Agriculture (USDA) approved Insect Containment Facility located at the HDOA-PPC, 1428 South King Street, Honolulu, Hawaii 96814 or the Hawaii Volcanoes National Park Containment Facility, Kilauea Research Station, Building 34, Volcano, HI 96718 , by trained or certified personnel designated by the permittee.

4. Upon request by the Plant Quarantine Branch (PQB), the permittee shall submit samples of the restricted article(s) prior to field release 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 Containment Facility, Kilauea Research Station, Building 34, Volcano, HI 96718 or the HDOA-PPC Containment Facility, 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 oviposition 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 importing any parcel containing the restricted article(s), the permittee shall notify the PQB Chief in writing and provide the following information:

   a. Expected arrival date;

   b. Waybill, bill of lading, and/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 Port of entry into the State (Honolulu, per number 11, below).

8. At least four sides of all parcels containing the restricted article(s) 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 document pertaining to the restricted article(s) and progeny under this permit, may be subject to post-entry inspections by the 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. 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).

14. The permittee 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 PQB Chief may be canceled upon revocation, suspension, or termination of any of the aforementioned documents.

15. 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, and shall include the following:

    a. Amount of the restricted article(s) released 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 *Quadrastichus erythrinae*; and

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

16. 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.

17. 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.

18. 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) being 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.

19. 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.

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

21. 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 or paid by the permittee.

22. 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 action disallowing a previously permitted use of the restricted article(s).

23. 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 Board approved permit conditions for the restricted article(s), as necessary to address scientifically validated risks associated with the restricted article(s).

STAFF RECOMMENDATION: Based on the favorable recommendations and comments of the Advisory Subcommittee on Entomology and the Advisory Committee's (6-0) recommendation to approve this request, the Plant Quarantine Branch recommends approval of this request, with the proposed permit conditions.

Respectfully Submitted,

JONATHAN K. HO
Acting Manager, Plant Quarantine Branch

CONCURRED:

CAROL OKADA
Acting Administrator, Plant Industry Division

APPROVED FOR SUBMISSION:

SHARON HURD
Chairperson, Board of Agriculture

ATTACHMENT 1

PQ-7 (01/04)

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: *January 13, 2023*

In accordance with the provision of Chapter 4-71 , 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
1000	parasitoid wasp of erythrina gall wasp	A prostocetus nitens (H ymenopteraE ulophidae)

Name and address of shipper: H awaiiD epartment of A griculture, P lantP estC ontrBlranch, 14 82S .King S t., H onoluluH I, 96814

O rigin: K enya, T anzani and S outh A fr ica

(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 fi eldrelease of b iocontragent fr omb iocontrinsect containment fa cility

Please type or print clearly.

Applicant's Name Darcy Oishi

Company Name H awaiiDepartment of A griculture, P PC
(If applicable)

Hawaii Mailing Address 1428 S. King S . t
H onoluluHI 96814

Telephone number 808-973-9530

Facsimile number 808-973-9533

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).

Aprostocetus nitens, collected in Kenya, South Africa, and Tanzania, was evaluated as another bio-control agent for managing erythrina gall wasp (EGW) infestations on Erythrina trees in Hawaii. Results of evaluations revealed it is host specific to EGW. Although the first biocontrol agent (Eurytoma erythrinae) released in Hawaii prevented the native wiliwili (Erythrina sandwicensis) from total extinction, damage to flowers, and seedlings persist. A. nitens is expected to compliment E. erythrinae in keeping EGW under control and reducing damage to Erythrina spp.

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

Darcy Oishi
Hawaii Department of Agriculture
Plant Pest Control Branch
1428 S. King St.
Honolulu, HI 96814
808-973-9530

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

Hawaii Department of Agriculture
Plant Pest Control Branch
Insect Rearing Facility
1428 S. King St.
Honolulu, HI 96814
808-973-9530

4. Method of disposition.

The Aprostocetus nitens colony will be removed from the HDOA Insect Containment (Quarantine) Facility to the Insect Rearing Facility (Insectary) for mass rearing. Approximately 100 to 200 adults will be removed from the HDOA Insectary to be released at each site throughout Hawaii State beginning with Oahu, Hawaii, Maui, and then Kauai Island. Releases of this parasitoid wasp will be continuous until such time that it becomes established at the intended sites.

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).

A. nitens (Hymenoptera: Eulophidae), a tiny wasp native to Africa, is proposed for biological control of EGW (Quadrastichus erythrinae, Eulophidae). Adult wasps, 1.1-1.7 mm long, lay eggs in galled plant tissues caused by EGW. Adult females are synovigenic which means they can produce eggs upon emerging, laying an average of 139 eggs through out their life span. Larvae of A. nitens feed exclusively on immatures of EGW and adult A. nitens feed on flower nectar. Each A. nitens larva can complete development on a single EGW larva or pupa. No adverse effects are anticipated on other animals or humans.

****

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** 1/13/2023
(Applicant)

USDA United States Department of Agriculture

ATTACHMENT 2

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:	Ms. Juliana A. Yalemar	**PERMIT NUMBER:**	P526P-20-03513
ORGANIZATION:	Hawaii Department of Agriculture	**APPLICATION NUMBER:**	P526-200423-007
		DATE ISSUED:	08/19/2020
ADDRESS:	1428 South King Street Honolulu, HI 96814	**EXPIRES:**	08/19/2023
		FACILITY NUMBER:	23
MAILING ADDRESS:	1428 South King Street Honolulu, HI 96814	**HAND CARRY:**	Yes
		FACILITY ACCOUNT:	Hawaii Department of Agriculture
PHONE:	808-973-9526		
ALT. PHONE:		**RESEARCH CENTER:**	
EMAIL:	juliana.a.yalemar@hawaii.gov	**FACILITY NAME:**	Insect Quarantine Facility
FAX:		**FACILITY ADDRESS:**	1428 South King Street P.O. Box 22159 Honolulu, Hawaii 96814
		FACILITY GPS:	Latitude 21.3 Longitude -157.8
		MAIL ADDRESS:	Insect Quarantine Facility, Hawaii Department of Agriculture 1428 South King Street, P.O. Box 22159 Honolulu, Hawaii 96814
		FACILITY CONTACT:	Ms. Darcy Oishi
		PHONE:	808-973-9524
		ALT. PHONE:	
		FAX:	808-973-9533
		EMAIL:	darcy.e.oishi@hawaii.gov

DESTINATION: 1428 South King Street, Hawaii Department of Agriculture, Honolulu, HI 96814
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
Unidentified Hymenoptera	Adult, Egg, Juveniles, Larvae, Pest-infected plant material, Plant Parts, Pupae	Research - Lab	Mozambique, Mauritius, Reunion, Tanzania, United Republic of, South Africa, Africa	Originally Collected from Foreign and Domestic Locations	

SPECIAL INSTRUCTIONS TO INSPECTORS

Permit Number P526P-20-03513

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.	DATE
Robert Pfannenstiel	08/19/2020

WARNING: Any alteration, forgery or unauthorized use of this Federal Form is subject to civil penalties of up to $250,000 (7 U.S.C.s 7734(b)) or punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both (18 U.S.C.s 1001)

See permit conditions below

This permit authorizes Juliana A. Yalemar, Hawaii Department of Agriculture, Honolulu, HI, State and Dr. Mohsen Ramadan also of the Hawaii Department of Agriculture, Honolulu, HI, to hand-carry or move the organisms via passenger baggage into the United States in accordance with the hand-carry conditions below.

DHS CBP INSPECTORS - HAND CARRY INSTRUCTIONS

1) For all hand carry events, the port of entry must have received hand carry requests at least 20 days in advance of the arrival of passenger(s), including the date and time of arrival and method of transport (maritime, land border, air) directly from CBP-OFO-APTL, originally provided by USDA-APHIS. The port of entry for hand carry does not need to appear as a designated port on the permit; this official notice containing the information listed above authorizes the port listed on the notice as a destination port for this hand carry event.
2) For all hand carry events, a valid PPQ permit number or the PPQ permit must be provided in order to identify the designated hand carrier.
3) If the two conditions above are met and the CBP Agriculture Specialist confirms that all hand carried materials/organisms are securely packaged as per the permit conditions, the permitted regulated material/organisms may be released for immediate transport by the designated hand carrier to the destination address listed on the permit.
4) If the permitted regulated materials/organisms arrive by hand carrying, in personal luggage, or by personal automobile without a hand carry authorization as specified in the permit, CBP may seize and destroy the package or send it to the nearest PPQ Plant Inspection Station for further processing. The permit holder is responsible for all costs incidental to such actions. If forwarding the shipment is not possible, contact the Pest Permit Staff at the number below.

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.

Permit Number P526P-20-03513

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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 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

This permit authorizes the importation of any life stages of various species of (unidentified) Hymenoptera, parasitoids of the Erythrina gall wasps from the listed African countries, to the permit holder Juliana Yalemar, Hawaii Department of Agriculture, at 1428 South King Street, Honolulu, HI 96814, to be received into the USDA APHIS inspected containment facility at that address.

The imported material may contain dead and dying (apparently parasitized) stages of target species, the erythrina gall wasp, Quadrastichus erythrinae , and non-propagative host plant parts of Erythrina

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spp. (Fabaceae).

This permit further authorizes, subject to approval by Customs and Border Protection Inspectors, the "hand carry" transport of permitted articles by the permit holder, Juliana A. Yalemar, Hawaii Department of Agriculture, Honolulu, HI, State and Dr. Mohsen Ramadan also of the Hawaii Department of Agriculture, Honolulu, HI.

This permit authorizes the possession and rearing of any species imported under this permit for research in the USDA APHIS inspected containment facility (Facility #23) at Hawaii Department of Agriculture, at 1428 South King Street, Honolulu, HI 96814, subject to the additional 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.

   • 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,

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- 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.

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.

Permit Number P526P-20-03513

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WARNING: Any alteration, forgery or unauthorized use of this Federal Form is subject to civil penalties of up to $250,000 (7 U.S.C.s 7734(b)) or punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both (18 U.S.C.s 1001)

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. HAND CARRY PART 1 OF 2

The following conditions apply to all authorized hand carry events. Note that no PPQ-issued labels are required for hand carry events.

a) At least 20 days prior to each hand carry event, the permit holder or designee must notify the PPQ Permit Compliance Officer by email. In the subject line of the email, write "Notification of Hand Carry - Permit # xxxx":

For pests/pathogens, federal noxious weeds/parasitic plants, and host plant materials, please use: PPQRegulatedOrganismsHandCarryRequest@usda.gov

The email must contain the following information:

- hand carrier's name and permit number
- anticipated first port of entry into the United States
- date and time of arrival and method of transport (maritime, land border, air)
- description of the regulated material/organism and packaging used for transport
- travel plans from the first port of arrival to the final destination

The PPQ Permit Compliance Officer will notify the Customs and Border Protection (CBP) Agricultural Specialist at the port of entry to document and facilitate the entry of the regulated material/organism.

If you have domestic (connecting) air travel plans, please contact the Transportation Security Administration (TSA) prior to arrival into the U.S.: TSA Contact Center Telephone:

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.	DATE
Robert Pfannenstiel	08/19/2020

1-866-289-9673; Email: TSA-ContactCenter@tsa.dhs.gov. Passengers can request special assistance with the screening process via the TSA Contact Center. Although special handling may be requested when traveling with fragile or sensitive items, TSA must conduct sufficient screening to ensure all property does not present a security threat. For more information visit www. TSA.gov.

Only the person(s) whose name(s) is/are listed on the issued permit is/are authorized to hand-carry.
b) The hand carrier must ensure the following:

- All materials/organisms must be packaged as described in the permit conditions.
- Packaging material must be free of insects, noxious weeds, and other plants pests and must be treated as described in the permit conditions before discarded or reused.
- Hand-carried regulated materials/organisms must fit in the plane's overhead bin or under the seat. Hand-carried materials/organisms are not to be checked as baggage/luggage, and must remain on or in close proximity to one's person.

6. HAND CARRY PART 2 OF 2

c) The hand carrier must declare the regulated material/organism at the port of entry. The hand carrier must present acceptable personal identification documents to CBP upon request. The hand carrier must also present a copy and/or permit number of the valid PPQ Permit that authorizes the hand carry.

d) In the event that a problem is detected, CBP may seize and destroy the package or send it to the nearest PPQ Plant Inspection Station for further processing. The permit holder is responsible for all costs incidental to such actions.

e) The authorization to hand carry is only for the regulated material/organism identified in the permit. The presence of unauthorized regulated materials/organisms is a permit violation.

f) After CBP confirmation and clearance through the first port of entry into the U.S., the hand carrier will not open or modify the package (including removal of anything applied to the package by CBP or another Federal Agency) until it arrives at the authorized facility. The hand carried regulated material/organism must be transported directly to the containment facility authorized in the permit. In the event that circumstances beyond the carrier's control cause a significant deviation in transport, the carrier must contact the PPQ Permit Compliance Officer at 866-524-5421 (pests/pathogens, federal noxious weeds/parasitic plants, soil, and host plant

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materials) or 877-770-5990 (for restricted or prohibited plant material).

g) Within 24 hours of the first business day of the regulated material/organisms' arrival at the facility, an independent third party (e.g. containment facility director, departmental chair, campus biosafety officer, etc.) must notify the PPQ Permit Compliance Officer via email that the shipment remained sealed until arrival. The notification must include what regulated material/organism was imported, its origin, permit number, date of arrival, and quantity. In the subject line of the email, please write: "Notification of Hand Carry Arrival - Permit # xxxx". See Hand Carry Part 1(a) above for the list of e-mail addresses to use for the notification.

Failure to notify the PPQ Permit Compliance Officer may result in loss of hand carry privileges. A PPQ inspector may visit the facility to confirm the arrival of the package and its contents.

7. 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.
8. 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.

9. This permit authorizes the importation and possession of live organisms of only the regulated articles or taxonomic groups listed above, from the regions or countries listed, 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 a previous permit, of which this is a "renewal". All other such live regulated organisms must be kept under separate USDA APHIS permit, or devitalized.
10. 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 23). Any distribution or other removal of live organisms regulated under this permit from the designated area of Containment Facility Hawaii Dept of Agriculture requires a separate prior authorization from APHIS PPQ.

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.	DATE
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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.

11. All operations must be consistent with information submitted in association with this Containment Facility (CF23) 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.

12. 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

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.	DATE
Robert Pfannenstiel	08/19/2020

No permit can be issued to move live plant pests or noxious weeds until an application is received (7 CFR 330 (live plant pests) or 7 CFR 360 (noxious weeds)).

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE
PERMITS AND RISK ASSESSMENT, UNIT 133
RIVERDALE, MARYLAND 20737

APPLICATION FOR PERMIT TO MOVE LIVE PLANT PESTS OR NOXIOUS WEEDS

SECTION A - TO BE COMPLETED BY THE APPLICANT

1. NAME, TITLE, AND ADDRESS (Include Zip Code)

Dr. Russell Messing
University of Hawaii
7370 Kuamoo Road
Kapaa, HI 96746

2. TELEPHONE NO. ( ) [illegible]

3. TYPE OF PEST TO BE MOVED

☐ Pathogens ☒ Arthropods ☐ Noxious Weeds
☐ Other (Specify) non-pests

This permit does not authorize the introduction, importation, interstate movement, or release into the environment of any genetically engineered organisms or products.

A. SCIENTIFIC NAMES OF PESTS TO BE MOVED	B. CLASSIFICATION (Orders, Families, Races, or Strains)	C. LIFE STAGES, IF APPLICABLE	D. NO. OF SPECIMENS OR UNITS	E. SHIPPED FROM (Country or State)	F. ARE PESTS ESTABLISHED IN U.S.?	G. MAJOR HOST(S) OF THE PEST
4. Hymenopterous	Chalcidoidea	all	hundreds	Africa,	no	Erythrina gall wasps
5. parasitoids				Asia		Quadrastichus erythrinae
6.						

7. WHAT HOST MATERIAL OR SUBSTITUTES WILL ACCOMPANY WHICH PESTS (Indicate by line number)
galled leaves & stems of Erythrina

8. DESTINATION	9. PORT OF ARRIVAL	10. APPROXIMATE DATE OF ARRIVAL OR INTERSTATE MOVEMENT
Honolulu	Honolulu	Sept. 2005

11. NO. OF SHIPMENTS	12. SUPPLIER	13. METHOD OF SHIPMENT
multiple	coopeators in Africa & Asia	☒ Air Mail ☒ Air Freight ☒ Baggage ☐ Auto

14. INTENDED USE (Be specific, attach outline of intended research)
Host range testing for biological control of Quadrastichus erythrinae in quarantine.

15. METHODS TO BE USED TO PREVENT PLANT PEST ESCAPE	16. METHOD OF FINAL DISPOSITION
APHIS-approved quarantine prodecures	unwanted material will be autoclaved

17. Applicant must be a resident of the U.S.A. I/We agree to comply with the safeguards printed on the reverse of this form, and understand that a permit may be subject to other conditions specified in Section B and C.

SIGNATURE OF APPLICANT (Must be person named in Item 1)

18. DATE 8/12/05

WARNING: Any alteration, forgery, or unauthorized use of this document is subject to civil penalties of up to $250,000 (7 U.S.C. s7734(b)) or punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both (18 U.S.C. s1001).

SECTION B - TO BE COMPLETED BY STATE OFFICIAL

19. RECOMMENDATION
☐ Concur (Approve) ☐ Comments (Disapprove)
☐ (Accept USDA Decision)

20. CONDITIONS RECOMMENDED
STATE CONCURRENCE ON FILE

21. SIGNATURE	22. TITLE	23. STATE	24. DATE

SECTION C - TO BE COMPLETED BY FEDERAL OFFICIAL

25. PERMIT NO. 73874

PERMIT

(Permit not valid unless signed by an authorized official of the Animal and Plant Health Inspection Service)

Under authority of the Plant Protection Act of 2000, permission is hereby granted to the applicant named above to move the pests described, except as deleted, subject to the conditions stated on, or attached to this application. (See standard conditions on reverse side.)

* For exotic plant pathogens, attach a completed PPQ Form 526-1.

SUBJECT TO ATTACHED CONDITIONS

HI 58+pl HI Items

24. SIGNATURE OF PLANT PROTECTION AND QUARANTINE OFFICIAL	25. DATE	26. LABELS ISSUED	27. VALID UNTIL	28. PEST CATEGORY
	SEP 30 2005	10004599	SEP 29 2008	K5 - 1

PPQ FORM 526 (OCT 2001) Previous editions are obsolete.

United States
Department of
Agriculture

Animal and
Plant Health
Inspection Service

4700 River Road
Riverdale, MD 20737

PPQ FORM 526 - ATTACHMENT

(Permit not valid unless signed by an authorizing official of the Animal and Plant Health Inspection Service)

Under authority of the Federal Plant Pest Act of May 23, 1957 or the Federal Noxious Weed Act of 1974, permission is hereby granted to the applicant named to move the described pests , subject to the following:

PERMITTEE NAME: Russell Messing	PERMIT NUMBER: 73874

APPROVED SPECIES

Scientific Name	Origin
Hymenoptera	Africa
Hymenoptera	Asia

TO BE COMPLETED BY FEDERAL OFFICIAL

SIGNATURE OF PLANT PROTECTION AND QUARANTINE OFFICIAL	DATE
	SEP 30 2005

APHIS - Protecting American Agriculture

United States
Department of
Agriculture

Animal and
Plant Health
Inspection Service

4700 River Road
Riverdale, MD 20737

PPQ FORM 526 - SECTION C

(Permit not valid unless signed by an authorizing official of the Animal and Plant Health Inspection Service)

Under authority of the Federal Plant Pest Act of May 23, 1957 or the Federal Noxious Weed Act of 1974, permission is hereby granted to the applicant named to move the described pests , subject to the following:

PERMITTEE NAME: Russell Messing

PERMIT NUMBER : 73874

PERMIT CONDITIONS

AUTHORIZATIONS, LIMITATIONS, EXCLUSIONS AND DISCLAIMERS

_____ 1. Rules promulgated under the authority of the Plant Protection Act (PPA) of 2000 by the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) Unit regulate plant pests and certain other viable organisms (N.B., the PPA subsumes the statutes cited above). Importation into the United States of America of viable organisms (all life stages) in the taxon(a) listed on the PPQ Form 526 - Attachment to this permit (henceforth referred to as "approved species" or "approved organisms") is authorized.

_____ 2. This authorization is limited to approved organisms derived from naturally occurring populations or colonies/cultures derived from natural populations located in the geographic region(s) identified on the PPQ Form 526 - Attachment to this permit. Importation of strains of approved species that have been genetically modified by recombinant DNA technology (i.e., genetically modified organisms; GMOs) is not authorized.

_____ 3. In conjunction with shipments of approved organisms, host plant material of approved species limited to non-propagative plant parts, is authorized.

_____ 4. Colonization and rearing of approved species are authorized

_____ 5. Field research and/or release of approved species into the natural environment are not authorized.

_____ 6. Distribution of the approved species to third parties (i.e., interstate transfer from the address of this permit holder) is not authorized without prior approval from State and Federal regulatory officials unless the recipient has a valid APHIS PPQ 526 permit.

CONDITIONS:

_____ 1. Shipments of living organisms must be packaged at the point of origin in sealed (no openings), secure, escape-proof containers, and remain sealed at all times while in transit.

_____ 2. Upon arrival at the first port of entry in the United States, all shipments must be declared for inspection in accordance with US Customs and Border Protection (CBP) regulations.

_____ 3. Following CBP clearance, shipments surrendered from the custody of a bonded courier or an individual who is not an employee of the US government with a security clearance must be accompanied by an APHIS PPQ red/white (From 599) label that directs it via a bonded courier to the main APHIS PPQ inspection station (Building 580) in Beltsville, Maryland, or another PPQ-operated or approved plant health inspection station. Each shipment must also carry supplementary address information for forwarding directly, via a commercially bonded courier, to the individual named on this permit (i.e., the permit holder) at the address shown on this permit (in item 1 of PPQ Form 526) following agricultural clearance (N.B., USDA does not defray any additional shipping costs incurred for transiting the shipment through an approved APHIS PPQ inspection station).

_____ 4. Following CBP clearance, agricultural clearance is waived for shipments entering in the custody of an US government employee who holds a valid US government security clearance. From the port of entry, such shipments must be transited by the entering US government official directly to the individual named on this permit (i.e., the permit holder) at the address shown on this permit (in item 1 of PPQ Form 526).

SEP 30 2005

United States Department of Agriculture

Animal and Plant Health Inspection Service

4700 River Road
Riverdale, MD 20737

PPQ FORM 526 - SECTION C

(Permit not valid unless signed by an authorizing official of the Animal and Plant Health Inspection Service)

Under authority of the Federal Plant Pest Act of May 23, 1957 or the Federal Noxious Weed Act of 1974, permission is hereby granted to the applicant named to move the described pests , subject to the following:

PERMITTEE NAME: Russell Messing	PERMIT NUMBER: 73874

PERMIT CONDITIONS (continued)

_____ 5. Use the individually numbered shipping label(s), PPQ Form 599, provided to enable foreign shipments to enter the U.S. under this permit. A label with complete information must be attached to the exterior of the package being imported under this permit, or to a separate document page that is included with the manifest, invoice, bill of lading or other documentation identifying each species in the shipment. The permit holder is responsible and accountable for each import shipping label provided with this permit, and must return any unused labels after this permit expires. The permit holder is responsible for providing complete and accurate information on each label used to accompany an import shipment. Record the following information for each label: label number; date mailed to supplier; supplier's name, address, and telephone number; date package received by permit holder; species of organisms. Provide this information to APHIS PPQ In the form of tracking sheets or copies of shipping manifests (with required additional information) by mail, fax or email at least annually on the anniversary of the date of issue of this permit. This permit may be revoked if required annual reporting is not completed within the 30-day period following each anniversary of the date of issue of this permit. A report on the disposition of all labels used since the last reporting date must accompany a request for additional labels. Upon expiration of this permit, return all unused labels to APHIS, and account for any labels used since the last reporting date. Failure to return unused labels or to provide a final report within 30 days of the expiration of this permit renders the permit holder liable for civil and/or criminal penalties, and may result in the denial of future permit applications.

_____ 6. The permit holder is responsible for ensuring that shipments are free of unauthorized pathogens, noxious weeds, other living organisms or plant products identified for detection, interception and seizure as AQI (agriculture quarantine inspection) actionable pests or products.

_____ 7. Without advance notification, during normal business hours, Plant Protection and Quarantine Officers may inspect any part of the premises where species approved under this permit are contained.

_____ 8. Prior to disposal in the municipal waste stream, all shipping/transport packages, wrapping and containers for import shipments must be completely destroyed (e.g., by incineration) or sterilized (i.e., by autoclaving) immediately after species approved under this permit have been extracted from shipments.

_____ 9. Approved organisms must be destroyed (e.g., by autoclave, incineration) and discarded, or stored as preserved, killed specimens prior to the expiration of this permit, or when no longer required for research studies, whichever comes first. APHIS does not routinely issue extensions or renewals of existing permits; the permit holder must submit a new permit application at least three months prior to the expiration of this permit if: (a) uninterrupted authorization to possess approved species is desired; (b) authorization for environmental release of species approved under this permit is sought (N.B., a separate permit is always required to authorize release of any species from quarantine containment and/or into the natural environment).

_____10. The permit holder is responsible at all times for the disposition of organisms during the valid term of this permit, and must maintain an official permanent work assignment at the site identified on this permit where approved species are present. If the permit holder's work assignment and/or official affiliation with the institution/organization/entity located at the address identified on this permit, is terminated, moved to a remote location, or is otherwise modified, so as to render direct supervision impracticable, live organisms of the species approved under this permit must be destroyed unless another individual located at the address identified on this permit obtains a valid PPQ 526 permit prior to a change in status of the permit holder named on this permit.

_____11. The permit holder named on this permit indemnifies USDA APHIS against additional costs or losses resulting from (a) routing shipments of species approved under this permit though its plant inspection station; (b) damage/Injury to living organisms approved for entry under this permit that may occur in conjunction with the imposition of its usual and customary inspection practices.

_____12. A valid APHIS PPQ 526 permit does not fulfill or modify the compliance requirements of any other Federal (e.g., Environmental Protection Agency; U.S. Fish and Wildlife Service; Food and Drug Administration; Centers for Disease Control and Prevention) or state regulatory authority. The permit holder is solely responsible for ensuring compliance with other Federal or state statutory requirements.

_____13. Failure to comply with the terms and conditions of this permit may be cause for: (a) revoking this permit; (b) revoking other valid permits issued to the individual named as the holder of this permit; (c) denial of future permit applications made by the holder of this permit; (d) making the holder of this permit liable for civil penalties; (e) subjecting the holder of this permit to criminal prosecution as provided In the PPA.

SEP 30 2005

United States
Department of
Agriculture

Animal and
Plant Health
Inspection Service

4700 River Road
Riverdale, MD 20737

PPQ FORM 526 - SECTION C

(Permit not valid unless signed by an authorizing official of the Animal and Plant Health Inspection Service)

Under authority of the Federal Plant Pest Act of May 23, 1957 or the Federal Noxious Weed Act of 1974, permission is hereby granted to the applicant named to move the described pests , subject to the following:

PERMITTEE NAME: Russell Messing	PERMIT NUMBER: 73874

PERMIT CONDITIONS (continued)

INSTRUCTIONS FOR CBP:

1. At the initial US port of entry, the shipment courier must provide: (a) a declaration of the shipment contents; (b) a copy of the validated permit (PPQ 526) with approved species list and associated conditions; (c) a valid red/white USDA shipping label (PPQ Form 599).

2. Following CBP clearance, agricultural inspection can be waived ONLY if the courier of the shipment presents documentation confirming identity as a traveler on official U.S. government business [including valid travel authorization and an official US government (brown) or U.S. Diplomatic (black) passport].

3. From the point of CBP clearance, if the courier does not conform to the specifications listed in paragraph 2 above, the shipment must be transported by a bonded courier under a red and white PPQ Form 599 label directing it to the address of the APHIS-approved inspection facility shown on the label.

4. For questions or concerns, contact the USDA APHIS PPQ Permit Unit in Riverdale, MD (301-734-8646).

INSTRUCTIONS FOR USDA APHIS PPQ INSPECTORS:

1. Agricultural inspection and clearance is required for shipments transported by a bonded courier. The courier must present a copy of the permit (PPQ Form 526), permit conditions, and an original shipping label (PPQ Form 599).

2. Confirm that the permit has not expired.

3. Confirm that the permit number on Form 599 is the same as on Form 526.

4. Confirm that the Form 599 is an original with a unique shipment number following the permit number.

5. Confirm that all containers are adequately packaged to prevent the escape/leakage of the enclosed organisms.

6. DO NOT CLEAR THE SHIPMENT if there is evidence of non-compliance with (a) any items listed in the sections entitled "AUTHORIZATIONS, LIMITATION, EXCLUSIONS, AND DISCLAIMERS;" (b) regulations provided in 7 CFR 330. If not in compliance, contact (301-734-8646) the Pest Permit Evaluations Branch at headquarters to determine subsequent action.

7. If full compliance with permit conditions and USDA APHIS regulations is validated, clear shipment for subsequent delivery to the individual and address shown on this permit (PPQ Form 526, Item 1). Fax the shipping label number (permit number,followed by unique shipment number) to the Pest Permit Evaluations Branch at 301-734-5392.

<End of Conditions>

TO BE COMPLETED BY FEDERAL OFFICIAL

SIGNATURE OF PLANT PROTECTION AND QUARANTINE OFFICIAL	DATE
	SEP 30 2005

ATTACHMENT 3

Zootaxa 2083: 27–45 (2009)
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Article

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ISSN 1175-5334 (online edition)

The tetrastichine wasps (Hymenoptera: Chalcidoidea: Eulophidae) associated with galls on *Erythrina* species (Fabaceae) in South Africa, with the description of five new species

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Abstract

Five new tetrastichine eulophid species are described from both sexes from South Africa: *Quadrastichus ingens, Q. gallicola* and *Q. bardus* induce leaf, petiole and shoot galls on indigenous *Erythrina* species (Fabaceae); *Aprostocetus nitens* and *A. tritus* are parasitoids of the *Quadrastichus* species; *Q. bardus* and *A. nitens* are also recorded from Tanzania and comments are provided on *A. exertus* La Salle, known from Tanzania and South Africa as a parasitoid of *Q. erythrinae* Kim and *Q. ingens*. A key is provided for the separation of the six eulophid species now known from South Africa.

Key words: Hymenoptera, Eulophidae, *Quadrastichus, Aprostocetus*, description, galls, *Erythrina,* Fabaceae

Introduction

There has been considerable interest in the chalcidoids that are associated with galls on *Erythrina* species (Fabaceae), commonly known as coral trees, following the recent discovery of *Quadrastichus erythrinae* Kim (Eulophidae: Tetrastichinae), an aggressive invasive gall inducer of these trees (e.g. Kim *et al.* 2004, Yang *et al.* 2004, Uechi *et al.* 2007, La Salle *et al.* 2009). *Quadrastichus erythrinae,* which in all probability is native to East Africa from where specimens are at hand (in Australian National Insect Collection), was first recorded from Mauritius and Singapore in 2002 and has since spread rapidly through certain parts of Asia and the Pacific, including the Hawaiian islands, and, most recently, to Florida on the North American continent (Gates & Delvare 2008). *Quadrastichus erythrinae* induces galls on the leaves, petioles and twigs of several species of coral tree, resulting in devastating tree losses wherever it is found (Gates & Delvare 2008).

A recent search for natural enemies of *Q. erythrinae* by various research groups has resulted in the discovery of at least 12 chalcidoid species, mostly eulophids, that are associated with *Erythrina* galls in West and East Africa (see "The eulophid fauna associated with *Erythrina* galls in Africa" below) in addition to five undescribed Southern African species, the existence of which has been known for many years. Although little is presently known about the relationships and interactions of most of these wasps, some will undoubtedly be shown to be of potential importance as biocontrol agents in their role as primary parasitoids of the gall inducing species.

In this paper we treat the South African fauna, which comprises the following five new tetrastichine species, namely *Quadrastichus ingens, Q. gallicola, Q. bardus, Aprostocetus nitens* and *A. tritus* in addition to *A. exertus* La Salle, which is being described in a companion paper by La Salle *et al.* (2009). These species are described from extensive material which has been reared in association with all six of the indigenous species of *Erythrina* found in South Africa and that has accumulated in the South African National Collection of Insects over many years. Based on this extensive material we are of the opinion that, in all probability, the six

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species treated here are representative of the entire eulophid complex that is associated with *Erythrina* galls in South Africa. Apart from this complex, *Eurytoma erythrinae*, which was recently described from various parts of Africa by Gates & Delvare (2008), is the only other wasp known from South Africa to be associated with *Erythrina* galls. It is thought to be a parasitoid of one or more of the eulophid gall inducers.

Unless stated otherwise the specimens on which this study is based are housed in the South African National Collection of Insects (SANC), Plant Protection Research Institute, Pretoria. The following acronyms are used in the text: ANIC (Australian National Insect Collection, Canberra, Australia), BMNH (The Natural History Museum, London, UK), CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France), MNHN (Muséum National d'Histoire Naturelle, Paris, France).

The eulophid fauna associated with *Erythrina* galls in Africa

Based on the South African material recorded in this study, and unrecorded voucher specimens and information from West and East Africa kindly provided by J. La Salle (ANIC) and G. Delvare (CIRAD), the following eulophids are now known to be associated with *Erythrina* galls in Africa:

Aprostocetus exertus La Salle: South Africa, Tanzania.
Aprostocetus nitens **sp. n.**: South Africa, Tanzania.
Aprostocetus tritus **sp. n.**: South Africa.
Aprostocetus spp.: at least one, possibly two undetermined species from Kenya.
Closterocerus spp: two undetermined species from Benin.
Quadrastichus bardus **sp. n.**: South Africa, Tanzania.
Quadrastichus erythrinae Kim: Tanzania, Kenya and widespread beyond its native range (see introduction).
Quadrastichus ingens **sp. n.**: South Africa.
Quadrastichus gallicola **sp. n.**: South Africa.
Quadrastichus spp: at least five undetermined species, one of which is from Benin, one from Benin and Togo, two from Kenya, one from Tanzania.

Identification of the South African species of *Aprostocetus* Girault and *Quadrastichus* Westwood

As in many other regions of the world, the Afrotropical Eulophidae are dominated by members of the Tetrastichinae. This subfamily is still very poorly known from the region with a great many new taxa awaiting description and discovery. The described component of the fauna, which comprises about 160 species in 18 genera, is equally poorly known. Many of these species, known only from their original descriptions, are in need of re-assessment. This would elucidate their specific identity and correct generic placement in accordance with present generic concepts, as first proposed by Graham (1987) and subsequently followed by workers such as Bouček (1988), Graham (1991) and La Salle (1994). For example, further study will in all probability show that many of the 74 Afrotropical species presently assigned to *Tetrastichus* would need to be transferred to *Aprostocetus*, an extremely large and diverse genus, which already contains 37 described Afrotropical species. Other species are likely to be better placed in *Quadrastichus,* to which not a single African species has been assigned prior to this study.

Although the relationships of the three South African species of *Quadrastichus* and three species of *Aprostocetus* remain largely unstudied because of the poor state of our knowledge of the Afrotropical Tetrastichinae, all these species are, as far as could be ascertained, undescribed. This is based on comparisons with either the literature or authentically identified specimens of most of the described Afrotropical tetrastichines, in addition to an assessment of published host data, which are available for about two-thirds of these species. In this regard, of the 19 described Afrotropical tetrastichine species known to be associated with

plant galls, none have been reared from plants belonging to the Fabaceae, the family to which the genus *Erythrina* belongs.

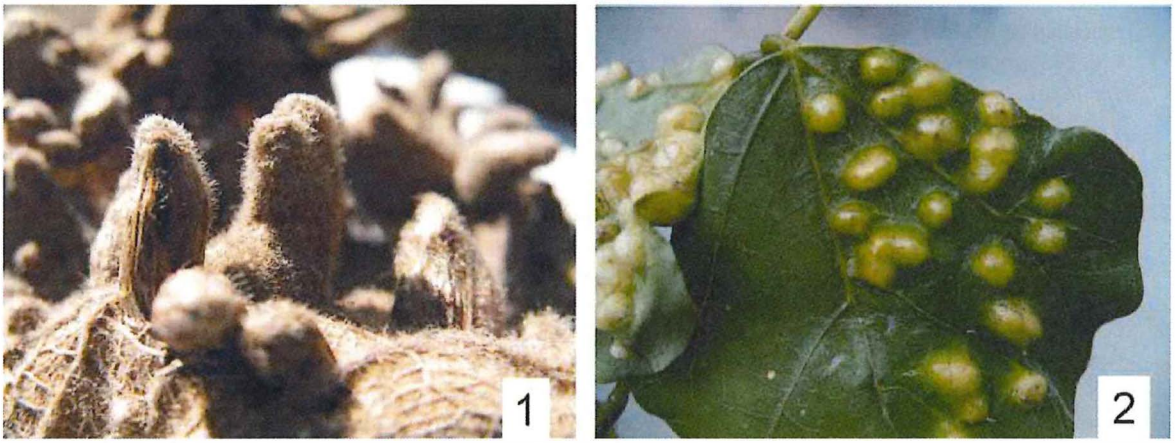
The South African species of *Aprostocetus* and *Quadrastichus* treated here have been compared with voucher material of all the *Erythrina* gall associated tetrastichines from elsewhere in Africa (listed above) and found to be distinct. These extra-limital species are, in all probability, undescribed as in the case of the South African species and have been shown to be distinct from the many tetrastichine species described by Risbec from Madagascar and tropical Africa (Delvare, pers.comm.). Comments on the characters that separate the South African *Erythrina* gall associated tetrastichines from those known from elsewhere in Africa are provided in the species descriptions below.

We have not been fully confident in our placement of some of the five new species in either *Aprostocetus* or *Quadrastichus* because, based on the detailed assessments by Graham (1987, 1991) and La Salle (1994) of the character states that separate these two genera, some of the new species could probably have been placed equally well to either of them. A reappraisal of these two genera that incorporates the African fauna is beyond the scope of this study but is evidently a prerequisite for future studies aimed at a major revision of the Afrotropical tetrastichine fauna. The five new species of *Quadrastichus* and *Aprostocetus* treated here can be separated from one another and from *A. exertus* by the characters given in the key.

Biology of the South African species

Apart from a study by Van Staden *et al.* (1977) of the life cycle and gall formation by *Q. ingens*, little is known about the biology of the species treated here other than some information gleaned from the rearing of specimens from galls of various indigenous species of *Erythrina*. The available information for each of the six species can be summarized as follows:

Quadrastichus ingens. This species appears to be exclusively associated with *E. latissima* galls since it has never been found in association with any other species of *Erythrina* from which wasps have been reared. *Quadrastichus ingens*, erroneously referred to "*Eurytoma* sp." by Van Staden *et al.* (1977) has been shown by these authors to induce leaf galls (Fig. 1) in *E. latissima*.



FIGURES 1–2. 1, leaf galls on *Erythrina latissima*; 2, leaf galls on *Erythrina lysistemon*.

Quadrastichus gallicola. This is the most abundant and widespread species in the *Erythrina* gall wasp complex in South Africa and is assumed to be the leaf gall inducer in the following species of *Erythrina* on which it is commonly found in great abundance: *E. lysistemon* (Fig. 2), *E. caffra* and *E. zeyheri*.

Quadrastichus bardus. This wasp, which emerges from the swollen twigs, petioles and leaflet veins of *E. humeana* and *E. zeyheri* is in all probability the gall inducer in these plants. It is also known from Tanzania, where it has been reared from galls on *E. abyssinica*.

Aprostocetus tritus and *A. nitens*. These two species are, in all probability parasitoids of the latter two species of *Quadrastichus*, each having been reared in association with both *Q. gallicola* and *Q. bardus*. Evidence of their parasitic role is supported by the fact that laboratory studies have shown that Tanzanian stock of *A. nitens* are primary parasitoids of *Q. erythrinae* Kim (La Salle *et al.* 2009).

Aprostocetus exertus. This species is known from Tanzania as a primary parasitoid of *Q. erythrinae* Kim (La Salle *et al.* 2009). It has also been reared from leaf galls on *E. latissima* in South Africa in association with *Q. ingens*, which appears to be another primary host of this parasitoid.

Key to the species of *Quadrastichus* and *Aprostocetus* associated with galls on *Erythrina* spp. in South Africa (Males and females)

1. Antennal funicle three-segmented (Figs. 7, 14, 21, 27, 32)..... Females.....2
- Funicle four-segmented (Figs. 6, 13, 20, 28, 33)..... Males.....7
2. Submarginal vein of forewing with 1 dorsal seta; mesosoma without a metallic lustre, either generally brown to black, or black with mesoscutal side lobes yellow in contrast; antenna with a single anellus (Figs.7, 14, 21); *Quadrastichus* species 3
- Submarginal vein with 2–4 dorsal setae or, if rarely with a single seta, then mesosoma black with a distinct dark green lustre; antenna with 4 anelli (Figs. 27, 32); *Aprostocetus* species.. 5
3. Large, at least 3 mm in length; ovipositor protruding strongly by at least one-third length of gaster; mesosoma black with mesoscutal side lobes yellow in contrast; associated with *Erythrina latissima* ..... *Q. ingens* **sp. n.**
- Smaller species, less than 2 mm in length; ovipositor not or only slightly protruded; colour of mesosoma different; associated with species of *Erythrina* other than *E. latissima*..... 4
4. Meso - and metasoma generally brown to blackish-brown with yellowish-brown suffusions; gaster somewhat circular in outline, hardly longer than wide; mesoscutum with 1 pair of adnotaular setae (Fig. 10) ..... *Q. gallicola* **sp. n.**
- Meso – and metasoma black save basal half or so of gaster yellow; gaster elongate, tapering to an acute apex, about 1.5 X as long as broad; mesoscutum with 2–3 pairs of adnotaular setae (Fig. 18) ..... *Q. bardus* **sp. n.**
5. Last gastral tergite (epipygium) extremely long and slender, tail-like, distinctly longer than head and remainder of body combined (Fig. 38)..... *A. exertus* La Salle
- Last gastral tergite short, triangular to conical in shape, distinctly shorter than remainder of gaster (Figs. 29, 36).... 6
6. Head and body without a metallic lustre, blackish-brown to almost black save base of gaster yellowish; mesoscutum with a row of 6–8 adnotaular setae on each side (Fig. 25); submarginal vein of forewing with 4 dorsal setae .... *A. tritus* **sp. n.**
- Head and body black with a distinct dark metallic green tinge, the base of gaster suffused with yellow; mesoscutum with 2–3 adnotaular setae on each side (Fig. 34); submarginal vein usually with 2 setae, rarely with 1 .... *A. nitens* **sp. n.**
7. Submarginal vein of fore wing with 1 dorsal seta; body without a metallic lustre; species of *Quadrastichus*..... 8
- Submarginal vein with 2--4 setae or, if rarely with 1, then mesosoma black with a distinct metallic greenish tinge; species of *Aprostocetus* 10
8. Head and body generally brown to blackish-brown with certain areas unevenly suffused with yellowish-brown; mesoscutum with 1 adnotaular seta on each side..... *Q. gallicola* **sp. n.**
- Head and body distinctly bicolorous, with certain areas black, others white; mesoscutum with more than 1 adnotaular seta on each side..... 9
9. Gaster dorsally entirely blackish; mesoscutum with a row of 3–5 adnotaular setae on each side ..... *Q. ingens* **sp. n.**
- Gaster blackish with basal half or so white in contrast; mesoscutum with a row of 2–3 adnotaular setae..... ..... *Q. bardus* **sp. n.**
10. Head and body non metallic, entirely blackish-brown save base of gaster suffused with yellowish-brown; legs with all coxae largely dusky; mesoscutum with a row of 6–8 adnotaular setae on each side; flagellar segments with whorls of long setae, as in Fig. 28. ..... *A. tritus* **sp. n.**
- Head and body black with a metallic green tinge, the basal third or so of gaster white in contrast; coxae entirely white; mesoscutum with 2–4 adnotaular setae on each side; flagellar segments without whorls of long setae (Fig. 33) 11
11. Antenna with 3 anelli..... *A. exertus* La Salle
- Antenna with 2 anelli ..... *A. nitens* **sp. n.**

Genus *Quadrastichus* Girault

Quadrastichus Girault, 1913: 232; Graham, 1991: 46; Graham & La Salle, 1991: 94; La Salle, 1994: 193.
Cecidotetrastichus Kostjukov, 1977: 189.

The genus *Quadrastichus* comprises fewer than 100 described species, the majority of which are known from the Holarctic region. Although the genus is found on all continents, including Africa, the only species hitherto recorded from the latter continent is *Q. ingens*, described below as new and previously referred to as "*Eurytoma* sp." by Van Staden *et al.* (1977).

Quadrastichus ingens sp. n.

Figs 3–9.

Eurytoma sp.: Van Staden, Davey & Noel, 1977: 283 (misidentification).

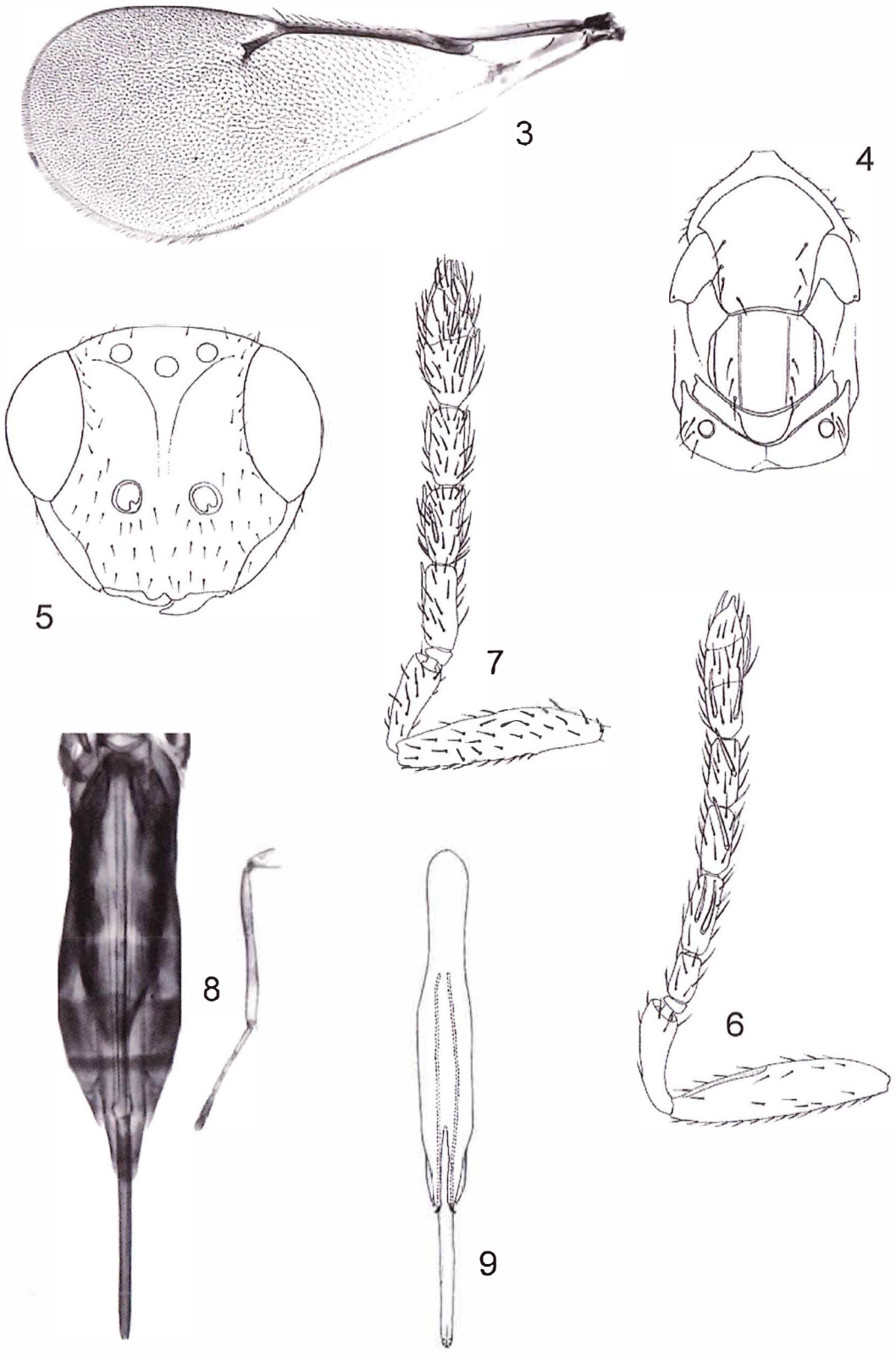
Female. Length: 3.7–4.4 mm. (including strongly protruding ovipositor). Colour: front aspect of head yellow, with brownish suffusions as follows: center of face below toruli, side of face below eyes, frontovertex from ocellar triangle to occipital margin, genae in some specimens; posterior aspect of head largely blackish above, the lower one-third or so yellowish; antenna ranging from yellowish-brown to blackish- brown, flagellum a little darker than scape in some specimens. Mesosoma black, with mesoscutal side lobes partly to entirely yellow in addition to the following areas that are also marked with yellow: hind margin of mesoscutal midlobe to a varying degree, hind margin of scutellum narrowly, prepectus and acropleuron. Metasoma black with uneven paler suffusions in some specimens, hind margin of second last tergite usually marked with yellow; protruding gonostyli blackish-brown. Forewing palely infuscated, venation brown. Legs whitish with following areas blackish- brown: all coxae basally, femora save basal and distal ends, the middle femur in some specimens almost entirely pallid, only the ventral margin narrowly darkened; distal tarsomere of all legs.

Head, in frontal view (Fig. 5), about 1.2 X as wide as high, about 1.9 X as wide as frontovertex at its narrowest; malar space 0.7 X as long as an eye, the sulcus distinctly curved, without a triangular fovea beneath the eye; POL 1.6 X OOL, 3 X OD; mandible bidentate with a truncation; head finely setose as in Fig. 5, the eyes naked; lower margins of toruli a little below lower eye margins; clypeus distinctly bilobed.

Antenna (Fig. 7) with scape 4.1–4.3 X as long as wide, a little shorter than the length of an eye, almost reaching vertex; pedicel 3 X as long as wide, a little longer than basal funicle segment; one strongly transverse anellus present; funcile three-segmented, the segments progressively decreasing a little in size, segment I about 2.4 X as long as wide, III about twice as long as wide; club a little shorter that distal two funicle segments combined, 2.7–3.2 X as long as wide; basal club segment 1.1–1.4 X as long as wide, distinctly broader than apical funicle segment; apical club segment longer than wide; apical spine short, distinctly shorter than apical segment; sensilla fairly sparse, the flagellum densely covered with short setae, as in Fig. 7.

Mesosoma (Fig. 4) about 1.6 X as long as wide; mesoscutum in profile gently convex, in dorsal view gently rounded from side to side; mesoscutal midlobe about as long as wide, with traces of a midline visible in some specimens; midlobe with a row of 3–5 adnotaular setae at each side; mesoscutum with fine lineate-reticulate sculpture; scutellum fairly strongly convex in profile, about 1.2 X as wide as long with distinct sublateral and submedian lines; sculpture much as in mesoscutum; scutellum with 2 or 3 setae at each side; dorsellum convex, smooth, medially about as long as propodeum; propodeum with a poorly defined median carina and no paraspiracular carinae, with fine reticulate sculpture; spiracles less than their own diameter from anterior propodeal margin; cali each with 4–5 setae. Middle leg with tibial spur about 0.5 X as long as basitarsus.

Forewing (Fig. 3) 2.6 X as long as wide, the disc densely setose; costal cell about 20 X as long as broad, subequal in length to marginal vein, naked; submarginal vein with 1 dorsal seta; marginal vein 3 X as long as



FIGURES 3– 9. *Quadrastichus ingens* **sp. n.** : 3, forewing, female; 4, mesosoma, female; 5, head, frontal view, female; 6, antenna, male; 7, antenna, female; 8, ovipositor and middle tibia, same scale, female; 9, male genitalia.

stigmal vein, the postmarginal vein subobsolete; subcubital line of setae extending basally as far as basal vein, closing speculum posteriorly; longest marginal cilia about 0.6–0.7 X as long as longest setae on marginal vein.

Metasoma with gaster (including strongly protruding ovipositor) long and slender, tapering strongly to an acute apex, about 2.5–2.9 X as long as mesosoma in dried specimens; epipygium distinctly longer than wide; hypopygium reaching to about two-thirds length of gaster; ovipositor, as seen in cleared slide-mounted specimens (Fig. 8), 3.0–3.5 X as long as middle tibia, 2.3–2.6 X as long as gonostyli, the latter protruding strongly caudally by at least one-third gastral length, 14–16 X as long as middle tibial spur; 2 cercal setae.

Male. Length: 2.4–3. 0 mm. Colour: distinctly bicolorous: head and antenna whitish, with ocellar triangle and upper part of occiput dusky; mesosoma black with the following areas white: sides and venter of pronotum, posterolateral sides of mesoscutal midlobe in a pattern that leaves the black area V-shaped, mesoscutal side lobes, prepectus and acropleuron; metasoma blackish save basal two to three segments of gaster ventrally palely suffused; wings palely infuscated; legs whitish with distal tarsomere of all legs dark. Differing structurally from the female mainly in the antenna (Fig. 6): scape with a ventral plaque, placed in apical half and extending from near apex to about mid length of scape, as in Fig. 6; one anellus present; funicle four-segmented, basal segment 1.5–1.7 X as long as wide, distinctly shorter than segments II–IV which become progressively a little shorter, segment II about 3 X as long as wide, IV 2.2 X as long as wide; flagellum sparsely setose, the setae on funicle segments short, curved, distinctly shorter than the segments that bear them, not arranged in whorls; genitalia as in Fig. 9.

Remarks. *Quadrastichus ingens* is a striking species that is readily separated from *Q. gallicola*, *Q. bardus, Q. erythrinae* and all the undescribed species of the genus known to be associated with *Erythrina* galls by its distinctive colour, large size, row of 3 – 5 adnotaular setae, long, slender, acutely pointed gaster and straight, strongly protruding ovipositor. *Quadrastichus ingens* does not fit any one of the two existing species-groups, namely *anysis* and *brevinervis*, which were established by Graham (1991) for the European fauna of the genus.

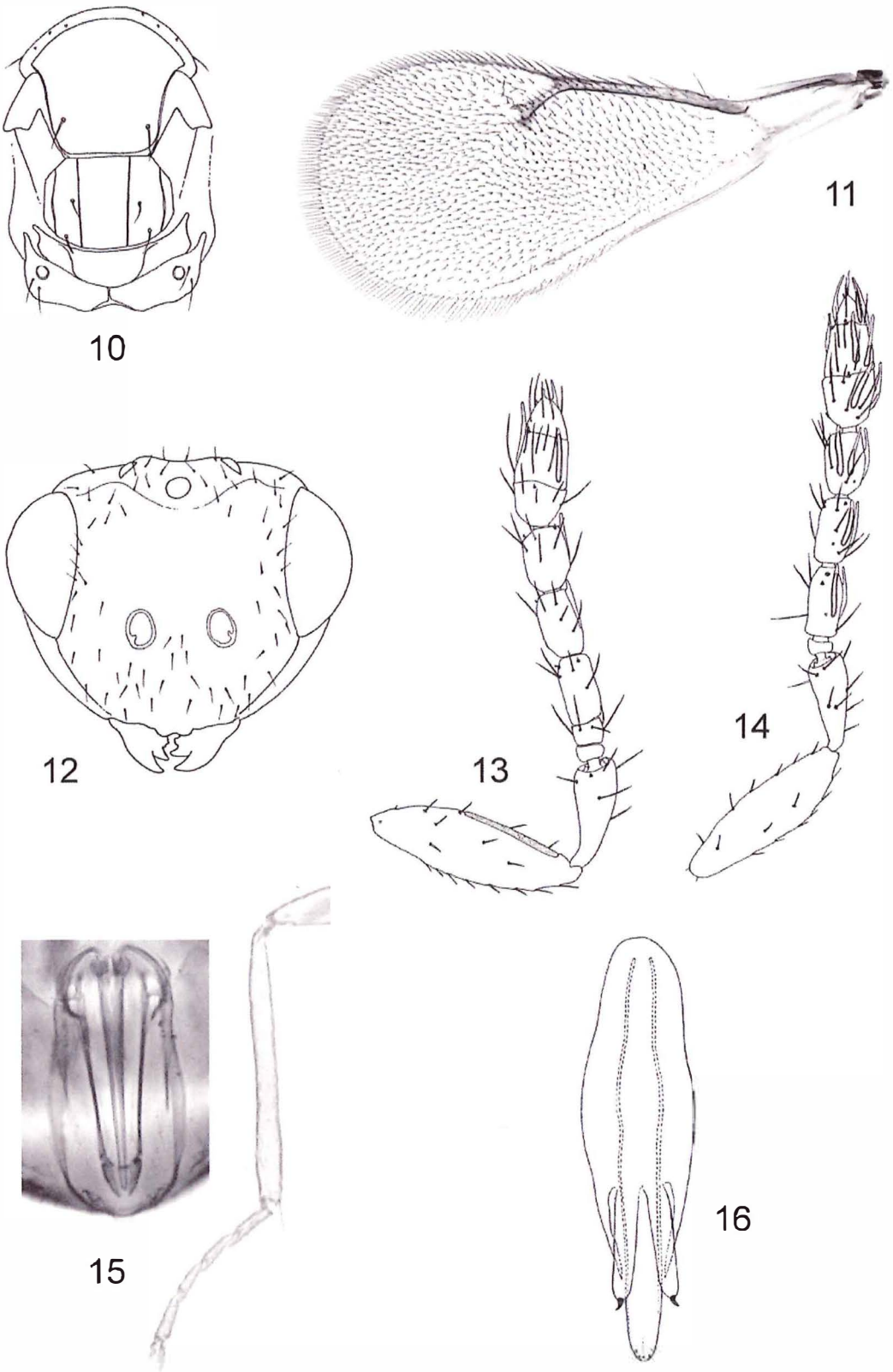
Type material examined. Female holotype, 21 female, 19 male paratypes as follows: SOUTH AFRICA. KwaZulu-Natal Province: Pietermartizburg, 29°36'S 30°22'E, B. Muller, vi.2008, ex leaf galls on *Erythrina latissima* (Female holotpye, 15 females, 14 males; HYMC05731); same data except D. J. Brothers, ix.2008 (5 females, 5 males; HYMC05732); 1 female, 1 male paratypes in each: ANIC, BMNH, MNHN.

Non type material examined. SOUTH AFRICA. KwaZulu-Natal Province: Pietermaritzburg, R. A. Noel, 1975, ex leaf galls on *Erythrina latissima* (7 females; HYMC00034).

***Quadrastichus gallicola* sp. n.**
Figs. 10–16.

Female. Length: 0.7–1.3 mm. Colour: front aspect of head yellowish, genae and temples with dusky suffusions; posterior aspect of head dusky above, the lower one-third or so yellowish; antenna dominantly white to yellow, flagellum a little darker than pedicel and scape in some specimens. Mesosoma almost entirely dark brown to blackish-brown or with side lobes and posterior half of mesoscutum, scutellum, prepectus and acropleuron variably suffused with yellowish-brown to pale brown in some specimens. Metasoma blackish-brown, the base of gaster dorsally broadly suffused with yellowish-brown. Forewing disc entirely hyaline, venation brownish. Legs white to yellowish-white save basal half or more of hind coxa, and apical tarsomere of all legs, dusky, the base of fore coxa also somewhat darkened in some specimens.

Head, in frontal view (Fig. 12), 1.1–1.3 X as wide as high, 1.7–1.8 X as wide as frontovertex at its narrowest; malar space 0.6–0.8 X as long as an eye, the sulcus slightly curved, without a triangular fovea beneath the eye; POL 1.4 – 1.6 X OOL, 3.1–3.6 X OD ; mandible bidentate with a truncation; head finely setose as in Fig. 12, eyes naked; lower margins of toruli a little below lower eye margins; clypeus distinctly bilobed.



FIGURES 10–16. *Quadrastichus gallicola* **sp. n.** : 10, mesosoma, female; 11, forewing, female; 12, head, frontal view, female; 13, antenna, male; 14, antenna, female; 15, ovipositor and middle tibia, same scale, female; 16, male genitalia.

Antenna (Fig. 14) with scape 2.8–3.3 X as long as wide, a little shorter than the length of an eye, almost reaching vertex; pedicel approximately 2.5 X as long as wide, 1.5 X as long as basal funicle segment; one strongly transverse anellus present; funicle three-segmented, segments about equal in size or progressively decreasing a little in size, each 1.5–2.1 X as long as wide; club about equal in length to distal two funicle segments combined, 2.6–3.2 X as long as wide; basal club segment about as long as wide, a little broader than apical funicle segment; apical club segment as long as wide to a little wider than long; apical spine short, distinctly shorter than apical segment; sensilla sparse, flagellum rather sparsely setose, as in Fig. 14.

Mesosoma (Fig. 10) 1.2–1.5 X as long as wide; mesoscutum in profile gently convex dorsally, in dorsal view gently rounded from side to side; mesoscutal midlobe slightly wider than long, without a median line, with 1 adnotaular seta at each side, in posterior half; mesoscutum with fine lineate-reticulate sculpture; scutellum fairly strongly convex in profile, 1.2–1.5 X wider than long with distinct sublateral and submedian lines; sculpture much as in mesoscutum; scutellum with 2 pairs of setae; dorsellum convex, smooth, medially about as long as propodeum; propodeum with median carina, without paraspiracular carinae, with very fine reticulate sculpture; spiracles less than their own diameter from anterior propodeal margin; cali each with 2–3 setae. Middle leg with tibial spur slightly shorter than basitarsus.

Forewing (Fig. 11) 2.3–2.4 X as long as wide; costal cell 16–21 X as long as broad, subequal in length to marginal vein, naked or with a variable number of ventral setae; submarginal vein with 1 dorsal seta; marginal vein 3.3 – 3.7 X as long as stigmal vein, the postmarginal vein less than 0.25 X length of stigmal vein; subcubital line of setae extending basally as far as basal vein, closing speculum posteriorly; longest marginal cilia about 1.4–1.7 X as long as longest setae on marginal vein.

Metasoma short, about as long as mesosoma in dried specimens, somewhat circular in outline, hardly longer than broad, broadly rounded apically; epipygium wider than long; hypopygium reaching to about half the length of gaster; ovipositor, as seen in cleared slide-mounted specimens (Fig. 15), about half as long as gaster, slightly shorter than middle tibia, 6.0–7.3 X as long as gonostyli, the latter short and broad, not or hardly protruding caudally, 1.1–1.5 X as long as middle tibial spur; 2–3 cercal setae.

Male. Length: 0.7–1.2 mm. Colour: much as in female except head more extensively yellow in some specimens, leaving only the posterior aspect partly dusky; hind coxa almost entirely pale, only the base slightly darkened.

Differing structurally from the female mainly in the antenna (Fig. 13): scape with a ventral plaque, placed in apical half and extending from near apex to beyond mid length of scape, as in Fig. 13; a single anellus present; funicle four-segmented, the basal segment quadrate to 1.3 X as wide as long, distinctly shorter than segments II-III which are subequal in size or progressively decreasing a little in size, each about 1.5–2.1 X as long as wide; flagellum sparsely setose, the setae on funicle segments fairly long, slightly curved, not arranged in whorls; genitalia as in Fig. 16.

Remarks. *Quadrastichus gallicola* can be easily distinguished from *Q. ingens, Q.bardus* and *Q. erythrinae* by a combination of characters that include colour, the presence of 1 pair of adnotaular setae and the short, broadly rounded gaster with ovipositor hardly protruding. *Quadrastichus gallicola* most closely resembles the undescribed *Quadrastichus* species known from Togo and Benin, which can be separated from the former species in the female by its distinctive colour in which the head and basal half or so of the gaster are yellow in contrast to the remainder of the body which is blackish. Both these species fit the *anysis*- species group, as defined by Graham (1991), to a large extent.

Type material examined. Female holotype, 33 female, 20 male paratypes as follows: SOUTH AFRICA. Western Cape Province: Stellenbosch, 33°56'S 18°51'E, xii.1975, ex leaf galls on *Erythrina caffra* (Female holotype, 12 females, 8 males; HYMC00065); same data except xi.1975 (1 female, 5 males; HYMC00036); Stellenbosch, vii.1980, ex leaf galls on *E. lysistemon* (7 females, 3 males; HYMC02282); Cape Town, 33°55'S 18°22'E, iii.1978, ex galls on *Erythrina* sp. (5 females, 2 males; HYMC02947); Gauteng Province: Pretoria, Rietondale experiment farm, 25°44'S 28°13'E, xi.2004, ex leaf galls on *Erythrina lysistemon* (8 females, 2 males; HYMC03772). All series collected by S. Neser. 2 female, 2 male paratypes each : ANIC, BMNH, MNHN.

Non type material examined. SOUTH AFRICA. Western Cape Province: Stellenbosch, 33°56'S 18°51'E, xi.1975, ex leaf galls on *Erythrina* ? *caffra* (2 females, 2 males; HYMC00064); same data except xii.1975 (4 females, 1 male; HYMC00067); Wynberg, xii.1975, ex *E.* ? *caffra* (4 females, 2 males; HYMC00066); Gauteng Province: Pretoria, Rietondale experiment farm, 25°44'S 28°13'E, iii.1993, ex leaf galls on *Erythrina lysistemon* (9 females, 4 males; HYMC02935); ii.2006 (4 females, 3 males; HYMC03792); ii. 2006 (5 females, 5 males; HYMC0580); Pretoria, Brummeria, ii.1993, ex leaf galls on *E. zeyheri* (2 females, 2 males; HYMC02976); Limpopo Province: Blouberg, NW of Polokwane, 23°04'S 28°59'E, v.2006, ex leaf galls on *E. lysistemon* (1 female; HYMC 03795); Mpumalanga Province: Pongola, v.1996, from *Erythrina* sp. (5 females, 3 males; HYMC02270); KwaZulu-Natal Province: Richards Bay, 28°44'S 32°05'E, xi.2003. M. Clark, ex leaf galls on *Erythrina* sp. (3 females, 3 males; HYMC05077). All series collected by S. Neser except HYMC05077.

***Quadrastichus bardus* sp. n.**
Figs. 17–23.

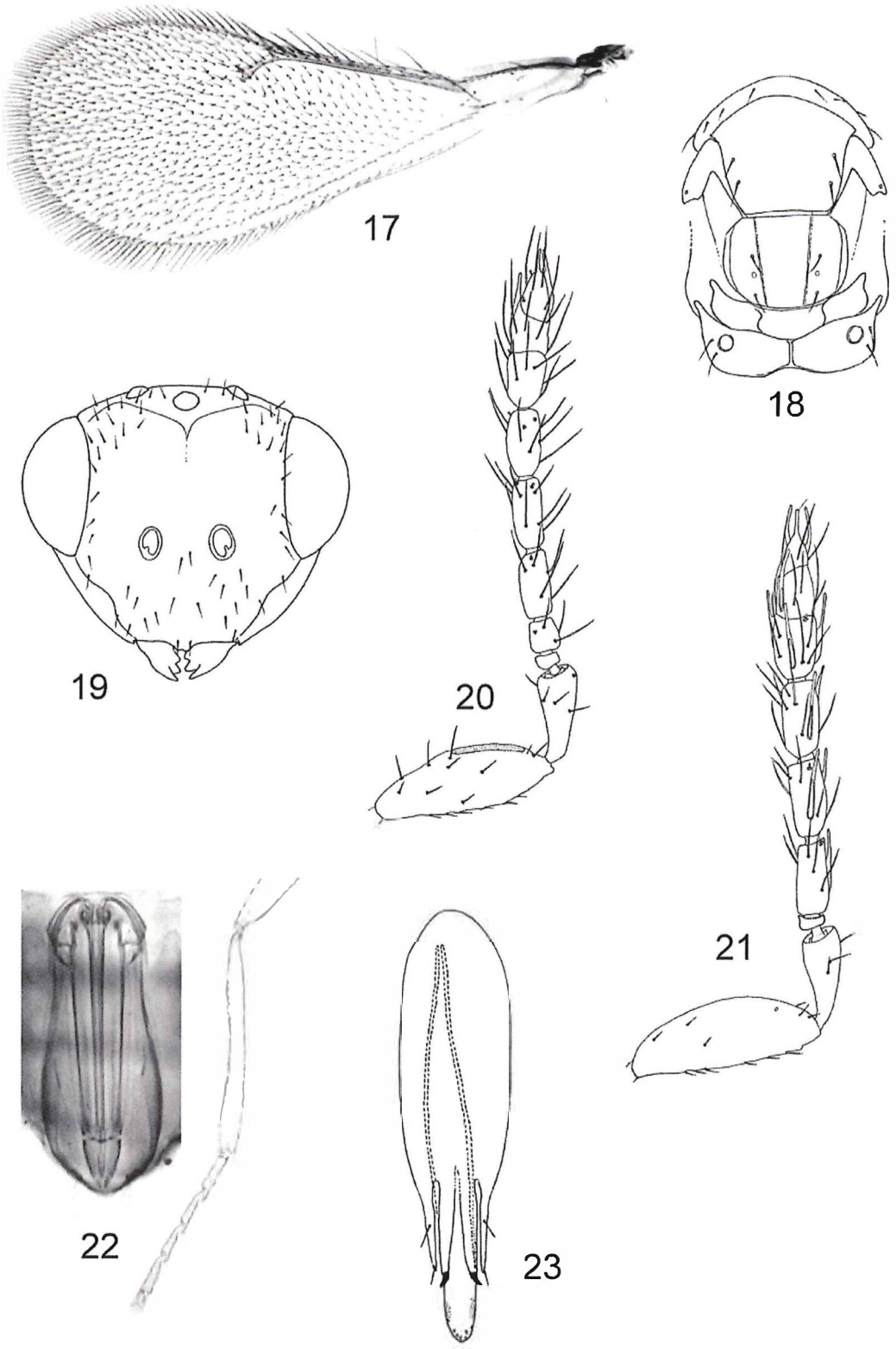
Female. Length: 0.8–1.3 mm. Colour: front aspect of head yellowish with sides, middle of face below toruli, and ocellar area, with variable dark suffusions; back of head black with dorsal margin broadly outlined in yellow, the ventral third or so white; antenna dominantly sordid white. Mesosoma uniformly black (blackish-brown in faded specimens), shiny, except acropleuron yellowish. Metasoma black save basal two and a half segments of gaster yellowish with a dark spot at each dorsolateral margin near base. Forewing disc entirely hyaline, venation pale brown. Legs white to yellowish except basal half or so of fore and hind coxae, and tarsal tips, dark.

Head, in frontal view (Fig. 19) 1.1–1.3 X as wide as high, 1.6–1.7 X as wide as frontovertex at its narrowest; malar space 0.6–0.8 X as long as an eye, the sulcus distinctly curved, without a triangular fovea beneath the eye; POL 1.6 – 1.8 X OOL, 3.0–3.3 X OD; mandible bidentate with a truncation; head finely setose as in Fig. 19, the eyes naked; lower margins of toruli about level with lower eye margins; clypeus bilobed.

Antenna (Fig. 21) with scape 2.8–3.3 X as long as wide, a little shorter than the length of an eye, almost reaching vertex; pedicel 2.1–2.4 X as long as wide, 1.2–1.4 X as long as basal funicle segment; one transverse anellus; funicle three-segmented, segments subequal in size, each 2.0–2.4 X as long as wide; club about as long as distal two funicle segments combined; basal club segment 1.2–1.5 X as long as wide, a little broader than distal funicle segment; apical segment 1.3–1.4 X as long as wide; apical spine long, a little shorter than apical segment; sensilla sparse, flagellum rather sparsely setose, as in Fig. 21.

Mesosoma (Fig. 18) about 1.5 X as long as wide; mesoscutum in profile gently convex dorsally, in dorsal view gently rounded from side to side; mesoscutal midlobe a little wider than long, without or with slight traces of a median line, with 2–3 adnotaular setae at each side, in posterior half; mesoscutum with fine lineate-reticulate sculpture; scutellum fairly strongly convex in profile, about 1.3 X as wide as long with distinct sublateral and submedian lines; sculpture much as in mesoscutum; scutellum with 2 pairs of setae, anterior pair level with the middle of scutellum; dorsellum convex, smooth, medially about as long as propodeum; propodeum with median carina and paraspiracular carinae absent; propodeum appearing a rather smooth with fine reticulate sculpture; spiracles less than their own diameter from anterior margin of propodeum; cali each with 2 setae. Middle leg with tibial spur slightly shorter than basitarsus.

Forewing (Fig. 17) 2.4–2.6 X as long as wide; costal cell 17–20 X as long as broad, about equal in length to marginal vein, with a row of ventral setae; submarginal vein with 1 dorsal setae; marginal vein 3.3 – 4.0 X as long as stigmal, the postmarginal vein less than 0.25 X as long as stigmal; subcubital line of setae extending basally as far as basal vein, closing speculum posteriorly; longest marginal cilia about 1.1–1.5 X as long as longest setae on marginal vein.



FIGURES 17–23. *Quadrastichus bardus* **sp. n.** : 17, forewing, female; 18, mesosoma, female; 19, head, frontal view, female; 20, antenna, male; 21, antenna, female; 22, ovipositor and middle tibia, same scale, female; 23, male genitalia.

Metasoma slightly longer than mesosoma in dried specimens, somewhat parallel-sided, tapering to an acute apex, approximately 1.5 X as long as broad; epipygium wider than long; hypopygium reaching to about half the length of gaster; ovipositor, as seen in cleared slide-mounted specimens (Fig. 22), a little shorter than gaster, 1.2–1.4 X as long as middle tibia, 5.6–6.5 X as long as gonostyli, the latter short and broad, not protruding caudally, 1.5–1.9 X as long as middle tibial spur; 2 to 3 cercal setae.

Male. Length: 0.7–1.0 mm. Colour: distinctly bicolorous: head and antenna white, the triangle demarcated by the ocelli dusky; mesosoma blackish with sides of pronotum, mesoscutal side lobes, prepectus and acropleuron white in contrast; metasoma blackish save basal half of gaster white; wings hyaline; legs entirely white.

Differing structurally from the female mainly in the antenna (Fig. 20): scape with a ventral plaque, placed in apical half and extending about halfway the length of scape, as in Fig. 20; one anellus present; funicle four-segmented, the basal segment quadrate to slightly wider than long, distinctly shorter than segments II–III which are subequal in size, each approximately twice as long as wide; flagellum sparsely setose, the setae on funicle segments long, slightly curved, not arranged in whorls; genitalia as in Fig. 23.

Remarks. *Quadrastichus bardus* can be separated most readily from *Q. ingens, Q. gallicola* and *Q. erythrinae* in the female by: its colour, which is generally black, the basal half or so of gaster yellowish in contrast; long apical spine of the antennal club; 2–3 adnotaular setae at each side of mesoscutal midlobe; relatively short, tapering gaster with non protruding ovipositor. *Quadrastichus bardus* structurally closely resembles the undescribed *Quadrastichus* species from Tanzania, which has been reared from galls on *E. abyssinica*, although the two species are distinctly different in colour. *Quadrastichus bardus* fits the *anysis*-group of species as defined by Graham (1991).

Type material Examined. SOUTH AFRICA. Female holotype, 39 female, 14 male paratypes as follows: Gauteng Province: Pretoria, Rietondale experiment farm, 25°44'S 28°13'E , viii.2006, ex leafless twigs of *Erythrina humeana* (Female holotype, 10 females, 1 male; HYMC05730); same data except xi.2003, ex petioles and leaf veins (12 females; HYMC01918); Pretoria, Brummeria, Botanic Gardens, ii.2007, ex swollen petioles of *Erythrina zeyheri* (17 females, 13 males; HYMC05729). All specimens collected by S. Neser. 2 females, 2 males each: ANIC, BMNH, MNHN.

Non type material examined. SOUTH AFRICA. Gauteng Province: Pretoria, ii.1986, ex thickened leaf vein of *Erythrina humeana* (2 females, 2 males; HYMC02271); same data except ii.1984 (2 females; HYMC02278); same data except iii.1986, ex galls on *E. humeana* in laboratory originating from stock reared from *E. zeyheri* (14 females; HYMC02273); KwaZulu-Natal Province: Midmar dam, nr. Howick, ii.1985, ex galls in petioles of *E. humeana* (2 females, 1 male; HYMC02276). All specimens collected by S. Neser. TANZANIA: Kisase-Mwanza, 12.ii.2006, M. Ramadan, ex *Erythrina* af. *abyssinica* (2 females; in CIRAD)

Genus *Aprostocetus* Westwood

Aprostocetus Westwood, 1833: 144; Graham, 1987: 86; La Salle, 1994: 136.

Noyes (2002) provides a complete list of the more than 40 synonymies that apply to this genus. *Aprostocetus* is by far the largest and most diverse of all the tetrastichine genera. The Afrotropical fauna has never been studied in any detail and is based mainly on scattered descriptions of fewer than 40 species, mostly from West and Central Africa, and listed by Noyes (2002).

Aprostocetus tritus sp. n.

Figs. 24–30.

Female. Length: 1.1–1.7 mm. Colour: head and body entirely blackish-brown to almost black save basal one and a half segments of gaster yellowish; antenna with the scape and pedicel yellowish, flagellum brown to

blackish-brown; legs white to yellowish, coxae partly to almost completely dusky, tarsal tips dark, hind femur with dusky suffusions in the middle in some specimens. Forewing disc entirely hyaline, venation pale brown. Head in frontal view (Fig. 26) about 1.2 X as wide as high, 1.6 X as wide as frontovertex at its narrowest; malar space about 0.6 X as long as an eye, the sulcus slightly curved, without a triangular fovea beneath the eye; POL 1.6 X OOL, 2.6 X OD; mandible bidentate with a truncation; head finely and rather densely setose as in Fig 26, eyes naked; lower margin of the toruli about level with lower eye margins; clypeus distinctly bilobed.

Antenna (Fig. 27) with scape about 4 X as long as wide, 0.8 X the length of an eye, not reaching vertex; pedicel twice as long as wide, about equal in length to basal funicle segment; four strongly transverse anelli; funicle three-segmented; basal two segments subequal in size, each not quite twice as long as wide, a little longer than the distal segment, the latter 1.5 X as long as wide; or segment II intermediate in size between I and III ; club about equal in length to the distal two funicle segments combined, 2.5 X as long as wide; basal club segment a little longer than wide, distinctly wider than apical funicle segment; apical segment wider than long; apical spine shorter than length of apical club segment; sensilla sparse, the flagellum sparsely setose, as in Fig. 27.

Mesosoma (Fig. 25) about 1.5 X as long as broad; mesoscutum in profile slightly convex dorsally, in dorsal view gently rounded from side to side; mesoscutal midlobe more or less as long as wide, with a median line which is barely discernible in some specimens, with 6–8 adnotaular setae at each side, roughly arranged in one or two rows; mesoscutum with clearly discernible lineate-reticulate sculpture; scutellum moderately convex, 1.2 – 1.4 X as wide as long with distinct submedian and sublateral lines; sculpture much as in mesoscutum; scutellum with 2 pairs of setae, anterior pair placed slightly behind mid-length of scutellum; dorsellum convex, smooth, medially subequal in length to propodeum; propodeum with a median carina, without paraspiracular carinae, with distinct reticulate sculpture; propodeal spiracles less than their own diameter from anterior margin of propodeum; cali each with 2 setae. Middle leg with tibal spur slightly shorter than basitarsus.

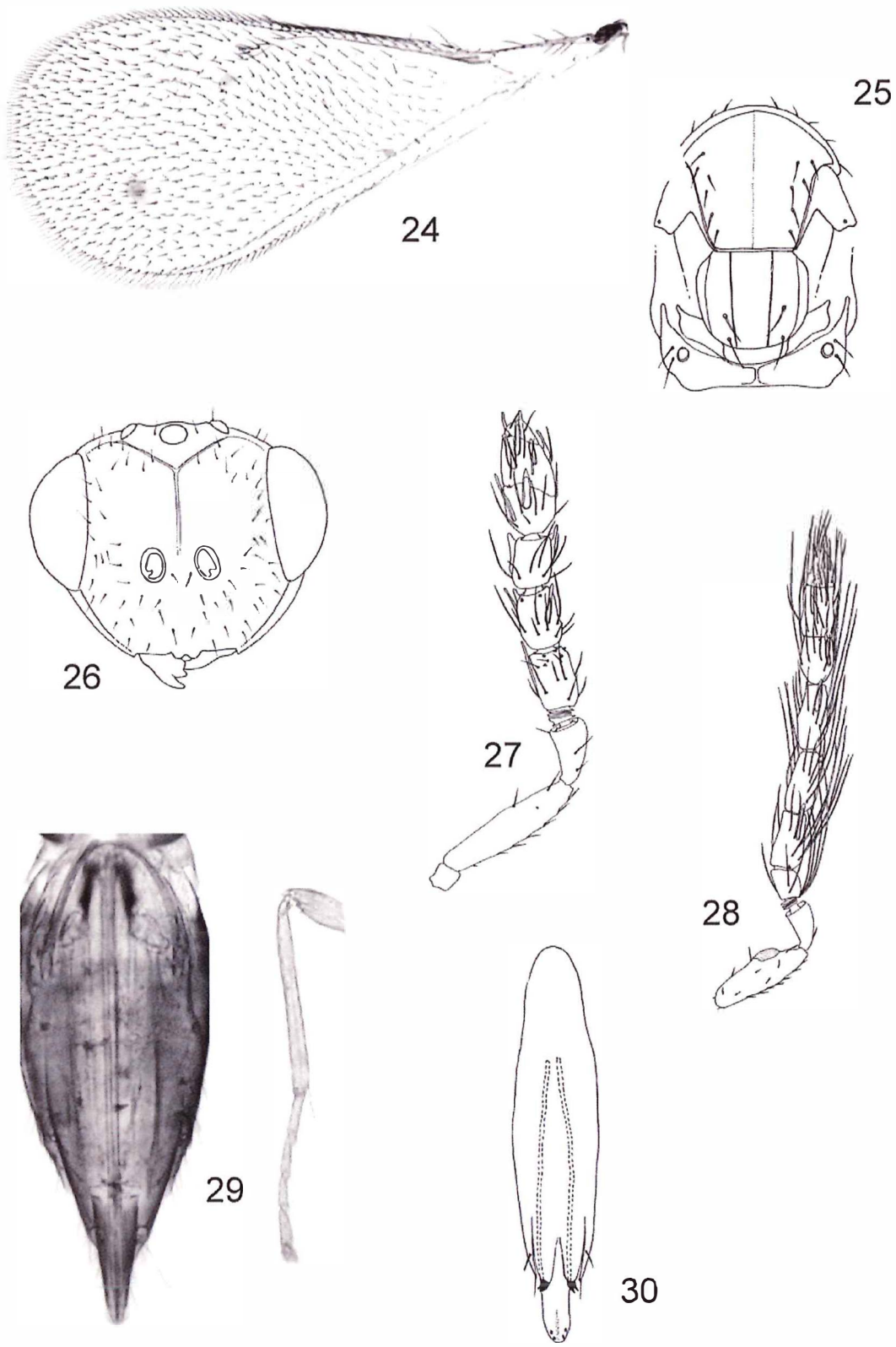
Forewing (Fig. 24) 2.2–2.3 X as long as wide; costal cell 12–15 X as long as broad, almost as long as marginal vein, with a short row of 3–5 ventral setae at distal end; submarginal vein with 4 dorsal setae; marginal vein 3.2–3.7 X as long as stigmal; postmarginal vein subobsolute; subcubital line of setae extending basally as far as basal vein, closing speculum posteriorly; longest marginal cilia about 0.7–0.9 X as long as longest setae on marginal vein.

Metasoma with gaster long and slender, tapering to an acute apex, 2.4–2.6 X as long as wide, 1.6–2.0 X as long as mesosoma; epipygium about as long as wide; hypopygium reaching to about half way the length of gaster; ovipositor, as seen in cleared slide mounted specimens (Fig. 29), as long as gaster, 2.2–2.5 X as long as middle tibia, 3.6–3.8 X as long as gonostyli, the later long, slender, protruding prominently caudally, 2.4–3.0 X as long as middle tibial spur.

Male. Length: 0.9–1.3 mm. Colour: entirely blackish-brown save gaster near base with a large yellowish-brown patch. Antenna sordid white, setation dark brown, lending the flagellum a dark appearance. Legs whitish with all coxae largely blackish-brown, the hind femur with a dusky suffusion in the middle in some specimens; tarsal tips dark. Forewing disc entirely hyaline.

Differing structurally from female mainly in the antenna (Fig. 28): scape about 4.4 X as long as wide, with a bold ventral plaque in apical half as in Fig. 28; three strongly transverse anelli present; funicle four-segmented, the basal segment subquadrate, distinctly shorter than each of segments II–IV, which are subequal in length, each approximately twice as long as broad; flagellum with whorls of very long setae as in Fig. 28. Genitalia as in Fig. 30.

Remarks. *Aprostocetus tritus*, which is best placed in the subgenus *Aprostocetus*, can be distinguished from *A. nitens, A. exertus* and the known undescribed species of *Aprostocetus* associated with *Erythrina* galls by a number of characters, which include: non-metallic body; long row of 6–8 adnotaular setae; 4 dorsal setae on the submarginal vein; long, slender, strongly tapering gaster with shortly protruding ovipositor; male flagellar segments with whorls of long setae.



FIGURES 24–30. *Aprostocetus tritus* **sp. n.** : 24, forewing, female; 25, mesosoma, female; 26, head, frontal view, female; 27 antenna, female; 28, antenna, male; 29, ovipositor and middle tibia, same scale, female; 30, male genitalia.

Type material examined. Material examined. SOUTH AFRICA. Female holotype, 23 female, 18 male paratypes as follows: Western Cape Province: Stellenbosch, vii.1980, ex leaf galls on *Erythrina lysistemon* (female holotype, 10 females, 11 males; HYMC02280); Cape Town, iii.1978, ex galls on *Erythrina* sp. (2 females, 1 male; HYMC00551); Gauteng Province: Pretoria, Rietondale experiment farm, 25°44'S 28°13'E, ii. 2004, ex leaf galls of *E. lysistemon* (1 female, 2 males; HYMC03773); same data except ii.2006 (2 females; HYMC0583); Pretoria, Botanic Gardens, 25°44'S 28°16'E, ii.2006, ex leaf galls on *Erythrina acanthocarpa* (4 females, 2 males; HYMC03799); Pretoria, Botanic Gardens, iv.2003, with leaf galls on *E. zeyheri* (2 females; HYMC03779); North-West Province: Hartbeespoort Dam, 25°44'S 27°51'E, ii.1976, G. L. Prinsloo & R. P. Brown, ex galls on *Erythrina* sp. (3 females, 2 males; HYMC00054). All series collected by S. Neser except HYMC00054. 2 females, 1 male each: ANIC, BMNH, MNHN.

Non type material examined. KwaZulu-Natal Province: Midmar Dam, nr. Howick, ii.1985, ex galls in petioles of *E. humeana* (1 female, 1male; HYMC02277); Limpopo Province: Blouberg NW of Polokwane, 23°04'S 28°59'E, v.2006, ex leaf galls on *E. lysistemon*, (1 female; HYMC03794); Gauteng Province: Pretoria, Rietondale experiment farm, 25°44'S 28°23'E, ii.1997, ex inflorescens of *Erythrina humeana* (2 females, 4 males; HYMC02274). All series collected by S. Neser.

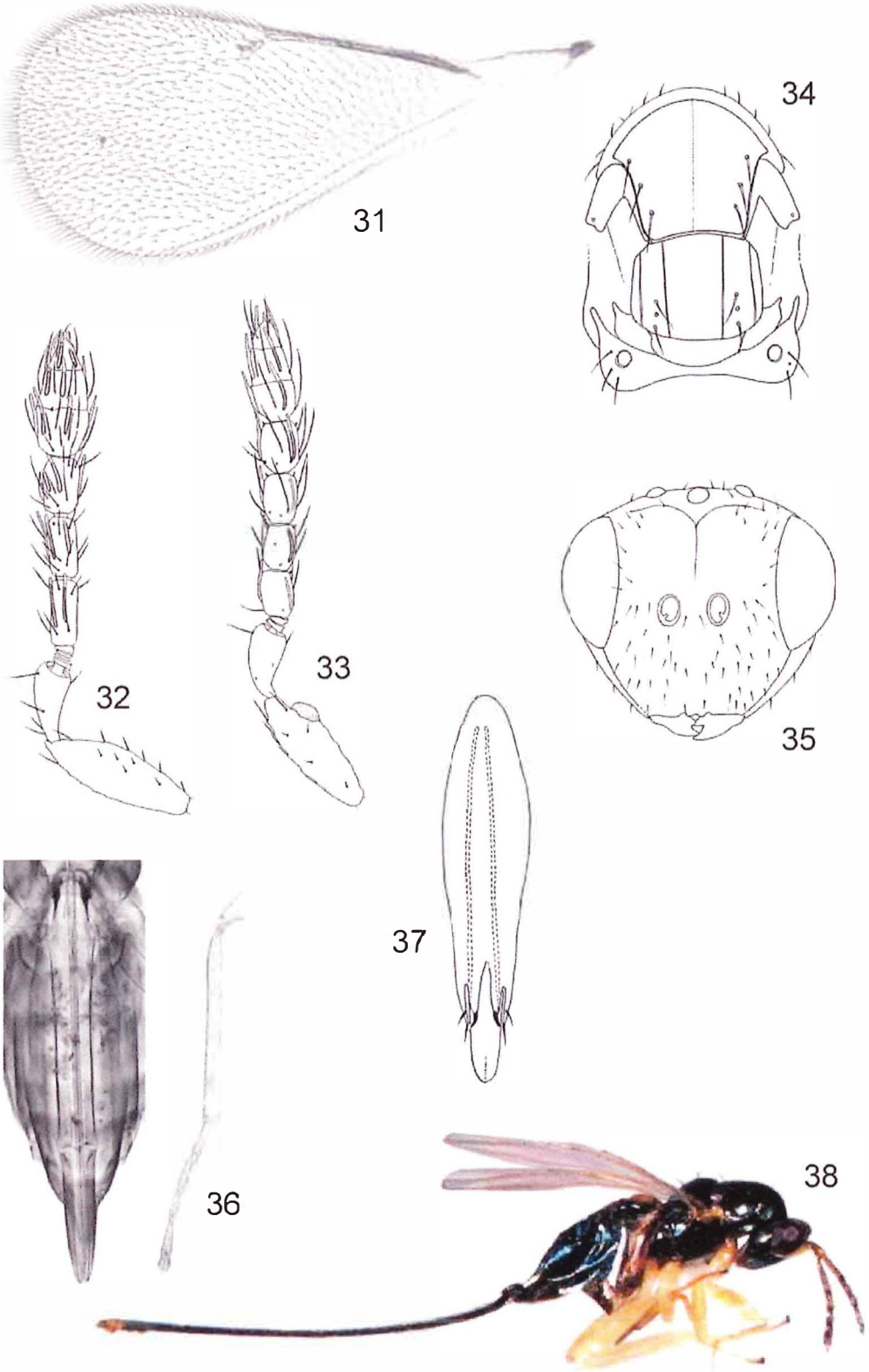
***Aprostocetus nitens* sp. n.**
Figs. 31–37.

Female. Length: 1.1–1.7 mm. Colour: head and body black, shiny with a distinct dark metallic green tinge, the base of gaster broadly suffused with yellow; antenna mostly yellowish, or with flagellum a little darker in some specimens; legs yellowish save hind coxa largely black with a metallic tinge, the middle and hind coxae slightly darkened in some specimens; tarsal tips dark; wings hyaline, venation pale brown.

Head (Fig. 35) in frontal view 1.2–1.3 X as wide as high, about 1.7 X as wide as frontovertex at its narrowest; malar space 0.5–0.6 X as long as an eye, the sulcus almost straight, without a triangular fovea beneath the eye; POL 1.6–1.9 X OOL, more than 4 X OD; mandible with two teeth and a truncation; head rather densely setose as in Fig. 35, eyes naked; lower margin of the toruli a little above lower eye margins; clypeus distinctly bilobed.

Antenna (Fig 32) somewhat variable: scape approximately 3 X as long as wide, about 0.7 X the length of an eye, not reaching vertex; pedicel 1.8–2.5 X as long as wide, subequal in length to basal funicle segment; antenna with four strongly transverse anelli, the middle two distinctly shorter than the remaining two, which are about equal in size; funicle three-segmented, either with basal two segments about equal in length, each 2.0–2.6 X as long as wide and segment III a little shorter, or segment II intermediate in length between segments I and III ; club as long as the distal two to two and a half funicle segments combined, 2.7–3.3 X as long as wide; basal club segment as long as wide to distinctly longer than wide, wider than apical funicle segment; apical club segment as wide as long to wider than long; apical spine distinctly shorter than length of apical club segment; sensilla sparse, the flagellum rather sparsely setose, as in Fig. 32.

Mesosoma (Fig. 34) about 1.3 X as long as broad; mesoscutum in profile slightly convex dorsally, in dorsal view gently rounded from side to side; mesoscutal midlobe about 1.2 X as wide as long with a distinct median line, with 2–3 strongly developed adnotaular setae at each side; mesoscutum with clearly discernible lineate-reticulate sculpture; scutellum strongly convex, 1.1–1.3 X wider than long with distinct submedian and sublateral lines; sculpture much as in mesoscutum; scutellum with 2 pairs of setae, anterior pair placed slightly behind mid-length of scutellum; dorsellum a narrow band, hardly convex, smooth, medially much longer than propodeum; propodeum medially very short, barely visible in some specimens, without a median and paraspiracular carinae, mostly smooth with fine, poorly defined sculptural cells; spiracles less than their own diameter from anterior propodeal margin; cali each with 3 – 4 setae. Middle leg with tibal spur slightly shorter than basitarsus.



FIGURES 31–38. *Aprostocetus* spp.: 31–37, *A. nitens* **sp. n.** : 31, forewing, female; 32, antenna, female; 33, antenna, male; 34, mesosoma, female; 35, head, frontal view, female; 36, ovipositor and middle tibia, same scale, female; 37, male genitalia. 38, *A. exertus* La Salle, female, lateral view.

Forewing (Fig. 31) 2.2–2.5 X as long as wide; costal cell 14–18 X as long as broad, about 0.75 X as long as marginal vein, with a short row of 3–4 ventral setae at distal end; submarginal vein with 2 dorsal setae; marginal vein 4.3–5.3 X as long as stigmal; postmarginal vein very short, less than 0.25 X as long as stigmal; subcubital line of setae extending basally as far as basal vein, closing speculum posteriorly; longest marginal cilia varying from 0.5 X to almost as long as longest setae on marginal vein.

Metasoma with gaster (including protruding gonostyli) long, slender, about 3.5 X as long as wide, 2.5 X as long as mesosoma, tapering strongly to an acute apex; epipygium conical, at least about 1.3 X as long as wide; hypopygium extending about half way length of gaster; ovipositor, as seen in cleared slide mounted specimens (Fig. 36), longer than gaster, 2.2–2.9 X as long as middle tibia, 2.9–3.5 X as long as gonostyli, the later very long, slender, protruding prominently caudally, more than 5 X as long as middle tibial spur.

Male. Length: 0.8–1.1 mm. Colour: head and body black, shiny with a dark metallic green tinge as in female, the basal third or so of gaster white in contrast; antenna whitish or with flagellum a little darker in some specimens; plaque shiny brown in contrast, visible as a distinct dark subapical patch on ventral margin of scape; legs entirely white save dark tarsal tips; wings entirely hyaline.

Differing structurally from female mainly in antenna (Fig. 33): scape 3.0–3.4 X as long as wide with a short, strongly raised subapical plaque on ventral margin as in Fig. 33; two transverse anelli; funicle with four subequal funicle segments, each 1.4–1.7 X as long as wide; flagellar setae fairly sparse, gently curved; Genitalia as in Fig. 37.

Remarks. Some of the specimens from Tanzania that are listed below differ from the majority of the study material by the base of the gaster which is not palely marked and by the legs which are, besides the coxae, not entirely yellow but with the femora distinctly infuscated to a varying degree. In addition, a few Tanzanian specimens have a single dorsal seta on the submarginal vein, instead of the normal two. Since these differences were found among specimens of the same series they are attributed to intraspecific variation.

Aprostocetus nitens is readily separated from *A. tritus, A. exertus* and the known undescribed *Erythrina* gall-associated *Aprostocetus* species by the following combination of characters: body with a metallic green tinge and prominently protruding ovipositor (but not unusually long and tail-like as in *A. exertus*); strongly developed row of 2–3 adnotaular setae; 2 (rarely 1) dorsal setae on the submarginal vein; male antenna with 2 anelli, scape with a short, strongly raised plaque. Although Kostjukov (2004) restored the generic status of *Ootetrastichus* Perkins we here follow Graham (1987), La Salle (1994) and many other subsequent authors in treating this taxon as a subgenus of *Aprostocetus*. In so doing the subgeneric placement of *A. nitens* remains uncertain since it has several character states that have been attributed to either *Ootetrastichus* or *Aprostocetus*, as defined by Graham (1987) and La Salle (1994).

Type material examined. Female holotype, 39 female, 26 male paratypes as follows: SOUTH AFRICA. Limpopo Province: Blouberg NW of Polokwane, 23°04'S 28°59'E, v.2006, ex leaf galls on *Erythrina lysistemon* (Female holotype, 1 female; HYMC03797); Gauteng Province: Pretoria, Rietondale experiment farm, 25°43'S 28°14'E, ii.2006, ex leaf galls on *E. lysistemon* (14 females, 14 males; HYMC05082); Pretoria, Botanical Gardens, 25°44'S 28°16'S, ii.2006, ex leaf and vein galls on *E. acanthocarpa* (8 females, 7 males; HYMC03798); Mpumalanga Province: Pongola, 27°23'S 30°38'E, v.1996, from *Erythrina* sp. (3 females, 5 males; HYMC02269); Western Cape province: Stellenbosch, vii.1980, ex leaf galls on *E. lysistemon* (13 females; HYMC02281). All series collected by S. Neser. 2 female, 2 male paratypes each: BMNH, ANIC, MNHN.

Non type material examined. SOUTH AFRICA: Gauteng Province: Pretoria, Rietondale experiment farm, 25°43'S 28°14'E, xi. 2004, ex leaf galls on *E. lysistemon* (14 females, 3 males; HYMC03774); same data except ii.2006 (3 females, 6 males; HYMC03790); Pretoria, Rietondale experiment farm, ii.1997, in inflorescens of *E. humeana* (1 female, 1 male; HYMC02275); Pretoria, iii.1986, ex leaf galls on *E. lysistemon* (3 females, 2 males; HYMC02284); same data except iii.1990 (2 females, 1 male; HYMC02279); Pretoria, ii.1986, ex leaf veins of *E. zeyheri* (1 male; HYMC02272); Western Cape Province: Stellenbosch, xii.1975, ex leaf galls on *E. ? caffra* (1 female; HYMC03780); all series collected by S. Neser; KwaZulu-Natal Province: Durban, i.2006, M. Ramadan, ex leaf galls on *E. lysistemon* (8 females). TANZANIA. Morogoro

region, ii.2007, ex galls on *Erythrina abyssinica* from the following villages: Bwawani and Gweta (28 females); Arusha region, Masai camp village, ii. 2007 ex galls on *E. abyssinica* (8 females); Mwanza region, Emeleia village, ii.2007, ex leaf galls on *E. variegata* var. *? indica* (15 females); Iringa, i.2006, ex leaf galls on *E. latissima* (2 females); all series collected by M. Ramadan; in ANIC.

***Aprostocetus exertus* La Salle**
Fig. 38

Aprostocetus exertus La Salle: in La Salle, Ramadan and Kumashiro, 2009:

Aprostocetus exertus is being described and illustrated in detail from Tanzania and South Africa in a companion article by La Salle (La Salle *et al.* 2009). This species is readily distinguished from all the other species of the genus associated with *Erythrina* galls by its extremely long epipygium and ovipositor (Fig. 38).

Material examined. SOUTH AFRICA. KwaZulu – Natal Province: Pietermaritzburg, University Botanic Gardens, 29°36'S 30°22'E, B. Muller, ex leaf galls on *Erythrina latissima* (20 females, 20 males; HYMC05766); same data except D.J. Brothers (20 females, 20 males; HYMC05767).

Acknowledgements

We are grateful to John La Salle (ANIC, Canberra) and Gérard Delvare (CIRAD, Montpellier) for the loan of specimens and their invaluable notes and comments on some of the *Erythrina* gall wasps treated in this study. We are greatly indebted to our colleague Stefan Neser for having collected most of the material on which this study is based and for the use of the photograph depicted in Fig. 2.

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JOSH GREEN, M.D.
Governor

SYLVIA LUKE
Lt. Governor

ATTACHMENT 4

SHARON HURD
Chairperson, Board of Agriculture

MORRIS M. ATTA
Deputy to the Chairperson

State of Hawai'i
DEPARTMENT OF AGRICULTURE
KA 'OIHANA MAHI'AI
1428 South King Street
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Phone: (808) 973-9600 FAX: (808) 973-9613

January 17, 2023

Ms. Mary Alice Evans, Director
State of Hawai'i
Office of Planning and Sustainable Development
Environmental Review Program
235 S. Beretania Street, Room 702
Honolulu, Hawai'i 96813

SUBJECT: FINAL ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT (FONSI) FOR THE PROPOSED STATEWIDE FIELD RELEASE OF *APROSTOCETUS NITENS* PRINSLOO & KELLY (HYMENOPTERA: EULOPHIDAE: TETRASTICHINAE) FOR BIOLOGICAL CONTROL OF THE ERYTHRINA GALL WASP, *QUADRASTICHUS ERYTHRINAE* KIM (HYMENOPTERA: EULOPHIDAE)

Dear Ms. Evans:

With this letter, the Hawai'i Department of Agriculture (HDOA) hereby transmits the Final Environmental Assessment and Finding of No Significant Impact (FEA-FONSI) for the Proposed Statewide Field Release of *Aprostocetus nitens* Prinsloo & Kelly, 2009 (Hymenoptera: Eulophidae: Tetrastichinae) for Biological Control of the Erythrina Gall Wasp, *Quadrastichus erythrinae* Kim (Hymenoptera: Eulophidae).

HDOA has reviewed the Draft Environmental Assessment (DEA) which was published in the Environmental Notice on December 23, 2019. The 30-day public comment period began on December 23, 2019. Comments were received and all were in support of this project. The agency has found this project will have no significant impact (FONSI) on the environment.

In addition to this letter, the online Environmental Review Program (ERP) Publication Form has been submitted through the ERP website, including one (1) electronic copy of the FEA-FONSI as an Adobe Acrobat PDF file.

If there are any questions, please contact Christopher Kishimoto, Plant Quarantine Branch Entomologist at: (808) 832-0581 or Christopher.M.Kishimoto@hawaii.gov.

Island Fresh

Sincerely,

Helmuth Rogg

Helmuth W. Rogg
Acting Manager, Plant Quarantine Branch
Administrator, Plant Industry Division

From: webmaster@hawaii.gov
To: DBEDT OPSD Environmental Review Program
Subject: New online submission for The Environmental Notice
Date: Tuesday, January 17, 2023 12:30:21 PM

Action Name

Proposed Statewide Field Release of Aprostocetus nitens for Biological Control of the Erythrina Gall Wasp (Quadrastichus erythrinae)

Type of Document/Determination

Final environmental assessment and finding of no significant impact (FEA-FONSI)

HRS §343-5(a) Trigger(s)

- (1) Propose the use of state or county lands or the use of state or county funds
- (2) Propose any use within any land classified as a conservation district

Judicial district

Statewide

Tax Map Key(s) (TMK(s))

(9)9-9-999:999

Action type

Agency

Other required permits and approvals

USDA-APHIS-PPQ, Board of Agriculture (HDOA Plant Quarantine Branch)

Proposing/determining agency

State of Hawai'i Department of Agriculture

Agency contact name

Janis Matsunaga

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Was this submittal prepared by a consultant?

No

Action summary

The HDOA, with the support of the DLNR and the University of Hawai'i, proposes the Statewide field release of Aprostocetus nitens, a host specific natural enemy of the erythrina gall wasp (EGW), Quadrastichus erythrinae. EGW, native to Africa, has attacked and killed hundreds of Erythrina trees in Hawai'i, including the endemic wiliwili (E. sandwicensis). Eurytoma erythrinae, a natural enemy of EGW in Africa, was released in Hawai'i in 2008 following rigorous testing and approved permits. Despite the successes of E. erythrinae in controlling EGW, damage by EGW on reproductive parts of wiliwili and young seedlings persist. Extensive experiments show A. nitens and E. erythrinae have different feeding preferences, controlling EGW on different parts of the plant. The release of A. nitens will complement E. erythrinae in suppressing infestations of EGW, and will improve the survival success of wiliwili, an ecologically and culturally important Hawaiian tree species.

Reasons supporting determination

Field observations and studies of material from Kenya, Tanzania, and South Africa, and host specificity studies in the HDOA Insect Containment Facility strongly indicate that Aprostocetus nitens is specific to Erythrina-galling species of African Quadrastichus wasps. In Hawai'i, there are no native or beneficial species of Quadrastichus, nor are there any native or beneficial gall formers specific to Erythrina, in particular, E. sandwicensis (wiliwili). Non-target host trials with various groups of gall-forming insects included native, beneficial, and pestiferous species. A. nitens showed no preference for any of the non-target species presented. No negative impacts on cultural values are anticipated from the release of this parasitoid on the human environment in Hawai'i, but instead would lead to positive impacts by reducing the damage from the Erythrina gall wasp to our culturally important native wiliwili. The proposed release of this Erythrina gall wasp biocontrol agent will not have any undesirable, negative, non-target effects on the natural environment of the Hawaiian Islands. All comments received during the Draft Environmental Assessment period were in support of the project. Therefore, the determination from this Final Environmental Assessment is a Finding of No Significant Impact (FONSI).

Attached documents (signed agency letter & EA/EIS)

- FONSI-ERP.pdf

Shapefile

- The location map for this Final EA is the same as the location map for the associated Draft EA.

Action location map

- Action-Location-Map-Not-Applicable-to-FEA-Field-Release-of-Aprostocetus-nitens-for-biocontrol-of-Erythrina-gall-wasp.zip
- FEA-Shapefile.zip

Authorized individual

Janis Matsunaga

Authorization

- The above named authorized individual hereby certifies that he/she has the authority to make this submission.

FIELD RELEASE OF *APROSTOCETUS NITENS* PRINSLOO & KELLY (HYMENOPTERA: EULOPHIDAE: TETRASTICHINAE) FOR BIOLOGICAL CONTROL OF THE ERYTHRINA GALL WASP, *QUADRASTICHUS ERYTHRINAE* KIM (HYMENOPTERA: EULOPHIDAE)

FINAL ENVIRONMENTAL ASSESSMENT

JANUARY 2023

Prepared by

Hawai'i Department of Agriculture
1428 South King Street
Honolulu, HI 96814

This Final Environmental Assessment (FEA) and Finding of No Significant Impact (FONSI) was prepared by the Hawai'i Department of Agriculture, Plant Pest Control Branch and submitted to the Environmental Review Program, State of Hawai'i Office of Planning and Sustainable Development, to comply with the provisions of Hawai'i Revised Statutes, Chapter 343, Environmental Impact Statements. Appendix 2 of this FEA contains public comment in the form of five letters of correspondence, all of which were supportive of the field release of *Aprostocetus nitens*.

ABSTRACT/EXECUTIVE SUMMARY

Erythrina gall wasp (*Quadrastichus erythrinae*) was first detected in Hawai'i on the island of O'ahu in 2005. This non-native species quickly spread to *Erythrina* species throughout the state, including wiliwili (*Erythrina sandwicensis*), a highly valued dominant species of Hawai'i's lowland dry forests (Figure 1). The invasion of Hawai'i by Erythrina gall wasp has resulted in the defoliation and mortality of thousands of *Erythrina* trees throughout the state, and it was not until the approval and release in 2008 of *Eurytoma erythrinae* Gates & Delvare, 2008 (Hymenoptera: Eurytomidae), a wasp parasitoid of Erythrina gall wasp, that wiliwili populations began to show signs of recovery. Ongoing monitoring of wiliwili has shown that inflorescences and seed pods are still being heavily impacted by the Erythrina gall wasp. A potential second biocontrol agent, *Aprostocetus nitens*, has been studied as a complementary biocontrol to *E. erythrinae*, and it is hoped that this species will further reduce the gall wasp's negative impacts.

The Hawai'i Department Agriculture (HDOA) is proposing to release *A. nitens* to reduce the impact of the gall wasp. This environmental assessment fulfills the requirements of the National Environmental Policy Act and the Hawai'i Environmental Policy Act by detailing the results of host specificity and biological studies of *A. nitens*. An environmental assessment is needed to acquire the necessary state and federal permits for the release of this insect.

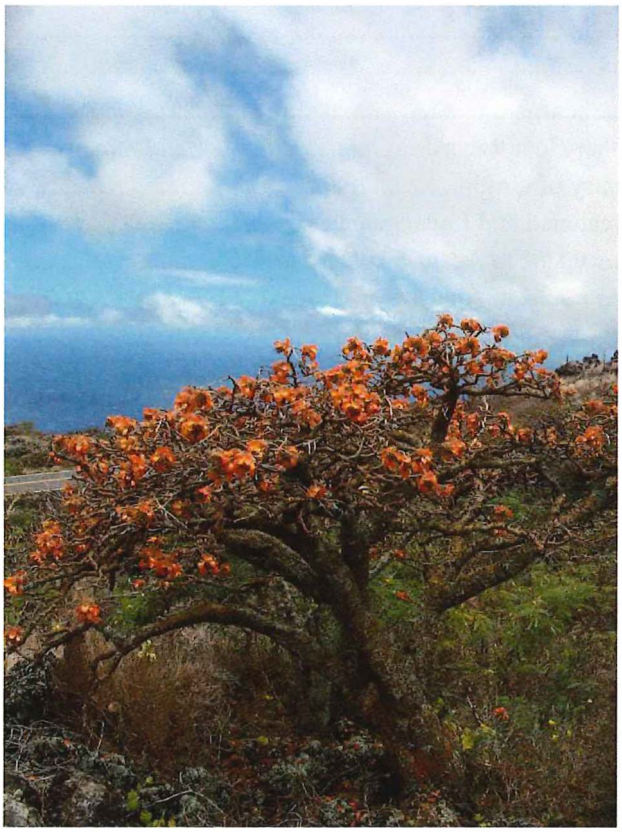

Figure 1. Flowering wiliwili (*Erythrina sandwicensis*); Photo by Forest & Kim Starr.

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PROJECT SUMMARY, BACKGROUND, AND PURPOSE AND NEED

Background

The presence of the Erythrina gall wasp (*Quadrastichus erythrinae*) was first detected in Hawai'i in 2005. The wasp spread quickly to several species of *Erythrina* in the state, including the important landscape plants *Erythrina crista-galli* and *E. variegata*, and the native species wiliwili (*E. sandwicensis*). Wiliwili showed greater than 40% mortality in some affected populations (Yalemar et al. 2016). Various control methods, including injecting priority trees with systemic pesticide, were attempted in an effort to kill the Erythrina gall wasp, with ultimately unsatisfactory results (Yalemar et al. 2016).

Subsequently, the Hawai'i Department of Land and Natural Resources Division of Forestry and Wildlife (DOFAW), the Hawai'i Department of Agriculture (HDOA), the University of Hawai'i (UH), and other government entities, initiated a project to examine species that would be appropriate biocontrols against Erythrina gall wasp. Three parasitoids found to attack Erythrina gall wasp were collected during biological control exploration in Kenya, South Africa, and Tanzania from 2005 to 2006; these are two eulophid parasitoids (*Aprostocetus exertus* La Salle and *Aprostocetus nitens* Prinsloo and Kelly) and the eurytomid parasitoid, *Eurytoma erythrinae* Gates and Delvare. *E. erythrinae* and *A. nitens*, in particular, showed promise as biocontrol agents.

After extensive evaluations at the HDOA Insect Containment Facility for host-specificity indicated that *E. erythrinae* prefers to feed exclusively on Erythrina gall wasp, field releases commenced in November 2008 and continued until the parasitoid was established throughout the state. More than 8,000 individuals were released at various sites on O'ahu, Maui, Kaua'i, the Big Island, and Moloka'i. Within the span of a few months, the wiliwili trees began to show signs of recovery, with healthy, non-galled new leaves and vigorous overall growth (Yalemar et al. 2016). By the second year after the release of *E. erythrinae,* more than 60% of young shoots were found to be free of damage by Erythrina gall wasp (Figure 2), and, by 2011, 90% of the targeted sample wiliwili trees had full canopy coverage (Figure 3).

Depending on the location, recent weather, and time of year, parasitism rates by *E. erythrinae* of Erythrina gall wasp larvae inside galls range from 20% to 100% (U.S. Forest Service 2014). Flowering and fruiting have resumed, and the number of flowers has increased each year post-release (Figure 4); however, 54% of wiliwili seeds sampled were not viable (Yalemar et al. 2016). This adverse impact on flower and seed production is not only an ecological concern, but it is also a cultural issue because Native Hawaiians value the red wiliwili seeds for lei making.

This environmental assessment fulfills the requirements of the National Environmental Policy Act and the Hawai'i Environmental Policy Act by detailing the results of host specificity and biological studies of *A. nitens.* An environmental assessment is needed to acquire the necessary state and federal permits for the release of this insect.

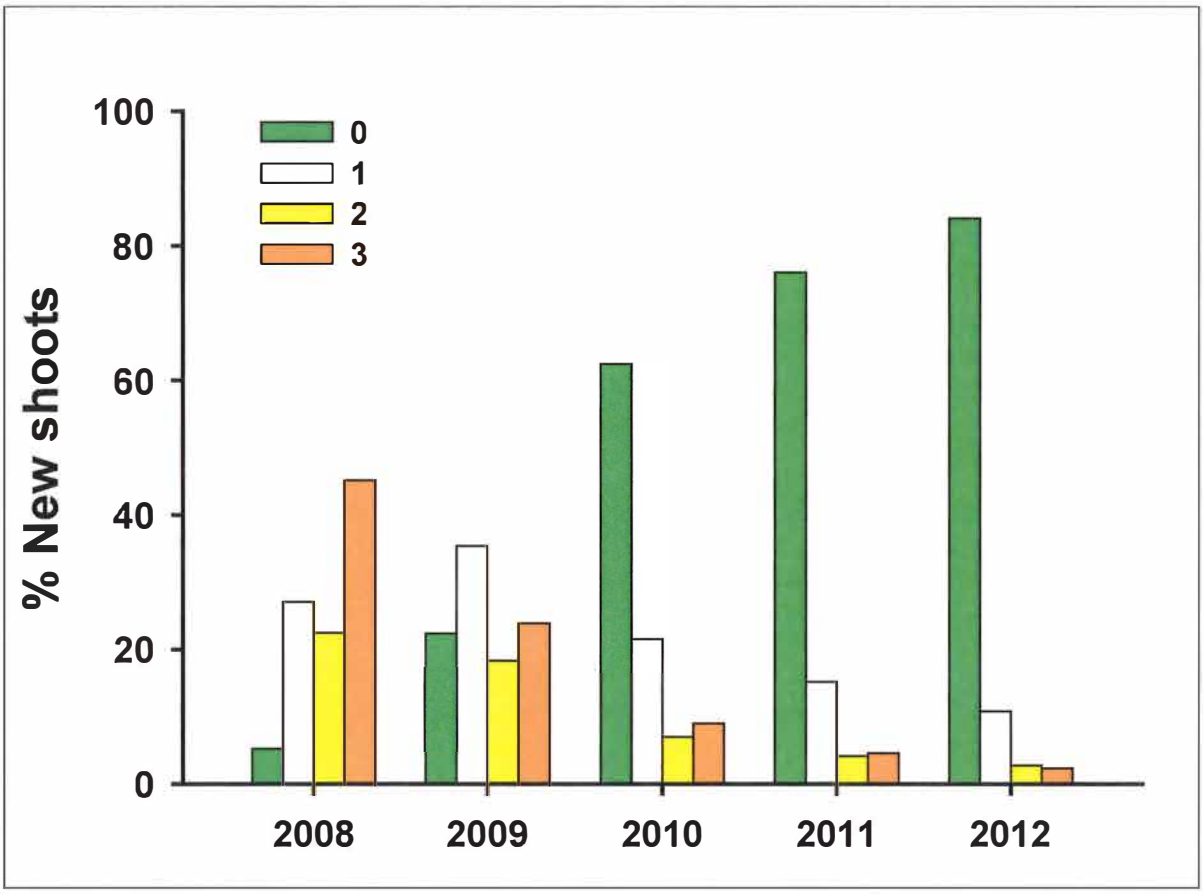

Figure 2. Percentage of young wiliwili shoots with Erythrina gall wasp damage over time where 0 = no damage, 1 ≤ 33% damage, 2 ≤ 66% damage, and 3 > 66% damage (Kaufman et al. 2014).

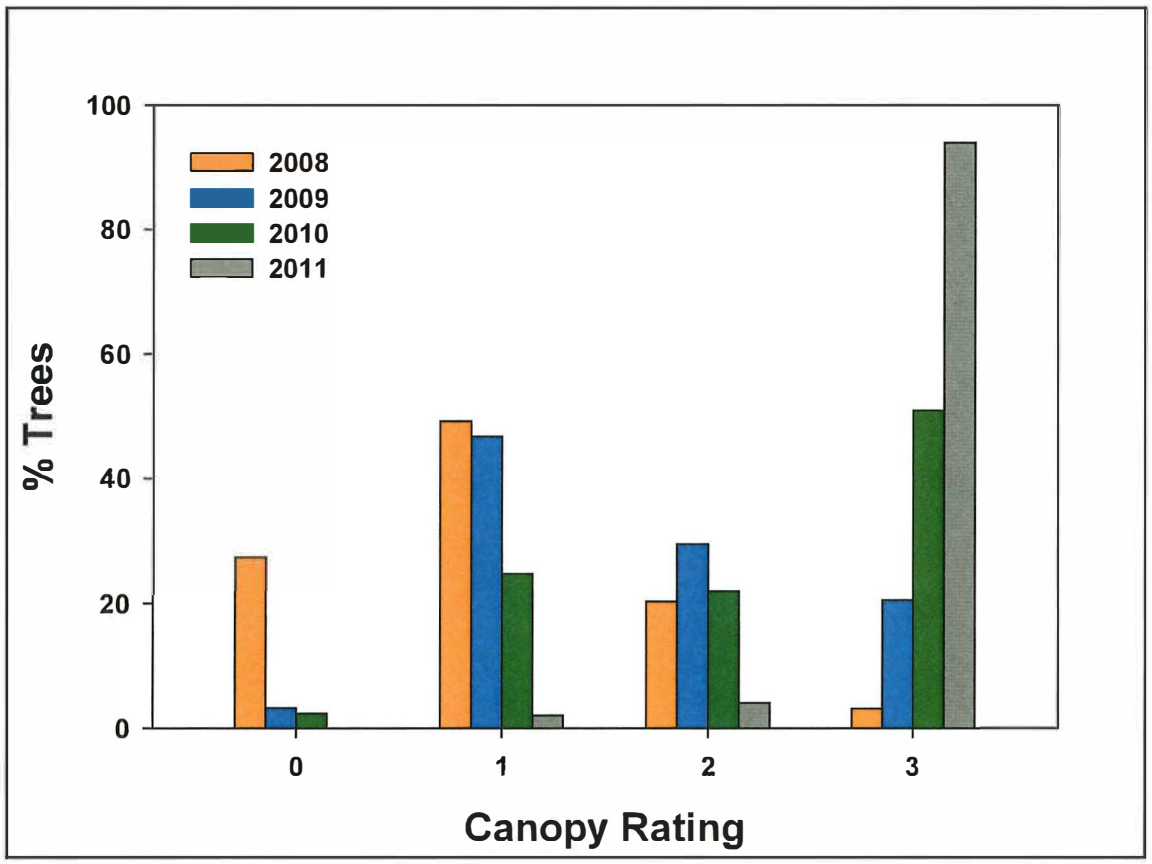

Figure 3. Canopy cover of wiliwili over time, where 0 = no canopy coverage, 1 ≤ 33% canopy coverage, 2 ≤ 66% canopy coverage, and 3 > 66% canopy coverage (Kaufman et al. 2014).

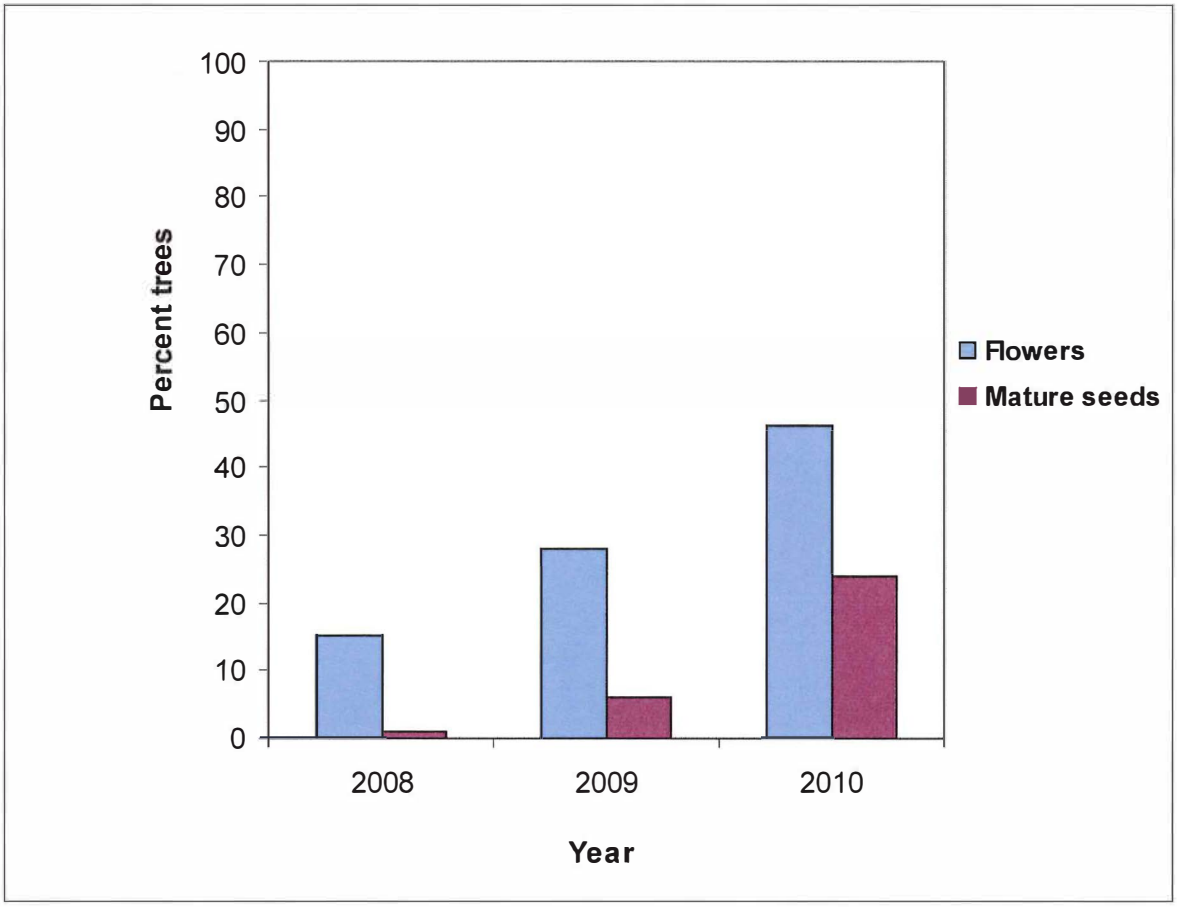

Figure 4. Flower and seed production in wiliwili after the release of *E. erythrinae* (Yalemar et al. 2016).

PURPOSE AND NEED FOR THE PROPOSED ACTION

Despite the success of the release of *Eurytoma erythrinae,* it has been known that a second species, *A. nitens,* would need to be released to enhance biocontrol efforts against Erythrina gall wasp. By releasing a second biocontrol agent, an additional non-chemical form of control will complement the suppression of Erythrina gall wasp populations (Yalemar and Bautista 2011). Because *E. erythrinae* acts as more of a predator than a parasitoid, with its larvae feeding in Erythrina gall wasp galls and tunneling to feed on additional larvae in adjacent galls, larger galls with many individual Erythrina gall wasps are preferred for oviposition. This feeding behavior leaves young *Erythrina* seedlings as well as reproductive parts (flowers and fruits)---where smaller galls tend to form—still vulnerable to attack by EGW and with little parasitism by the *Eurytoma erythrinae* parasitoid (Yalemar et al. 2016).

The Hawai'i Department of Agriculture, with support from the Hawai'i Department of Land and Natural Resources, proposes to release *Aprostocetus nitens* from its Insect Containment Facility [quarantine containment] into the natural environment of the state of Hawai'i as a biological control agent. Unlike *E. erythrinae*, this parasitoid utilizes only one host individual to complete its development, and, therefore, it is able to live on much smaller galls, such as those found in flowers, seed pods, and young seedlings. This release will supplement the success of *E. erythrinae* in suppressing infestations of Erythrina gall wasp,

and will improve the survival success of wiliwili, an ecologically and culturally important native Hawaiian tree species.

Public Involvement and Agency Coordination

Comments received during Early Consultation and the 30-day public review period for the Draft Environmental Assessment (EA) for the "Field Release of *Eurytoma* sp. (Hymenoptera: Eurytomidae), for the Biological Control of the Erythrina Gall Wasp, *Quadrastichus erythrinae* Kim (Hymenoptera: Eulophidae), in Hawai'i" were reviewed and considered during preparation of the Draft EA. Additional consultation was done (Table 2) through the Cultural Impact Assessment prepared by ASM Affiliates for the proposed action (Appendix 1).

In December 2019, a Draft Environmental Assessment was submitted to the Office of Environmental Quality Control (OEQC) [Environmental Review Program] with an Anticipated Finding of No Significant Impact. The Draft EA was published in OEQC's Environmental Notice on December 23, 2019, for a 30-day public review period. All comments received during this period are included in Appendix 2. All comments were positive and in support of the release of *Aprostocetus nitens* for biological control of the invasive Erythrina gall wasp.

PROPOSED ACTION AND ALTERNATIVES

The actions being considered in this Final Environmental Assessment are 1) issuing a permit for release of the second parasitoid of Erythrina gall wasp, *A. nitens.* (The Proposed Action) and 2) no action (the No Action Alternative).

Proposed Action

An application has been submitted by the HDOA Plant Pest Control Branch to the HDOA Plant Quarantine Branch, 1849 Auiki Street, Honolulu, Hawai'i, 96819, for a permit to introduce *Aprostocetus nitens* Prinsloo & Kelly (Hymenoptera: Eulophidae: Tetrastichinae) into the State of Hawai'i under the provisions of Hawai'i Revised Statutes, Chapter 141, Department of Agriculture, and Chapter 150A, Plant and Non-Domestic Animal Quarantine. *A. nitens* would be released to supplement efforts to control the Erythrina gall wasp, an invasive, gall-forming eulophid wasp that infests *Erythrina* trees in natural and landscaped areas in Hawai'i.

Locations of Rearing Facilities and Release Sites

The HDOA Insect Containment Facility is located at the HDOA Main Office Complex in the city of Honolulu, Island of O'ahu, State of Hawai'i. The address of the property is 1428 South King Street, Honolulu, Hawai'i, 96814-2512. If *A. nitens* is approved for release from containment (laboratory quarantine) as a biocontrol agent, mass propagation of the wasp will be done in the HDOA Insect Rearing Facility at the same location. Release sites on all islands will be selected according to the availability of *Erythrina* trees infested with Erythrina gall wasp. Initial releases will begin on the islands of O'ahu, Maui, and Hawai'i. Areas with endemic wiliwili trees infested with the Erythrina gall wasp will be prioritized. *A. nitens* will be hand-carried to the other Hawaiian Islands for release where needed.

Method of Release

Mature adults of *A. nitens* would be released on *Erythrina* trees infested with Erythrina gall wasp, and inoculations of this species would continue to be made statewide until *A. nitens* becomes established. HDOA expects to rear and release thousands of individuals of this wasp until the species is established. No particular timing of releases is planned.

No Action Alternative

Under the No Action Alternative, no permit would be approved and *A. nitens* would not be released. The No Action Alternative would be expected to result in the continued decline of wiliwili, due to their inability to produce viable seed. Although the release of *E. erythrinae* proved to be a success with recommencement of fruiting and flowering in *Erythrina* species, 54% of wiliwili seeds sampled after the release failed to form viable seeds as a result of gall wasp damage (Yalemar et al. 2016). This adverse impact on flower and seed production is both an ecological and cultural issue. Unlike *E. erythrinae*, *A. nitens* uses only one host individual to complete its development, so it is able to live in much smaller galls.

Alternatives Considered but Eliminated from Detailed Analysis

Because the Erythrina gall wasp feeds within plant tissues, it was thought that systemic pesticides could be used to control infestations of this species. However, widespread use of this method is cost-prohibitive, and frequent, long-term use of insecticides in natural areas is neither feasible nor advisable. Attempts in downtown Honolulu to control Erythrina gall wasp on *Erythrina variegata* using systemic pesticides were unsuccessful, and eventually resulted in the trees being cut down, after thousands of dollars were spent on chemicals (Yalemar 2016). Therefore, this alternative was not carried forward for detailed analysis in this EA.

AFFECTED ENVIRONMENT

Biological Testing

Target Organism: Erythrina Gall Wasp

The Erythrina gall wasp was first detected in 2005 when galls were observed on *Erythrina variegata* on the University of Hawai'i campus on O'ahu. Emerging adult wasps were subsequently identified as *Quadrastichus erythrinae*, a gall-forming eulophid wasp native to Africa. The current distribution of the Erythrina gall wasp as an invasive species encompasses American Samoa, Florida, Guam, India, mainland China, Puerto Rico, Singapore, and Taiwan. Like other gall-forming wasps, the Erythrina gall wasp inserts its eggs inside young leaf and stem tissue. Wasp larvae develop inside the tissue, causing a gall to form. As the infestation worsens, leaves and stems become deformed, which results in reduced levels of photosynthesis. The plant quickly loses vigor and may eventually die (Yang et al. 2004). Generation time for Erythrina gall wasp is rapid; in Hawai'i, the full life cycle from egg to adult has been observed to be approximately 20 days (HDOA Plant Pest and Control Branch 2008). Once the wasp has

established, it is dispersed via wind and through human activities such as hiking and shipping (Centre for Agricultural Bioscience International [CABI] Invasive Species Specialist Group 2015).

Organism Proposed to Be Released: *Aprostocetus nitens*

Aprostocetus nitens was first described to science by Prinsloo and Kelly (2009) after it was collected during exploratory surveys for natural enemies of Erythrina gall wasp in South Africa, Tanzania, and Kenya between 2005-2006. This species is quite small (1.1–1.7 mm long), and shiny black in color with a dark metallic green tinge and yellow gaster, antennae, and legs. The wings are transparent with brown venation (see Prinsloo and Kelly, 2009, for full description).

Biological studies of *A. nitens* were performed at the HDOA Insect Containment Facility. This species exhibits female parthenogenesis or thelytoky in laboratory conditions, which means that the eggs (Figure 5) do not need to be fertilized by a male to be viable and produce female offspring. The entire life cycle for this species from egg to adult (Figures 5 through 8) takes approximately 20 days, and newly hatched female offspring contain one or two mature eggs in their ovaries (Figure 9) (Yalemar et al. 2016). Females are synovigenic, which means they continue to produce mature eggs, laying an average of 139 eggs throughout their lifespan. This species can survive 4 days without food and lives for an average of 120 days (Yalemar 2016).

Figure 5. *A. nitens* egg; Photo by HDOA.

Figure 6. *A. nitens* larva feeding on Erythrina gall wasp pupa; Photo by HDOA.

Figure 7. *A. nitens* pupa; Photo by HDOA.

Figure 8. *A. nitens* adult; Photo by HDOA.

Figure 9. *A. nitens* ovaries; Photo by HDOA.

Host Specificity Trials

Host specificity studies were performed at the HDOA Insect Containment Facility. The non-target gall-forming insects tested were the same as those used in trials of *Eurytoma erythrinae* (Yalemar et al. 2016): banyan gall wasp (*Josephiella microcarpae*), a scale insect (*Tectococcus ovatus*) on strawberry guava (*Psidium cattleianum*), a eulophid wasp (*Ophelimus* sp.) on eucalyptus, a native psyllid, (*Pariaconus* sp.) on ʻōhiʻa lehua (*Metrosideros polymorpha*), lantana gall fly (*Eutreta xanthochaeta*) (Diptera: Tephritidae), Hamakua pamakani gall fly (*Procecidochares alani*), and Maui pamakani gall fly (*Procecidochares utilis*) (Table 1).

Table 1. Gall-Forming Insects Used in Host Specificity Tests against *Aprostocetus nitens* (Yalemar et al 2016).

Family, Order	Gall-former (Scientific, common name)	Gall-former status	Gall-former source	Host plant (Scientific, common name)	Infested plant part used for testing
Pteromalidae Hymenoptera	*Josephiella microcarpae* Beardsley & Rasplus Banyan gall wasp	Immigrant	Field-collected Honolulu, Oʻahu	*Ficus macrocarpa* Chinese banyan	Cuttings
Eriococcidae Hemiptera	*Tectococcus ovatus* Hempel a Brazilian scale	Biocontrol agent	Lab-reared, USFS, HVNP Quarantine Facility and lab-reared HDOA	*Psidium cattleianum* Strawberry guava	Whole plants
Eulophidae Hymenoptera	*Ophelimus* sp. a eucalyptus gall wasp	Immigrant	Field-collected Camp Maluhia, Maui	*Eucalyptus* sp. Eucalyptus	Cuttings
Triozidae Hemiptera	*Pariaconus* sp. ʻŌhiʻa psyllid	Endemic (native)	Field-collected, ʻAiea and Mānoa, Oʻahu	*Metrosideros polymorpha* ʻŌhiʻa	Cuttings
Tephritidae Diptera	*Eutreta xanthochaeta* Aldrich Lantana gall fly	Biocontrol agent	Field-collected, Hauʻula, Oʻahu and lab-reared	*Lantana camara* Lantana	Whole plants
Tephritidae Diptera	*Procecidochares alani* steyskal Hāmākua pamakani gall fly	Biocontrol agent	Field-collected, Nuʻuanu, Oʻahu and lab-reared	*Ageratina riparia* Hāmākua pamakani	Whole plants
Tephritidae Diptera	*Procecidochares utilis* Stone Maui pamakani gall fly	Biocontrol agent	Lab-reared, UH Mānoa and lab-reared HDOA	*Ageratina adenophora* Maui pamakani	Whole plants

Host specificity assays consisted of choice tests, which approximate choices of host the parasitoid is presented with in the field, and no-choice tests to determine whether *Aprostocetus nitens* would feed on non-target hosts in the absence of its intended host. In a choice test, the parasitoid is allowed to choose plants infested by either the target (Erythrina gall wasp) or a non-target gall-forming insect for oviposition and development. In the no-choice test, the parasitoid is given only the option of using a non-target gall-former as host. At the end of each test, the mature parasitoids are removed, and the plant is held in a cage to await emergence of the parasitoid from the galls. After 1 month, galls from each test plant are dissected and examined under a microscope to determine whether parasitism has taken place (Yalemar et al. 2016) (see Figures 10 through 12).

Results of the host specificity trials indicate that *A. nitens* is host specific to *Quadrastichus erythrinae* and has no preference for any of the seven non-target gall forming species studied. In addition, even if *A. nitens* were to parasitize these non-target species, it would be unable to produce any offspring because none of these species was shown to be suitable for supporting this species' development.

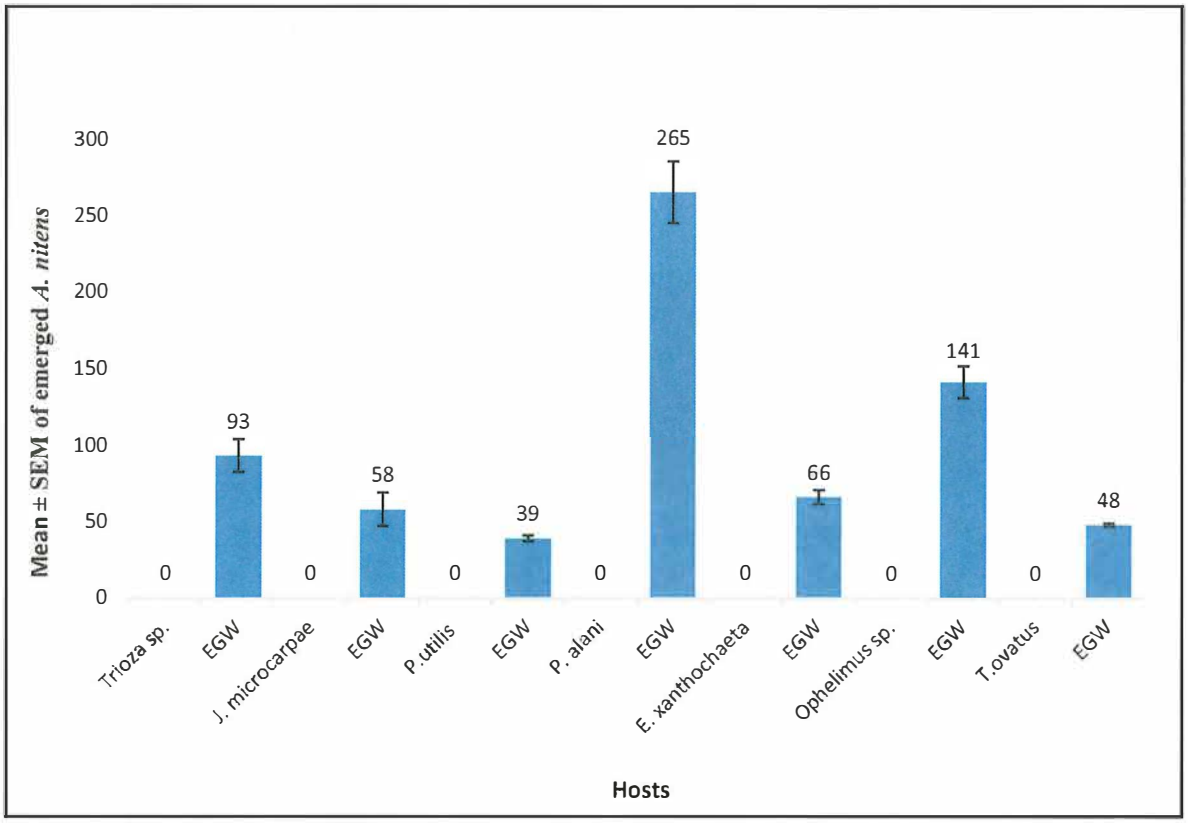

Figure 10. Average number of emerged *A. nitens* in choice tests. (EGW = Erythrina gall wasp).

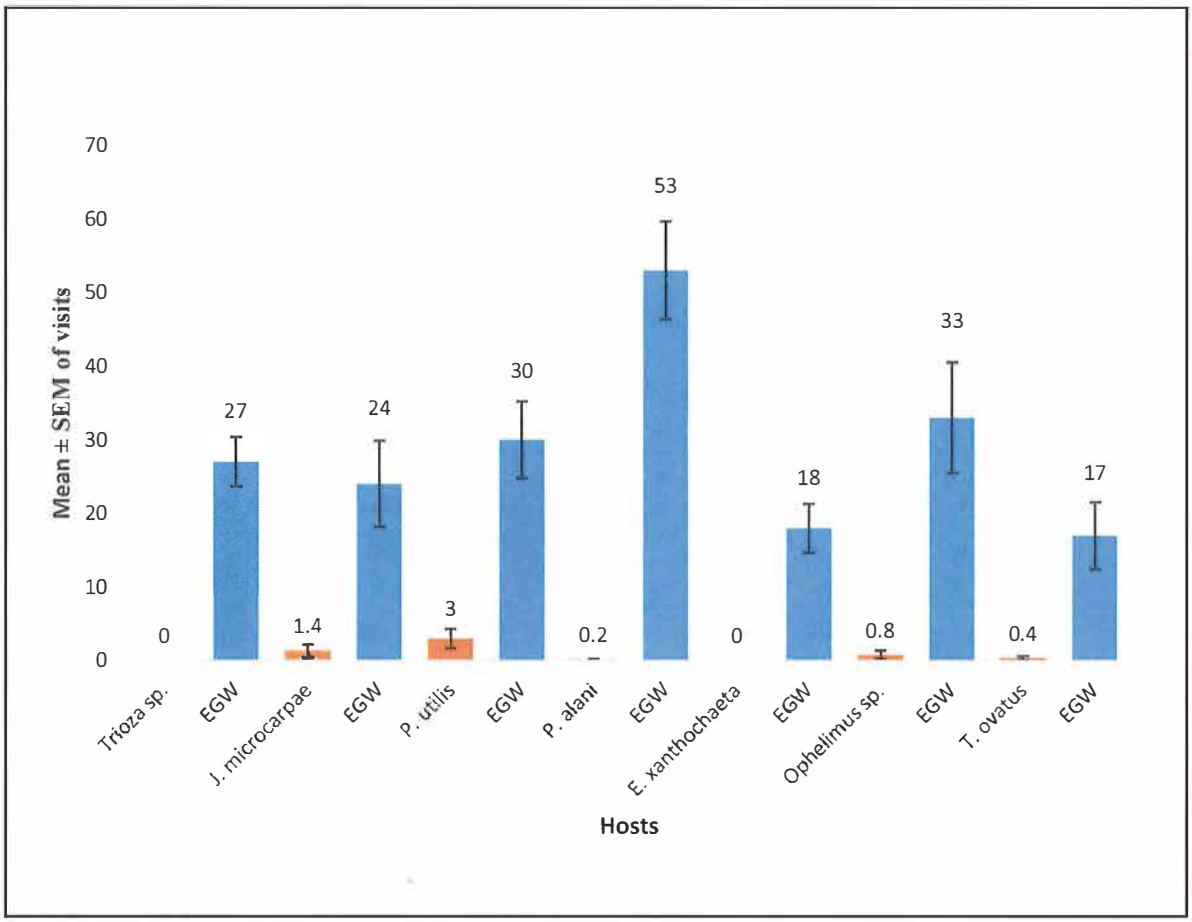

Figure 11. Average number of visits on *E. variegata* and non-target gall-forming insect hosts by *A. nitens*.

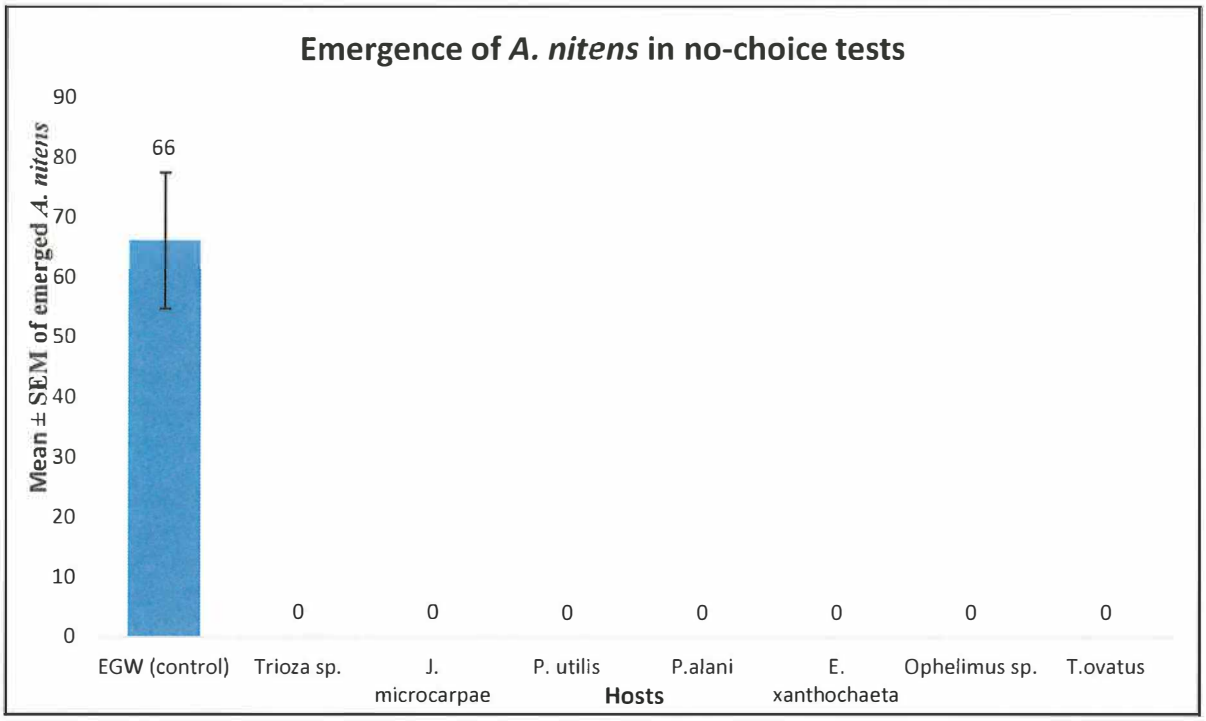

Figure 12. Average number of emerged *A. nitens* in no-choice tests.

Multiparasitism Trials

Because *A. nitens* is proposed to be released to complement the progress made by the introduction of *E. erythrinae*, multiparasitism trials were performed to determine the potential interaction between these two parasitoids. Interactions were measured as follows:

- Quantify the level and rate of Erythrina gall wasp parasitism (= predation) by the two parasitoids when either is used alone or when both are used concurrently (= multiparasitism).
- Determine if the sequence and pattern of Erythrina gall wasp exposure to the two parasitoids will have differential effects on their progeny.
- Determine if interspecific competition would make each or both parasitoids ineffective.

These trials were performed in the HDOA Insect Containment Facility. Gravid females of *E. erythrinae* (7 days old) and *A. nitens* (3 days old) were introduced to gall-infested *Erythrina variegata.* Before the introduction of the two parasitoids, the level of galling was rated to ensure that both were exposed to similar levels of galling. Galled-infested *Erythrina* were exposed to each parasitoid, alone and in combination, in cages separated by treatment type, for 72 hours.
The treatments were as follows:

- Control: Plants with Erythrina gall wasp only, no parasitoids.
- Galled *Erythrina* plants were exposed to 10 females of *E. erythrinae* alone for 72 hours. Erythrina gall wasp and *E. erythrinae* that emerge were tallied and recorded.
- Galled *Erythrina* plants were exposed to 10 *A. nitens* alone for 72 hours. Erythrina gall wasp and *A. nitens* that emerge were tallied and recorded.

- Galled *Erythrina* plants were exposed to 10 females of *E. erythrinae* and 10 females of *A. nitens* concurrently for 72 hours.
- Galled *Erythrina* plants were exposed to 10 females of *E. erythrinae* for 72 hours. Then, after 4 days, the same plants were exposed to 10 *A. nitens* for 72 hours.
- Galled *Erythrina* plants were exposed to 10 females of *A. nitens* for 72 hours. Then, after 4 days, the same plants were exposed to 10 females of *E. erythrinae* for 72 hours.

After each treatment was applied, any individuals of Erythrina gall wasp, *E. erythrinae,* and/or *A. nitens* that emerged were tallied and recorded. After this time, the plants were removed from the cages and held for 4 weeks to rear out the parasitoids. During this time, all emerging adults were captured and counted, and the sex of each was noted. Fourteen days after exposure to the parasitoids, a sample of the galls was removed from each plant and dissected to determine the number of each parasitoid developing within the galls or to determine the parasitism rate of each parasitoid. The experiment was repeated five times.

Results of the multiparasitism trials indicated that there was no significant difference in the ratio of the two parasitoids when either is released first on the host. When the two parasitoids were released concurrently, the proportion of *E. erythrinae* was found to be significantly higher than that of *A. nitens* (Figure 13). No significant difference was found in Erythrina gall wasp suppression levels when parasitoids were combined, compared to the effects of *E. erythrinae* alone (Figure 14). Most importantly, *A. nitens* and *E. erythrinae* were shown to have different feeding preferences, with *A. nitens* preferring foliage and *E. erythrinae* showing a preference for stems and petioles (Figure 15), which supports observations of these species' behavior in their native range.

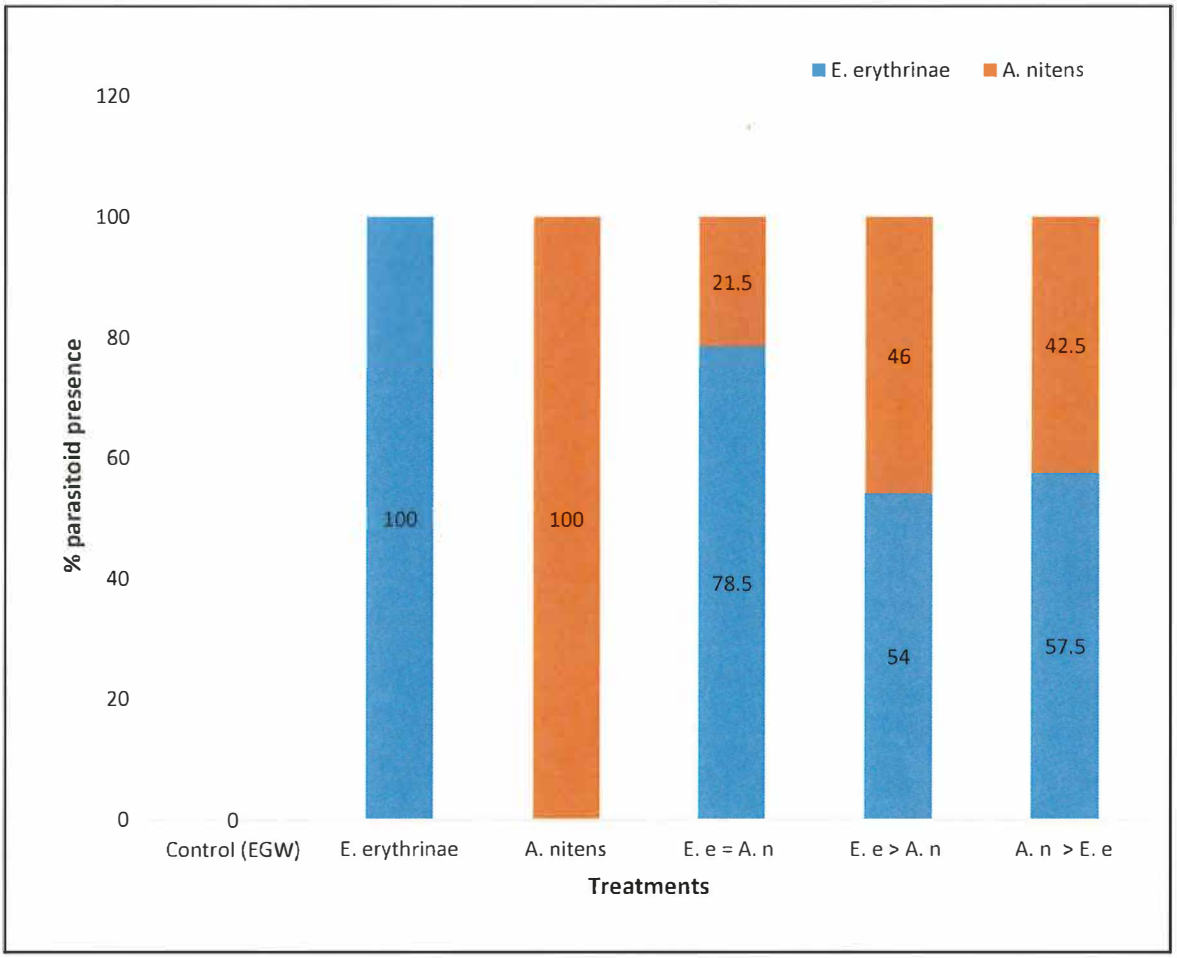

Figure 13. Ratio of parasitoid presence in plant tissues.

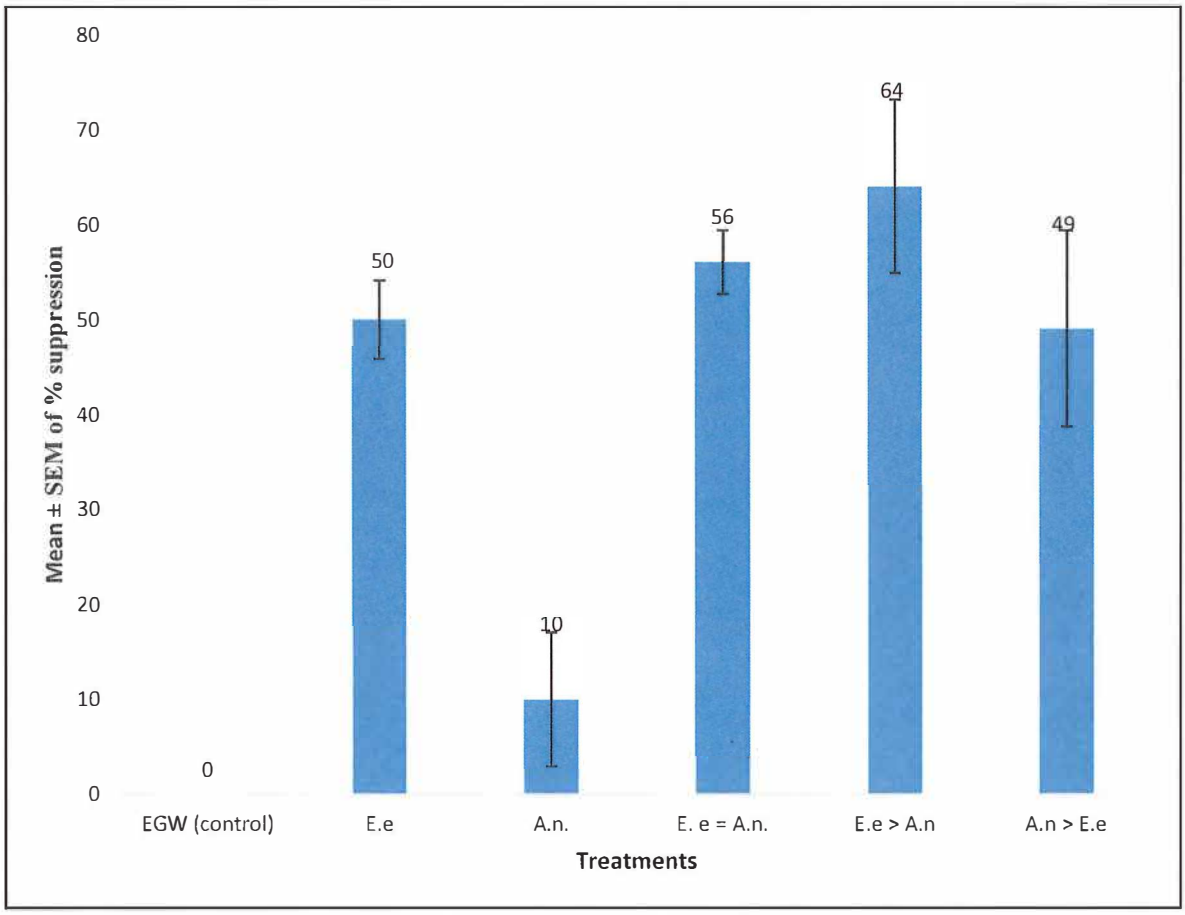

Figure 14. Erythrina gall wasp suppression levels by parasitoids.

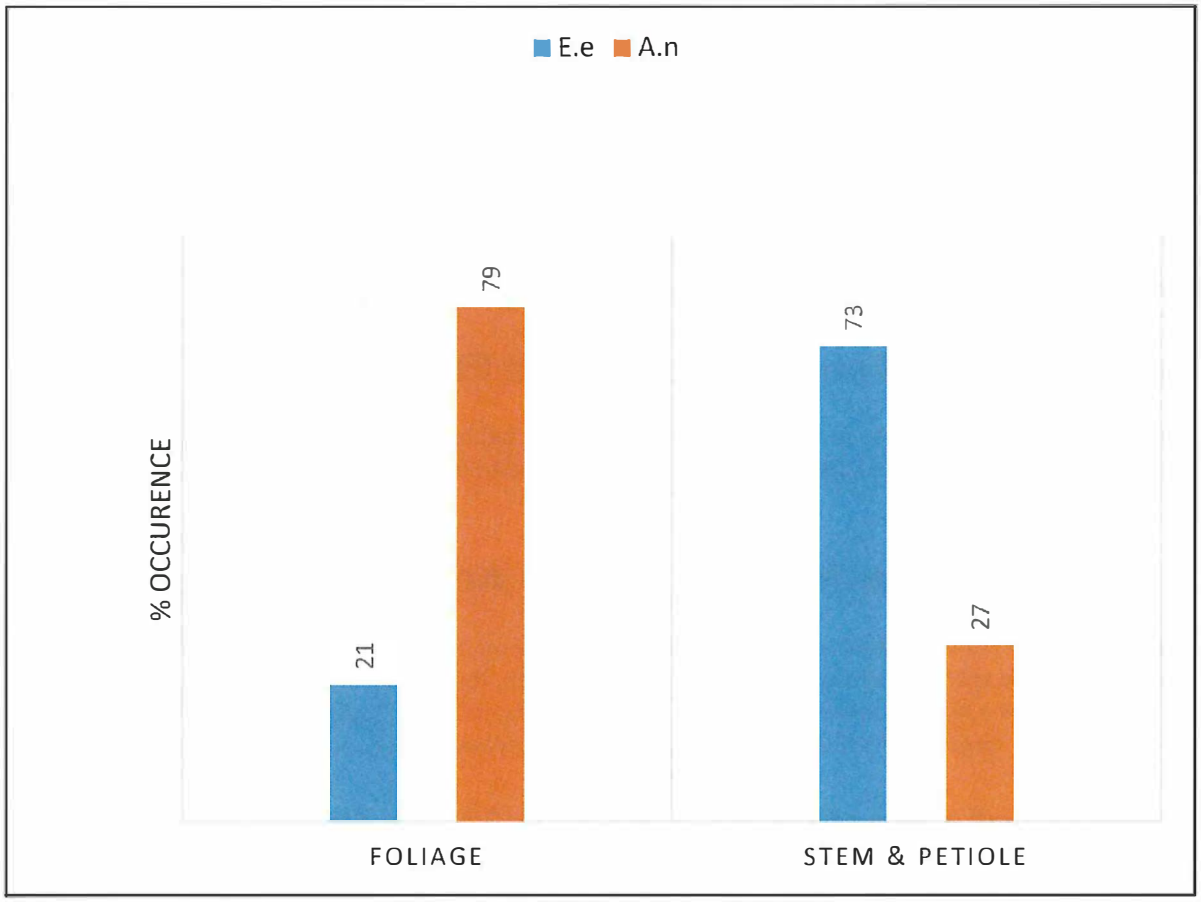

Figure 15. Feeding preferences of *A. nitens* and *E. erythrinae*.

ENVIRONMENTAL IMPACTS

Field observations of *A. nitens* in Tanzania and South Africa, and quarantine lab studies conducted in containment in Hawai'i, strongly indicate that the proposed release of this Erythrina gall wasp biocontrol agent will not have any undesirable, negative, non-target effects on the natural environment of the Hawaiian Islands. Environmental impacts associated with the No Action Alternative of not issuing permits for release are those resulting from the continued damage to the native wiliwili tree and other species in the genus *Erythrina* caused by Erythrina gall wasp and environmental damage caused by other methods (such as systemic pesticide) employed to control Erythrina gall wasp in affected trees. The proposed release and establishment of *A. nitens* is expected to supplement the success of *E. erythrinae* in suppressing infestations of Erythrina gall wasp, effectively reducing these impacts further.

Literature Search for Other Host Records

A literature search found little to no information about *A. nitens* other than a description of the taxonomy of this species and host and plant associations with known collections used for the species description (Prinsloo & Kelly 2009). No information was found to indicate that *A. nitens* has ever been used for biological control anywhere else in the world. Therefore, the only information presently available on hosts for *A. nitens* comes from Prinsloo & Kelly (2009), field collections performed during exploration in

South Africa and Tanzania, and research performed in the HDOA Plant Pest Control Branch ICF (Yalemar et al 2016).

Host Specificity in Country of Origin

Field observations in Tanzania and South Africa indicated that *A. nitens* emerged only from galls produced on *Erythrina* species. Such galls may contain Erythrina gall wasp (*Quadrastichus erythrinae*) or other African *Quadrastichus* species. This finding of host specificity was confirmed by experiments performed at the HDOA Insect Containment Facility (Yalemar et al 2016).

Potential Impact on Threatened and Endangered Species

Because *A. nitens* feeds exclusively on gall-forming insects and because there are no gall-forming species classified as threatened or endangered in Hawai'i, no impacts to threatened or endangered species are anticipated.

Potential of *Aprostocetus nitens* to Act as a Hyperparasite

This information is not available because scientific literature on *A. nitens* is limited to a taxonomic description of the species. Because of this lack of information, there is uncertainty regarding this species' potential to act as a hyperparasite, however field observations and host specificity studies indicate that this species only targets Erythrina gall wasps and does not develop effectively within any other host.

Potential of *Aprostocetus nitens* to Attack Non-Targets

Field observations in South Africa and Tanzania, and host specificity tests in quarantine, in Hawai'i have confirmed that *A. nitens* will not attack non-target gall forming species (Yalemar et al 2016) and, therefore, release of *A. nitens* would not have any negative impact on the natural environment in Hawai'i. Results of the host specificity trials indicate that *A. nitens* is host-specific and has no preference for any of the seven non-target gall-forming species studied. In addition, even if *A. nitens* were to parasitize these non-target species, it would be unable to produce any offspring, because none of these species were shown to be suitable for supporting this species' development.

IMPACTS TO CULTURAL VALUES

No negative impacts on cultural values are anticipated from the release of this parasitoid on the human environment in Hawai'i. A positive impact would be the further reduction of Erythrina gall wasp damage to economically important cultivated *Erythrina* species and culturally important wiliwili trees.

ASM Affiliates Hawai'i, a Heritage and Cultural Resource Management firm, prepared a Cultural Impact Assessment (CIA) for the proposed action, which is attached as Appendix A and summarized below. The CIA report 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, on November 19, 1997, and pursuant to Act 50, approved by the Governor on April 26, 2000.

In general, CIA studies are 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 particular 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 on understanding the cultural and historical context of the Erythrina gall wasp and the endemic wiliwili with respect to Hawai'i's host culture. 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 *E. erythrinae* to the Hawaiian Islands. It also includes a discussion of potential impacts as well as appropriate actions and strategies to mitigate such impacts.

Location
Conventional CIAs assess the potential impacts on cultural practices and features within a geographically defined "project area," which are often 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 emphasis on areas where the target species can be found in abundance. In Hawai'i, *E. erythrinae* is found on the island of O'ahu, Hawai'i, Kaua'i, Maui, Moloka'i, Kaho'olawe, and Lāna'i.

Consultation
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 Erythrina gall wasp and wiliwili and its habitat. Gathering input from community members with genealogical ties and long-standing residency or relationships to the anticipated area of impact or to the target species is vital to the process of assessing potential cultural impacts on resources, practices, and beliefs.

In an effort to identify individuals knowledgeable about traditional cultural practices and/or uses associated with the subject-affected environment, a public notice was submitted by ASM Affiliates to the Office of Hawaiian Affairs (OHA) for publication in the May 2019 issue of their monthly newspaper, *Ka Wai Ola.* While no responses were received from the public notice, 45 individuals were contacted via email and/or phone regarding the preparation of the CIA report. A list of those individuals is available upon request. Of the 45 individuals contacted, 20 responded to the request with either brief comments, referrals, or acceptance of the interview request (see Table 2). ASM Affiliates conducted a total of eight interviews, the summaries of which can be found in the CIA.

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

Table 2. Persons that responded to request 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 CIA

John Repogle	Retired from The Nature Conservancy, Ka'ū Preserve, Hawai'i	3/6/2019	See summary in CIA
Nohealani Ka'awa	The Nature Conservancy, Ka'ū Preserve, Hawai'i	3/6/2019	See summary in CIA
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 CIA
Robert Yagi	Waikōloa Dry Forest Initiative, Hawai'i	4/3/2019	See summary in CIA
Wilds Brawner	Ho'ola Ka Manaka'ā at Ka'ūpūlehu, Hawai'i	4/9/2019	See summary in CIA
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 CIA
Wili Garnett	Cultural practitioner, Moloka'i	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, O'ahu	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 in CIA
Forest Starr	Starr Environmental, Maui	5/9/2019	See summary in CIA
Manaiakalani Kalua	Cultural practitioner, Hawai'i	5/30/2019	See summary in CIA
Talia Porter	Honolulu Botanical Gardens, O'ahu	6/3/2019	Responded to interview request but was unable to secure an interview.
Robert Keano Ka'upu		6/16/2019	

	Cultural practitioner, O'ahu		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		7/16/2019	
	Cultural practitioner, O'ahu	7/31/2019	Responded to interview request but was unable to secure an interview.
Pelehonuamea Harman			Referred ASM staff to Dennis Kana'e Keawe.
	Cultural practitioner, Hawai'i	8/12/2019	
Dennis Kana'e Keawe			See summary in CIA
	Cultural practitioner, Hawai'i	8/30/2019	
Iliahi Anthony			See summary in CIA
	Cultural practitioner, Hawai'i		

End of Table 2

Summary of Culture-Historical Background, Consultation, and Significance Assessment
A review of the cultural-historical background in addition to the consultation efforts has yielded no reported cultural use for Erythrina gall wasp nor is there any evidence to suggest that Erythrina gall wasp is crucial to any particular ethnic groups' cultural history, identity, practices, or beliefs, nor does it meet any of the significance criteria outlined by the CIA. Although Erythrina gall wasp does not meet any of the significance criteria, the use of wiliwili in Hawaiian culture and its appearance in traditional legendary accounts are both extensive and well-documented.

The use of wiliwili in Hawaiian culture and its appearance in traditional legendary accounts are both extensive and well-documented in mo'olelo, 'ōlelo no'eau, and Kumulipo. Wiliwili clearly played a vital role in enhancing and maintaining the traditional lifestyle of the Hawaiian people. Its availability to those who settled in the leeward parts of the islands proved most useful as the lightweight and highly buoyant wood was carved into small fishing canoes but more commonly fashioned into 'iako (outrigger booms) and ama (outrigger floats) for larger canoes. Wood of wiliwili has also been used for fishing and aquatic gear, carved into wooden images in traditional hula ki'i and pendants, shaped into water troughs and used as firewood. Flowers and seeds have been used in traditional lei making and bark and flowers were employed in traditional healing practices. The brightly colored flowers are known to indicate increasing presence of sharks in nearshore waters.

Reference to an extensive wiliwili forest in the Kohala District of Hawai'i Island is found in the account of Kapunohu, a hero, who, in a test of strength, is said to have forced his spear with a single thrust through some eight hundred trees. Wilds Brawner described observing many kupuna wiliwili (ancient wiliwili) trees in the North Kona District of Hawai'i Island. Consultation with Wilds Brawner and Mike DeMotta also indicates that an extensive wiliwili forest was also present in the Kahikinui and Kaupō areas of Maui Island—an area that has been severely devastated by the EGW in more recent years.

It is evident from culture-historical background research and from the consultation efforts that wiliwili was widely used in various traditional Hawaiian cultural practices. While historical accounts describing its abundance are somewhat conflicting, it is evident that wiliwili populations were in decline by the late 19th-century as a result of the changing political economy of the islands, particularly the shift to large scale ranching and commercial agriculture which severely impacted Hawai'i's dryland forest habitat. The

overall decline in dryland forest habitat coupled with the impacts of private property rights are likely the key factors that have contributed to the decline in the cultural uses of this plant. Although the cultural uses of wiliwili may have waned during the 20th century, as evident in the consultation efforts, knowledge of the cultural and ecological significance of this plant have remained deeply embedded in the hearts and minds of Hawai'i's people. Though the arrival of the EGW has decimated thousands of wiliwili trees, it has also generated more public awareness about this plant's importance to Hawai'i's dryland forest ecosystem and to Hawaiian culture.

Identification of Cultural Impacts and Recommendations

Based on a synthesis of cultural uses summarized above and described in depth in the CIA, it is clear that wiliwili is a culturally significant floral species and the primary habitat (dryland forest) in which it is found could be considered a transitional cultural property that is significant under Criterion E – because it has an important value to the native Hawaiian people. For these reasons protecting the remaining populations of *Erythrina* is imperative as this will help to ensure that its environmental and cultural significance are not diminished. It is likely that increasing populations of wiliwili may help in the revitalization of certain Hawaiian cultural practices.

Based on the information derived from the cultural-historical background and from the insight shared by the consulted parties, it is the assessment of this study that the release of the proposed biocontrol agent, *Aprostocetus nitens*, 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 *Quadrastichus erythrinae* from claiming more of Hawai'i's native *Erythrina*, impacts to this valued resource would be anticipated.

While no specific cultural impacts were identified through the CIA, 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 in the CIA:

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.

The CIA recommends that conducting background research, consulting with community members, and taking steps toward mitigating any potential cultural impacts is done in the spirit of Aloha 'Āina, a contemporary movement founded on traditional practices and beliefs that emphasize the intimate relationship that exists between Native Hawaiians and the 'āina (land).

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 pest insect 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 pest insect 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 the invasive pest wasp on native wiliwili and therefore the State's natural environment. 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 pest 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 invasive erythrina gall wasp. The biological control agent is a stingless wasp 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 pest 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 invasive wasp and is expected to improve environmental quality by reducing the negative impacts caused by the wasp 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 native wiliwili by reducing the direct attack and negative impact caused by the target pest.

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 direct impact of this invasive species on native wiliwili trees, protecting the tree from extinction in the wild, and thus beneficial to 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 species and is not expected to affect air or ambient noise levels.

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 pest 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 will not substantially affect scenic vistas or viewplanes identified in county or state plans or studies. The biocontrol agent will have a positive impact on scenic vistas by preserving the native wiliwili tree.

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

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 a Finding of No Significant Impact (FONSI) with the FEA.

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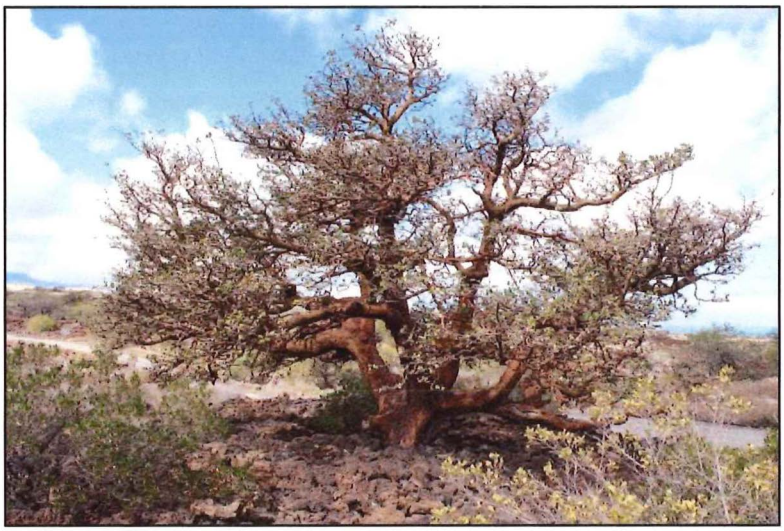
APPENDIX 1: CULTURAL IMPACT ASSESSMENT FOR THE PROPOSED STATEWIDE RELEASE OF A WASP PARASITOID (*APROSTOCETUS NITENS*) AS A BIOCONTROL FOR THE ERYTHRINA GALL WASP (*QUADRASTICHUS ERYTHRINAE*)

A Cultural Impact Assessment for the Proposed Statewide Release of a Wasp Parasitoid (*Aprostocetus nitens*) as Biocontrol for the Erythrina Gall Wasp (*Quadrastichus erythrinae*)

State of Hawai'i

FINAL



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ASM Project Number 31270.00

A Cultural Impact Assessment for the Proposed Statewide Release of a Wasp Parasitoid (*Aprostocetus nitens*) as Biocontrol for the Erythrina Gall Wasp (*Quadrastichus erythrinae*)

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 wasp parasitoid (*Aprostocetus nitens*) to further combat the erythrina gall wasp (EGW) (*Quadrastichus erythrinae*), a destructive pest that has adversely affected the endemic *wiliwili* tree (*Erythrina sandwicensis*) and other non-native *Erythrina* species found in Hawai'i (Heu et al. 2008; Suszkiw 2010). EGW was first described in 2004 as a new species originating from specimens in Singapore, Mauritius, and Reunion (Kim et al. 2004). On April 19, 2005, damage from the EGW was discovered on coral trees (*Erythrina varigata*) at Mānoa on O'ahu and by August of that year, the EGW had reportedly spread to the islands of Hawai'i, Kaua'i, Maui, and Moloka'i (Bell et al. 2013; Li et al. 2006). By October of 2005, the EGW was reported on the islands of Kaho'olawe and Lāna'i (Heu et al. 2008). In 2008, following the completion of extensive studies to identify a natural predator, the *Eurytoma erythrinae* was identified and subsequently released as a biocontrol agent targeting EGW at various locations across the State of Hawai'i. The introduction of *E. erythrinae* has significantly reduced the EGW populations resulting in the recovery of many *wiliwili* trees. Despite the overall decrease in the EGW, continued statewide monitoring of the surviving populations of *wiliwili* by the State of Hawai'i has shown that the inflorescences and seed pods are still being adversely impacted by the EGW. The proposed biocontrol agent *Aprostocetus nitens*, is expected to enhance control against the EGW by complimenting the previously introduced biocontrol agent *E. erythrinae*. In the State of Hawai'i, the EGW is formally recognized as one of numerous "invasive species." 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). To further combat the remaining populations of EGW, the State of Hawai'i is proposing to release another natural enemy (*A. nitens*, a wasp parasitoid) by the year 2021 to lower the population of EGW in inforescence and seed pods.

The current CIA is intended to supplement 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 the endemic *wiliwili* 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 description of the EGW's impacts on the *Erythrina spp.* and the proposed biocontrol agent, *Aprostocetus nitens*. 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 presentation of the natural and cultural history of *wiliwili*; 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 through the use of biological control (also referred to as biocontrol). 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.

ERYTHRINA GALL WASP AND THE PROPOSED BIOLOGICAL CONTROL AGENT

The erythrina gall wasp (EGW), scientifically termed *Quadrastichus erythrinae* (Figure 1) is a non-native gall-forming eulophid wasp that deposits its eggs into the leaf and stem tissue of the host plant (Bell et al. 2013; Heu et al. 2008). As the wasp larvae develop, they induce the formation of galls on the leaflets and petioles (Figure 2). If the infestation progresses, it results in the loss of growth and vigor, and sometimes defoliation and death of the tree (ibid.). Of all the species of *Erythrina* in Hawai'i that have been impacted by the EGW, the endemic *wiliwili* tree—a keystone species of Hawai'i's dryland forest—prompted officials to make serious efforts to respond to this rapidly destructive infestation. Bell et al. (2013:216) reports that a variety of treatments, including insecticide application and infected tissue removal, were tested but proved to be "insufficient to address the large spatial scale of the *Q. erythrinae*." Bell et al. (ibid.:216) goes on to report that the Hawai'i Department of Agriculture and the University of Hawai'i at Mānoa College of Tropical Agriculture and Human Resources began identifying and assessing "the biological life history and host specificity of three potential biocontrol agents with origins in Africa". Of the three agents studied, *Eurytoma erythrinae* (Figure 3), a predator of the erythrina gall wasp was the selected candidate and on November 28, 2008, some 500 specimens reared in captivity were released at a gall-infested *wiliwili* stand in the Lili'uokalani Botanical Garden in Honolulu (Suszkiw 2010). Specimens of *E. erythrinae* were subsequently released at sites on the islands of Hawai'i, Maui, O'ahu, and Kaua'i (Bell et al. 2013). The introduction of *E. erythrinae* has significantly reduced the EGW populations resulting in the recovery of many *wiliwili* trees (Figure 4). Despite the overall decrease in the EGW, continued statewide monitoring of the surviving populations of *wiliwili* has shown that the inflorescences and seed pods are still being adversely impacted by the EGW. The proposed biocontrol agent *Aprostocetus nitens* is expected to enhance control against the EGW since it targets infested inflorescences and seed pods which are still vulnerable to the EGW. Host specificity tests conducted at the State of Hawai'i Department of Agriculture (HDOA) indicated that *A. nitens* is host specific and has different feeding preferences than *E. erythrinae*.

Figure 1. Pair of EGW, male (left) and female (right) (Plant Pest Control Branch 2013).

Figure 2. Close up of galling to *wiliwili*, showing gall wasp emergence holes (Plant Pest Control Branch 2013)

Figure 3. *Wiliwili* gall wasp parasitoid, *Eurytoma erythrinae* (Plant Pest Control Branch 2013).

Figure 4. Shalan Crysdale of The Nature Conservancy Ka'ū Preserve points to formerly infected areas on a *wiliwili* tree in Ka'ū.

2. BACKGROUND

To generate an understanding of the Hawaiian cultural significance and value of *wiliwili* and to establish a cultural context in which to assess any potential impacts that may result from the use of biocontrol to save existing populations of *wiliwili* trees across the Hawaiian Islands, a general culture-historical context is provided that includes information on traditional legendary accounts, documented traditional uses, and excerpts from 19th and 20th century Hawaiian language newspapers.

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.

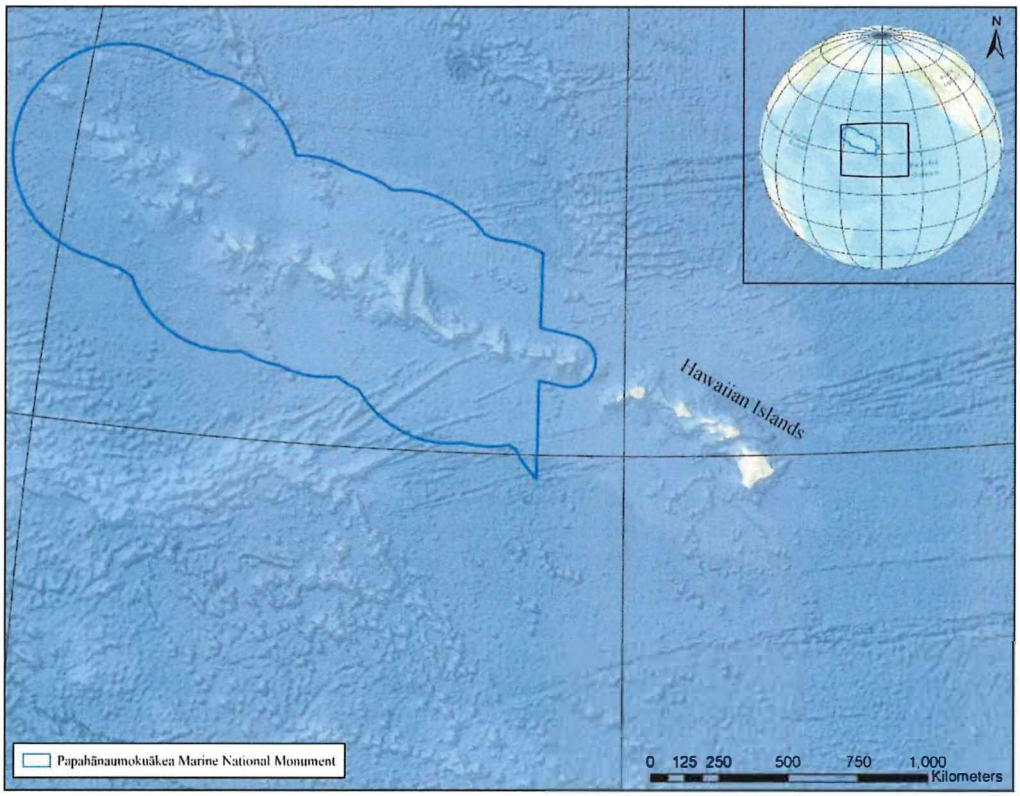

Figure 5. Map of the Hawaiian archipelago.

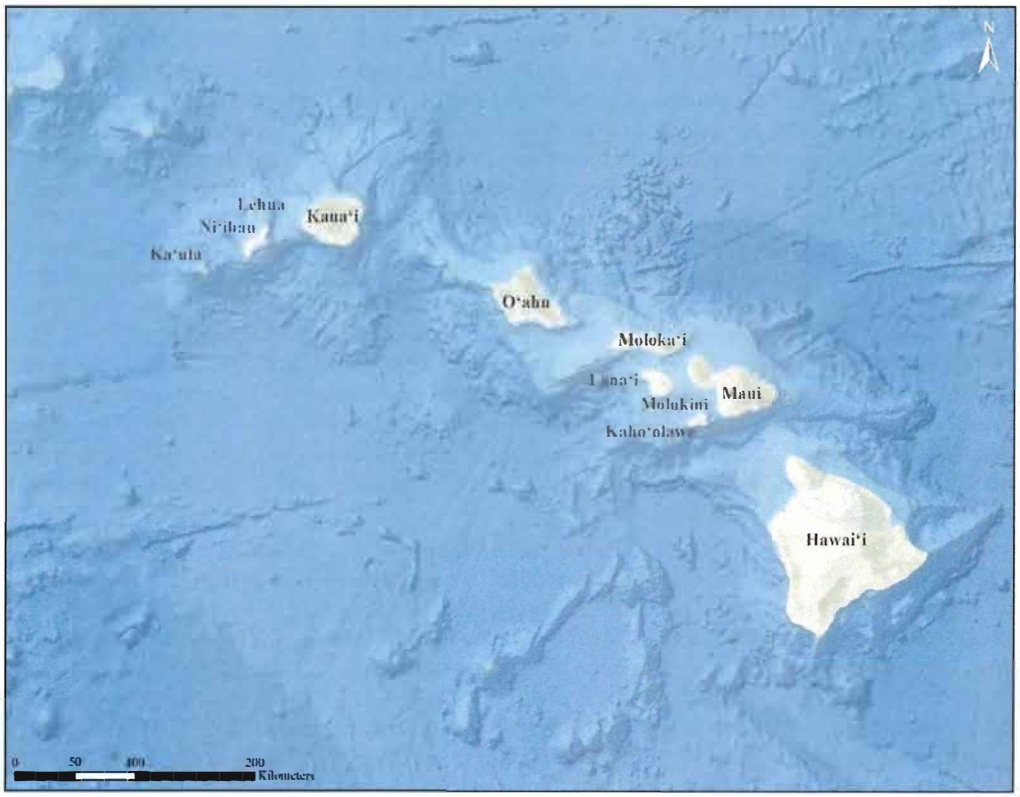

Figure 6. Map of the main Hawaiian Islands.

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 and shape 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 communities 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, which *hoa'āina* often retained for 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 to Hawai'i's Native Forests

Their ancient and ingrained philosophy of life tied Hawaiians 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 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 "[t]he 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 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, land, natural resources, 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).

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. Elbert and Pukui (1986:132), defined *kapu*

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 researchers 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 sociopolitical 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 voyages, 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 *'iliahi* 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 *ali'i* 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, 'Ama'u, or Hapu'u, 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).

On May 8th, 1819, Kamehameha, who had seen the impacts brought about by foreign introductions, died at his royal residence at Kamakahonu in Kailua-Kona and named his son 'Iolani Liholiho heir to his kingdom (Kamakau 1992). By May 21st 'Iolani 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), Ka'ahumanu (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 Kuamo'o (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 socially and 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 Hawai'i 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 Hawai'i's royalty, including Ka'ahumanu 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 *ali'i* 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 *Mō'ī* 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 'Āina* 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 *ahupua'a* 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 Hawai'i 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 Hawai'i, the planting of *kiawe* or algaroba (*Prosopis pallida*) 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 Hawai'i'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 sugarcane 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 Hawai'i. 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). The history of classical biocontrol in the Hawaiian Islands has certainly evolved, from unregulated and often poorly thoughtout introductions to one requiring government oversight and a stringent range of pre-release testing protocols that screens agents for host specificity and potential adverse impacts to other species (Reimer 2002). The origins of biocontrol in the Hawaiian Islands emerged during latter half of the 19th century, as the islands became an agricultural hotspot for sugarcane and many new plant species, some of which carried insect pests, that 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 metaphorically to refer to people or things that exhibited wild behavior and for people who came to the islands without having any 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 College 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 impacts on other species. None of the agents introduced since the review process was initiated in 1975 have attacked any native or beneficial plant or animal species. This was not the case before 1975.

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.

NATURAL AND CULTURAL HISTORY OF *WILIWILI*

The endemic *wiliwili* (*Erythrina sandwicensis*) grows primarily in Hawai'i's tropical dryland forest (Figure 7) below the 600-meter (1,968 feet) elevation and on volcanic substrates characterized by its high viscosity that tends to form loose, rough blocks of basaltic lava (Bell et al. 2013). Because of the preferred environmental conditions, *wiliwili* are more likely to be non-uniformly distributed across a particular lava flow. Although *wiliwili* have been found growing in Hawai'i's dry coral plains, its preferred habitat is within the biologically diverse and critically threatened tropical dryland forests ecosystem—an ecosystem that is sustained with as little as 30-120 centimeters (10-55 inches) of annual rainfall (Krauss 1993). Hawai'i's dryland forests host 25% of all endangered Hawaiian flora and studies have estimated that only 5-10% of Hawai'i's dryland forest ecosystem remains (Bell et al. 2013; Bruegmann 1996).

The dramatic decline in Hawai'i's dryland forest has been "attributed to deforestation, land development, invasive plant species, changes in fire regime, and introduced ungulate grazing" (Bell et al. 2013:215). In the 1930s, American Ecologist, Frank E. Egler (1942) wrote about the changes to Hawai'i's dryland forest areas following Western contact. In identifying some of the main causes, Egler wrote:

> With the arrival of Europeans came the introduction and semi-naturalization of cattle, sheep, and goats—the greatest single blunder that could have been unwittingly perpetrated upon a scientifically and economically valuable vegetation cover. Some of these animals had taboos placed upon them; they multiplied rapidly and became naturalized in the hills and mountains. The animals completed the destruction of the original foothill vegetation, permitting the soil cover to be stripped from the lava rock, and causing the dry summer to be vastly more unfavorable for plant life. (ibid.:18)
>
> Within a relatively short period following European colonization, there was created a large area practically devoid of closed vegetation, an unsaturated region ready to absorb any of dozens of pioneer species, be they introduced or native. The lowlands, being the site of the ports, towns, gardens, and experimental stations, did receive a tremendous influx of foreign plants, some of which found favorable the barren unoccupied overgrazed lowlands. They are said to have spread over the island like uncontrolled fire. Thus lantana, opuntia, and klu (*Acacia farnesiana* (L.) Willd.) came to dominate the lower slopes while kiawe (*Prosopis chilensis* (Molina) Stuntz.) covered the dusty coastal plain with an evergreen verdure that transformed the face of the land. (ibid.:18)

The transformation of the native vegetation in the dryland forest is shown in a historic photo found at the Hawai'i State Archives that shows two *wiliwili* growing in the dry desolate conditions of Kaho'olawe Island (Figure 8). In spite of these sweeping changes, some pockets of dryland forests across Hawai'i managed to escape this devastating onslaught. Egler's (1942:20) note about *wiliwili* as "apparently unpalatable to cattle" may explain why these trees managed to survive, even in pasture lands. In the North Kona District on the Island of Hawai'i stands some of the largest remaining pockets of dryland forest. On the island of Maui, along the leeward slopes of Haleakalā in Auwahi Ahupua'a, stands another pocket of dryland forest surrounded by the grazing lands of 'Ulupalakua Ranch. These patches of dryland forest, however, continue to be adversely impacted by introduced plants including fountain grass (*Pennisetum setaceum*); ungulates, mainly cattle, and feral goats and sheep; and pests such as rats (Bruegmann 1996).

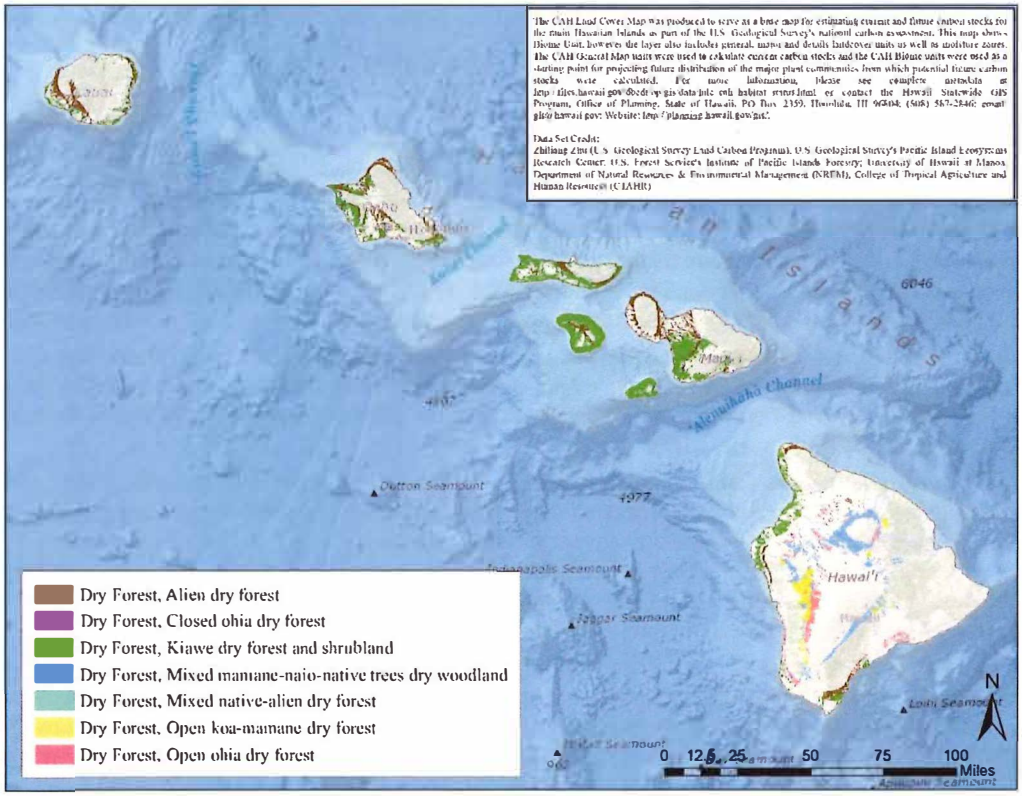

Figure 7. Estimated extent of Hawai'i's dryland forest habitat

Figure 8. Historical photo showing two *wiliwili* trees growing on Kaho'olawe Island, date and photographer unknown. Hawai'i State Archives, PP-46-10-002.

Cultural Value of Hawai'i's Dryland Forests

The diversity of flora and fauna found in Hawai'i's dryland forests provided an array of natural resources that were extensively utilized by Hawaiians for utilitarian, ceremonial, and medicinal purposes. In an ethnobotanical study conducted for Auwahi on the island of Maui, Program Manager of the Auwahi Forests Restoration Project, Arthur C. Medeiros, writes:

> From a utilitarian point of view, nearly everything that could be obtained from the rain forests could found in the dryland forests, as well as probably a much greater seasonal productivity of birds and spring flushing of vegetation. Dryland forests were also the source of a wide variety of tree species that provided wood to early Hawaiians. To human cultures without metal, sources of abundant and diverse hardwoods are one of the most important of ethnobotanical resources. (Medeiros et al. 1998:7)

The array of unique natural materials found in Hawai'i dryland forests, particularly hardwoods, likely played a vital role in the expansion of Hawaiian society into the leeward regions of the islands. Such resources were traditionally utilized for medicine, tool-making, canoe and house construction, weapons, fishing, dyes, and for ceremonial purposes (ibid.). Medeiros et al. (ibid.:l) also notes other miscellaneous uses of dryland forests including the collection of "edible fruits or seeds, bird lime, cordage, a fish narcotizing agent, firewood... scenting agents, *poi* boards, and *hōlua* sled construction." Historical accounts have identified multiple areas across Hawai'i where dryland forests were located and where *wiliwili* could be obtained. The *'ōlelo no'eau* (proverbial saying) "Ka wiliwili o Kaupe'a," (The *wiliwili* grove of Kaupe'a) makes reference to a *wiliwili* grove that grew in Kaupe'a, 'Ewa, O'ahu (Pukui 1983:180). In summarizing known *wiliwili* habitat, Tommy Holmes, in his book *The Hawaiian Canoe*, (1981:23) writes:

> *Wiliwili*, by some accounts, was never very plentiful. Kalokuokamaile notes that "in the olden days...there were very few places in which this tree grew." This is somewhat at odds with botanists W. E. Hillebrand, who wrote that *wiliwili* was "much more common formerly than now." It was said by some that Ka'ū was the best place for *wiliwili*. Today *wiliwili* can be found flourishing in certain areas. The author had visited a grove of *wiliwili* above the Mākena area on Maui that comprises several hundred acres. Many of the trees are 3 to 4 feet in diameter with trunks often rising 15 to 20 feet high before branching. Other sizeable stands of *wiliwili* dating from precontact times can still be found in the Pu'uanahulu, Pu'uwa'awa'a and Kalapana areas of Hawai'i. Smaller populations are also found on Kaua'i behind Kekaha, in west O'ahu, south and west Moloka'i, Kaupō on Maui, Ka'ū on Hawai'i and on Kaho'olawe.

Physical Description of *Wiliwili*

Wiliwili is a large, Hawaiian endemic, dryland forest tree that can reach heights between eighteen to forty-five feet tall (Figures 9 and 10). This slow-growing tree has a thin yellowish-orange bark with shallow fissures with a sparsely armed trunk and branches (Figures 11 and 12) (Lilleeng-Rosenberger 2005). The branches and bark of the *wiliwili* have short spines (Figure 13) and the tree often has a gnarled appearance (Krauss 1993). As the tree matures, the spines become less noticeable (ibid.). Its gnarled and twisted (*wili*) appearance is a striking and distinguishing feature of this dryland tree (Figure 14), which Hawaiians duly named *wiliwili*, meaning "to wind, twist, writhe, crank, turn, screw" (Pukui and Elbert 1986:385). *Wiliwili* have developed highly specialized adaptations suitable for the arid conditions of Hawai'i's leeward regions. The thin outer bark and stems are photosynthetically active (Doccola et al. 2009). *Wiliwili* is one of few deciduous native trees found in Hawai'i. It loses its leaves during the dry summer months as well as during periods of prolonged droughts to conserve water loss (Lilleeng-Rosenberger 2005). Leaves are most present from November through April but correlate more with rainfall (Doccola et al. 2009). Each leaf has three round to triangular-shaped leaflets (Figure 15). The leaves of a healthy *wiliwili* tree measure about six centimeters long by seven centimeters wide with a smooth upper surface and a hairy underside ((Lilleeng-Rosenberger 2005). The flowers of the *wiliwili* are bilaterally symmetrical and clustered at the end of the branches (Figures 16 and 17). The corolla, or petals, ranges in color from orange, yellow, white, to light green (see Figures 16 and 17). The flowers are bilaterally symmetrical and occur in terminal inflorescences (Lilleeng-Rosenberger 2005). When the tree is in full bloom it is strikingly beautiful and vibrant and can be quite easily observed.

The *wili* (twisting or winding) characteristic is also evident in the brown woody pods that become twisted when they mature (Figure 18). These hanging pods are slightly woody and can contain anywhere from one to three seeds per pod. *Wiliwili* seeds range in color from bright red-orange (Figure 19) to purplish in color and are bean-shaped measuring approximately 1.5 centimeters long by 1 centimeter wide. Each seed is capsuled in a hard outer coating

that softens when exposed to water. *Wiliwili* seeds have been incorporated into the Hawaiian tradition of *lei* making (Shimizu Ide 2000). These seeds, so highly prized by *lei* makers are also a food source for rodents and beetles. The soft, whitish wood was also utilized by Hawaiian. The buoyant nature of the dried wood (Figures 20 and 21) was the choice material for surfboards, net floats, and the outriggers (*ama*) on canoes (Lilleeng-Rosenberger 2005).

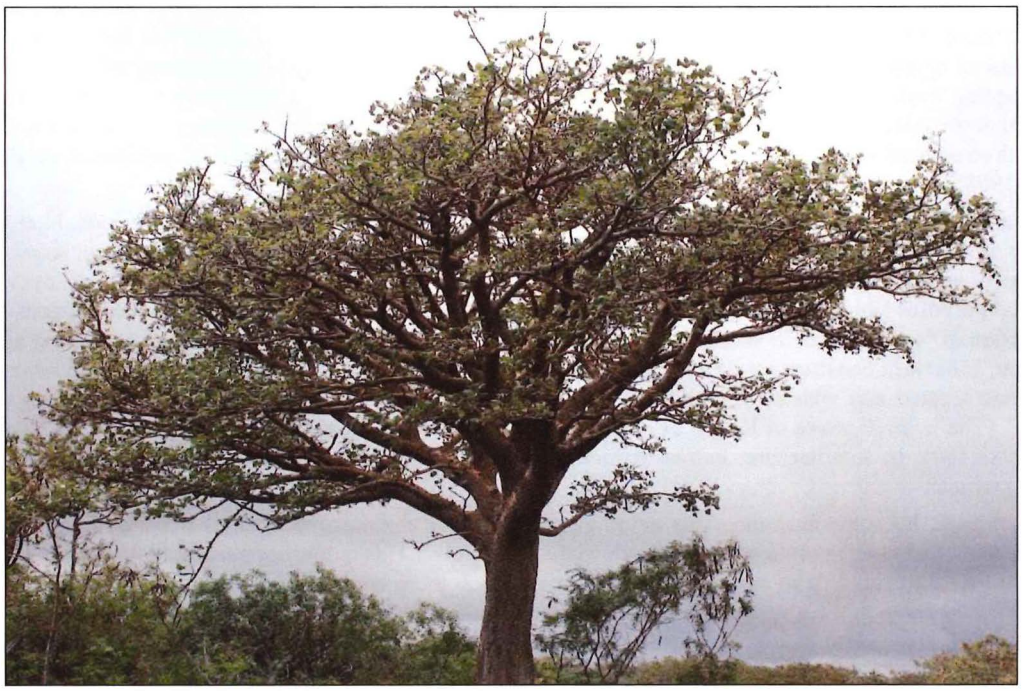

Figure 9. Tall *wiliwili* tree in Ka'ū, Hawai'i Island.

Figure 10. *Wiliwili* growing in the uplands of Kau Ahupua'a, North Kona, Hawai'i Island.

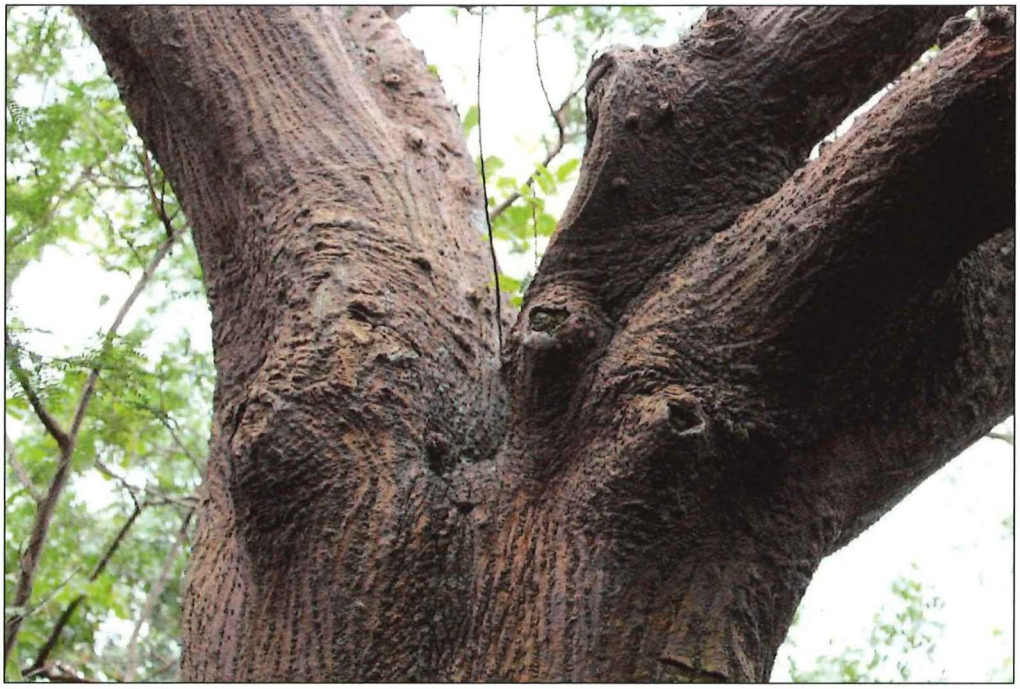

Figure 11. The bark of a *wiliwili* tree, Ka'ū, Hawai'i Island.

Figure 12. Close up of the thin and porous outer bark from a dried *wiliwili* tree.

Figure 13. Short spines on a young *wiliwili* tree.

Figure 14. Low-lying *wiliwili* tree twisting over the rugged lava landscape in Waikōloa Ahupua'a, South Kohala, Hawai'i Island.

Figure 15. Leaves of the *wiliwili* tree, Ka'ū, Hawai'i Island.

Figure 16. Close-up of *wiliwili* flowers, Waikōloa, Hawai'i.

Figure 17. *Wiliwili* blossoms in Kaū Ahupua'a, North Kona, Hawai'i Island.

Figure 18. Close-up of a *wiliwili* seed pod, Ka'ū, Hawai'i Island.

Figure 19. Reddish-orange seeds of a *wiliwili* tree, Ka'ū, Hawai'i Island.

Figure 20. Dried *wiliwili* trunk at Waikōloa Ahupua'a, Kohala, Hawai'i.

Figure 21. Close up of dried *wiliwili* wood, Ka'ū, Hawai'i Island.

Traditional Legendary Accounts Concerning *Wiliwili*

Several traditional legendary accounts concerning the *wiliwili* have been recorded, one of which includes the famed Kumulipo, a Hawaiian cosmogony chant that describes the birth of this tree. The second account titled *Nā Wiliwili O Pā'ula,* originally told in Hawaiian by Mrs. Wiggins and recited by Mary Kawena Pukui tells of how three distinct features of the *wiliwili* came to be. The third account concerns the adept and youthful demigod Māui and his use of *wiliwili* during the battle to entangle and slow the speeding sun, and the following five legendary accounts contains brief mentions of *wiliwili* trees at specific location on the islands of Kaua'i, O'ahu, and Hawai'i.

Birth of the Wiliwili in the Hawaiian Cosmogony Chant, Kumulipo

The Kumulipo is a *mele ko'i honua* (Hawaiian cosmogonic chant) that describes the birth of various life forms found in the Hawaiian Islands. Containing over 2,000 lines, this chant was uttered by the high priest Puou in Kealakekua, Kona upon the birth of the 18th-century high chief Ka'ī'īmamao as a way to recognize and fortify the depth of his royal family's divine origin (Liliuokalani 1978). This chant, nonetheless, anchors the Hawaiian world and its people to the ocean by way of the primal substance known to Hawaiians as *walewale* (slime). According to the *Kumulipo*, all animate and inanimate objects were literally born or *hānau 'ia*, with the *'uku ko'ako'a* or coral polyp being identified as the very first organism born in the ocean. This lengthy chant is broken up into sixteen *wā* or eras with the first four *wā* centered around the reoccurring theme of duality where each aquatic life form is paired with a land counterpart. Throughout the third and fourth *wā*, the birth of various dryland forest plants are described, one of which includes the *wiliwili*. In this chant, the *wiliwili* is paired with its aquatic counterpart, *wili*, the name given to a boring type of fish (Andrews 1865). That portion of the chant describing the *wiliwili* reads:

O kane ia Wai'ololi, o ka wahine ia Wai'olola	Man by Waioloili, woman by Waiolola
Hanau ka Wili noho i kai	The Wili was born and lived in the sea;
Kia'i ia e ka **Wiliwili** noho i uka	Guarded by the **Wiliwili** that grew on land (tiger's claw
He po uhe'e i ka wawa	tree)
He nuku, he la'i ka 'ai a kolo	A night of flight by noises
O ke Akua ke komo, 'a'oe komo kanaka	Through a channel; la-i is food, and creeps
(Beckwith 1951:198)	So the gods may enter, but not man.

(Liliuokalani 1978:16–17)

Nā Wiliwili O Pā'ula (The Wiliwili Trees of Pā'ula)

In the book, *Folktales of Hawai'i*, Mary Kawena Pukui retells a *mo'olelo* (story), that describes the varied and unique characteristics of the branches and leaves of the *wiliwili*. In this story, three sisters were transformed into *wiliwili*, with characteristics similar to their physical human traits. The story begins with the birth of four daughters to a mother, who is unnamed in the story. The eldest and most beautiful daughter was Moholani. Born after Moholani was Wiliwili'ohe'ohe, Wiliwilipe'ape'a, and the youngest daughter was Wiliwilikuapu'u all of whom did not match the beauty of Moholani. In describing the features of the three younger sisters, Pukui and Green write:

> Wiliwili'ohe'ohe was marred by baldness, and Wiliwilipe'ape'a had a mass of tangled hair which was tossed here and there when the wind blew. As for Wiliwilikuapu'u, the hunchbacked one, we can see from her name that she lacked beauty altogether. (Pukui and Green 1995)

To Moholani was born one son, named Kauilamākēhāokalani meaning "Lightning flashing from the heavens" who was "given into the care of the gods" and raised in Kuaihelani, "the land hidden in the clouds" (ibid.:13). Moholani's husband, who was a fine man, frequented a point at the seashore where he was admired by two *wāhine kupua* (supernatural women) named 'Ahikananā and 'Ahikāhuli. These *wāhine kupua* "seized every opportunity to tempt him by chanting the songs of the sea and relating tales of the deep blue ocean" (ibid.:13). Bewitched by the wiles of the *wāhine kupua*, Moholani's husband plunged into the depth of the sea and accompanied the women to their cavern at the ocean floor.

After waiting for his return home, Moholani set out in search of her husband, but her efforts were in vain. Distressed by her husband's disappearance, Moholani called out to her sister Wiliwili'ohe'ohe:

> "O Wiliwili'ohe'ohe, listen! Come to my aid! O Wiliwili'ohe'ohe come to my aid! Do you know if my husband has been carried away by 'Ahikananā and 'Ahikāhuli to the place where the little stones rattle."
>
> But Wiliwili'ohe'ohe looked at her crossly and answered, "Ugh! He is a big, worthless man! I do not know where your husband is!"
>
> Moholani walked on, weeping, to the second sister and called, "O Wiliwilipe'ape'a, listen! Come forth! O Wiliwilipe'ape'a, come forth! Do you know if my husband has been carried away by 'Ahikananā and 'Ahikāhuli to the place where the littles stones rattle?"
>
> But Wiliwilipe'ape'a answered like her older sister, "Ugh! He is a big, worthless man! I do not know where your husband is!" (ibid.:13)

Moholani proceeded on to the home of her younger sister, Wiliwilikuapu'u and cried out in the same manner only to be met with the same dreadful response. Having received no sympathy or assistance from her sisters, Moholani sought her one and only son, Kauilamākēhāokalani and requested that the gods, who were his guardians release him from Kuaihelani to aid in the search of his father. Kauilamākēhāokalani eventually located his father at the bottom of the ocean floor and when:

> 'Ahikananā and 'Ahikāhuli refused to relinquish their lover, the boy's wrath flashed forth; because of their obstinacy, he changed his body into a lightning flame, and at the glancing of his lightning on the ocean floor, the women were cut into pieces and transformed so that from them come all that kind of fish called mackerel. Gone were their powers to tempt other women's husbands, for they were not nothing but fishes! (ibid.:14)

Because of the sisters' unkindly response to Moholani, they were each transformed into *wiliwili* trees:

> Because Wiliwili'ohe'ohe was bald, she became a tree which is almost leafless; Wiliwilipe'ape'a became a tree whose leaves flutter in the whispering breeze; and Wiliwilikuapu'u was a hunchback, her trunk became crooked. (ibid.:14)

It is noted that the appearance of a *wiliwili* varies according to its environment and the weather. It has, says Miss Green, "all the characteristics borne by the sisters."

While the account provided by Pukui describes the physical features of the *wiliwili* tree, another account written by W. D. Westervelt, tells of a large *wiliwili* tree in Kaupō, Maui, where the young and agile *kūpua* (demi-god) Māui hid and tethered the sun in his attempt to slow the heedless sun across the sky.

Māui Snares the Sun by Tethering Its Legs to a Wiliwili Tree in Kaupō, Maui

The swift and strong-willed *kupua* Māui is noted in Hawaiian lore for accomplishing many epic feats. While the accounts of Māui often involves grueling battles and trickery, his brave acts ultimately lead to an improved life for humankind. One such account recorded by W. D. Westervelt (1910) in his book *Legends of Ma-ui—A Demi God of Polynesia and of his Mother Hina*, tells of Māui's heroic adventure to slow the fast-moving sun that raced across the heavens. This tale begins with Māui's mother Hina, who took to her wooden mallets daily, tirelessly pounding bark and felting them into sheets of bark cloth known as *kapa*, which would be fashioned into sleeping mats and clothing. These *kapa* cloths, however, had to be thoroughly dried, but the days were so short that by the time Hina had laid out her *kapa,* the sun would race across the sky and descend into the underworld, leaving Hina in the dark and forcing her to gather up her *kapa.* The reckless moving sun also created other troubles "[t]he food could not be prepared and cooked in one day. Even an incantation to the gods could not be chanted through ere they were overtaken by darkness" (Westervelt 1910:43).

Māui pitied his mother and set out with determination to alter the pace of the sun. Māui traveled to the northwest of the island to the summit of 'Iao to study the course of the sun. Māui saw that the sun rose on the eastern side of Haleakalā and passed directly over its summit. After studying the sun's path, Māui returned to his mother's home and informed her that he would "...cut off the legs of the sun so that he could not run so fast" (ibid.:43). After talking with her son, Hina handed Māui "...fifteen strands of well-twisted fiber and told him to go to his grandmother, who lived in the great crater of Haleakala..." (ibid.:44). Hina continued:

> You must climb the mountain to the place where a large **wiliwili** tree is standing. There you will find the place where the sun stops to eat cooked bananas prepared by your grandmother. Stay there until a rooster crows three times; then watch your grandmother go out to make a fire and put on food. You had better take her bananas. She will look for them and find you and ask who you are. Tell her you belong to Hina. (ibid.:45)
>
> When she had taught him all these things, he went up the mountain to Kaupo to the place Hina had directed. There was a large **wiliwili** tree. Here he waited for the rooster to crow. The name of that rooster was Kalauhele-moa. When the rooster had crowed three times, the grandmother came out with a bunch of bananas to cook for the sun. She took off the upper part of the bunch and laid it down. Maui immediately snatched it away. In a moment she turned to pick it up, but could not find it. She was angry and cried out: "Where are the bananas of the sun?" Then she took off another part of the bunch, and Maui stole that. Thus he did until all the bunch had been taken away. She was almost blind and could not detect him by sight, so she sniffed all around her until she detected the smell of a man. She asked: "Who are you? To whom do you belong?" Maui replied: "I belong to Hina." "Why have you come?" Maui told her, "I have come to kill the sun. He goes so fast that he never dries the tapa Hina has beaten out." (ibid.:45-46)

Māui's grandmother then handed him a magical stone ax and another rope and taught him how to catch the sun. She explained:

> "Make a place to hide here by this large **wiliwili** tree. When the first leg of the sun comes up, catch it with your first rope, and so on until you have used all your ropes. Fasten them to the [*wiliwili*] tree, then take the stone axe to strike the body of the sun." (ibid.:47)

Māui then dug a hole and concealed himself among the roots of the *wiliwili* and watched closely for the sun. Soon the first leg—the first ray of the sun---came up over the mountain and Māui threw his rope and ensnared the first leg then fastened it to the *wiliwili.* One-by-one, Māui continued to entangle the legs of the sun as they came over the crater of Haleakalā, tethering each rope to the *wiliwili* until all that remained was the longest leg. Using the rope given to him by his grandmother, Māui caught the last leg of the sun.

> When the sun saw that his sixteen long legs were held fast in the ropes, he began to go back down the mountain side into the sea. Then Maui tied the ropes fast to the tree and pulled until the body of the sun came up again. Brave Maui caught his magic stone club or axe, and began to strike and wound the sun, until he cried: "Give me my life." Maui said: "If you live, you may be a traitor. Perhaps I had better kill you." But the sun begged for life. After they had conversed a while, they agreed that there should be a regular motion in the journey of the sun. There should be longer days, and yet half the time he might go quickly as in the winter time, but the other half he must move slowly as in summer. Thus men dwelling on the earth should be blessed. (ibid.:46-47)

The sun assented to Māui's request and an agreement was made. Māui released the sun back onto its course and from that day the sun agreed to move slower through the heavens.

Wiliwili Mentioned in the Legend of Kawelo

Wiliwili is briefly mentioned in a chant featured in the legend of Kawelo, a famous ruler of Kaua'i. The chant describes the lands of Kalehuawehe in Waikīkī, O'ahu, which was known for its blooms of *lama* (*Diospyros sandwicensis*) and *wiliwili*. Kaweloleimakua (Kawelo) was one of five children born to Malaiakalani, the mother and Maihuna, the father. Kaweloleimakua'a maternal grandparents were skilled at foretelling the future of a child through palpating the child's limbs and examining all aspects of the body. The grandparents performed this act on all their grandchildren and found nothing spectacular about them, however, when examining Kawelo, the grandparents were thrilled at what they found.

> After the examination the old people called the parents of Kawelo and said to them: "Where are you two? This child of yours is going to be a soldier; he is going to be a very powerful man and shall some day rule as king." (Fornander 1918–1919:2)

Kawelo was taken from Hanamā'ulu to Wailua on Kaua'i and raised by his grandparents. While Kawelo was bring raised, 'Aikanaka, the son of the king of Kaua'i was born as was Kauahoa of Hanalei, two characters that would later play a key role in Kawelo's rise to *ali'i*. These three chiefly children were raised together but Kawelo showed all the signs of a powerful future chief, one of which was his profound appetite for food, strength, and skill. His grandparents grew tired of the boy's insatiable appetite and thought that giving him a canoe would entice him away from his continual eating. A canoe was made for Kawelo, which he paddled up and down Wailua River. Kawelo's new canoe caught the eye of his childhood friend, Kauahoa, who in a display of character made himself a kite which caught the eye of Kawelo. In response, Kawelo's grandparents made him a kite and one day as the two boys were playing, their kites had become entangled. Kawelo's kite snapped Kauahoa's string, sending his kite floating over the mountains and landed at Kaho'oleināpe'a, Kōloa, a placed named after this particular event. Kawelo thought that Kauahoa would surely attack him since he was bigger than Kawelo, but he didn't. Kawelo thought to himself "Kauahoa will never overcome me if we should ever meet in any future battle" (ibid.:4). In any competition against the other boys, Kawelo always displayed greater strength and skill. After some time, Kawelo's grandparents in their longing to see their other grandchildren who had moved to O'ahu, packed up and sailed to Waikīkī, O'ahu, taking Kawelo with them.

While on O'ahu, Kawelo took up farming and married Kanewahineikiaoha. Kawelo went on to master both fishing and the art of war and had become renowned for his feats of strength. He eventually returned to Kaua'i to defend his family against 'Aikanaka, who had stolen Kawelo's parents land and resources. Kawelo, in his attempt to recapture his parent's land, made preparation to return to Kaua'i to battle with 'Aikanaka. While adrift off the coast of Wailua, some of 'Aikanaka's people who were at the top of Nounou Hill roused 'Aikanaka and told him of the coming of large canoes. 'Aikanaka dispatched his runners, chief officers, and warriors and had his men set up blockades on the shore hoping to stop the approaching canoe from landing. A large crowd had gathered on the shores of Wailua at which time Kaehuikiawakea, 'Aikanaka's messenger was sent out to sea to investigate the canoe and found only Kamalama, who was not perceived as a threat to the warriors of Kaua'i. Kawelo, however, hid on the canoe and was not spotted by Kaehuikiawakea. Assuming that only Kamalama was on the canoe, Kaehuikiawakea permitted the canoes to land. When they reached the beach, 'Aikanaka's men anxiously waited to attack, but Kaehuikiawakea stopped them saying:

> Don't fight them now. Let us carry the canoes to the dry sand and let these people go and have a bath, and when they return, let them partake in some food; when they are satisfied they can then gird on their loin cloths, then after that we can fight them. (ibid.: 34)

The warriors of Kaua'i proceeded to lift the canoes out of the water and as they carried the canoes ashore, Kamalama had loosened the sack that held Kawelo at which time, Kawelo jumped out and announced his presence in a loud voice. This created a great scurry and cause them to drop the canoe crushing many people. Kawelo then looked towards Wailua and saw a great disorder amongst 'Aikanaka's people. A great battle ensued between Kawelo and the people of Kaua'i. After slaying some of 'Aikanaka's top warriors, Kawelo found himself in a head-to-head battle with his childhood foe, Kauahoa, who was the most noted warrior in 'Aikanaka's army. Kauahoa's large stature and skillful fighting maneuvers greatly intimidated Kawelo. Instead of hastily rushing into battle, Kawelo carefully studied his childhood opponent and began to recall the memories of their youth. Taking pity on his opponent, Kawelo chanted to Kauahoa, hoping to put the matter of combat in the hands of Kauahoa. After Kawelo ended his chant, Kauahoa replied:

> This club will never spare you in the day of battle. You have slain our men so that there are none left; how can you then expect this club to spare you? As it has been your deal, you can see the results; and when it will be my deal, I will see the result. (ibid.:54)

Kauahoa's response continued to fill Kawelo with fear, however, the daring Kawelo reminisced on his childhood and recalled "how his kite got tangled up with Kauahoa's kite and how Kauahoa's kite broke ways, and how Kauahoa was afraid to fight him" (ibid.:55-56). Knowing that Kauahoa's bravery did not match his own, Kawelo in his final impromptu, chanted to Kauahoa:

O Hanalei aina ua,	Hanalei, the land of rain,
Aina anuanu, aina koekoe,	The cold land, the wet land,
Aina a ka pea i noho ai,	The land where the end is.
Noho ana e liu ana e,	Sitting there, delaying there,
Maewa ana ka ukiukiu o Honokoa	For the anger of Honokoa is reviling.
I ka pali o Kalehuawehe;	At the cliff of Kalehuawehe
Pua ka lama me ka ***wiliwili***	Where the *lama* and ***wiliwili*** bloom,
O ka ua lele ma waho o Mamalahoa,	Where the rain sweeps on the outside of Mamalahoa.
O Kauahoa o ka meeui o Hanalei,	Kauahoa, the stalwart youth of Hanalei,
O ke kanaka a Kamalama i hopo ai o Kauahoa,	The person of whom Kamalama is afraid, Kauahoa,
He mea e ka nui—e—a!	For he is indeed large.
Eia ka hoi ua kanaka nui	He is the largest man
O Kauai, o Kauahoa	Of Kaua'i, Kauahoa

Wiliwili of Kohala Pierced by the Spear of Kapunohu

The legend of Kapunohu, as told by Fornander (Fornander 1918–1919) is set in the Kohala District of Hawai'i Island which was ruled by the *ali'i* Kukuipahu. This story briefly mentions a great grove of *wiliwili* in Kohala. While out enjoying the game of "glancing spear" Kapunohu saw the spear of a man named Kanika'a (ibid.:214). Kapunohu came along and picked it up and quickly ran off with it. Having seen Kapunohu's actions, Kanika'a gave chase and the two men became entangled in a battle which they peaceably resolved. Having befriended each other, Kapunohu adopted Kanika'a as his god and kept Kanika'a's spear which was named Kanikawī. After an insulting situation arose between Kapunohu and the king of Kohala, Kapunohu wandered into the uplands. Fonander continues:

> From this place Kapunohu went on up towards the uplands until he came to a row of **wiliwili** trees. These trees were of large size, resembling the kukui trees, but very light and not as hard as the wood of the kukui. Kapunohu then, with an idea of testing his strength, threw his spear at the first tree and the spear went through them all. It is said there were eight hundred of the trees which stood in a straight row. He made a clean hole in each tree, all in one thrust. (ibid.:216)

The story continues with Kapunohu traveling into the interior parts of Kohala where he eventually joined the forces of the chief Niuli'i. In an act of retaliation, Kapunohu exacted death to the Kukuipahu.

Wiliwili Wood Carved into an Image in Ka'ao no Pupuhuluena

The account describing the carving of *wiliwili* wood into an image used to appease the gods appears in *Ka'ao no Pupuhuluena*, written by Fornander (1916–1917). This story provides thought-provoking details regarding the introduction of edible food plants to the lands of east Kohala by way of Ka Lae, Ka'ū on account of the legendary hero Pupuhuluena. Upon arriving and settling along the steep cliffs of east Kohala, Pupuhuluena learned that no food plants were being grown, "no taro, no potatoes, no yams, nor anything else in the shape of food" (ibid.:570). Pupuhuluena learned that all of the food plants were taken and hidden by the gods in Ka Lae in the Ka'ū District. Having no luck with procuring food, Pupuhuluena took to the sea, setting out in his canoe. While fishing off the coast of Maka'ūkiu, Pupuhuluena observed that fishes of various kinds, including the *uhu*, *nenue*, *ulua*, *kāhala*, *'ōpakapaka*, *he'e*, *manini*, *'ōpelu*, and *aku* had congregated under this canoe. When the fish began to move away, he followed suit. Pupuhuluena continued in his canoe, following the fish past the lands of Kohala. When they arrived at Manini'ōwali, the *manini* fish remained behind, but Pupuhuluena continued. From the Kekaha lands until Ka'elehuluhulu the *aku* and *'ōpakapaka* stayed behind. When arriving at Kapukaulua just before Ka Lae, the *ulua* fish stayed behind. While at Kapukaulua he saw a canoe "with a large-mouth net let down on the coral bed" (ibid.). Pupuhuluena placed a *kukui* nut in his mouth and chewed it and blew the oily substance on the surface of the sea, allowing him to see a great school of fish entering the net of the two fishermen, Ieiea and Poopalu. Pupuhuluena called out to the two fishermen informing them to haul up their net. The two fishermen were not aware that their net was full of fish because they were using the *mohihi* bean instead of the *kukui* to look underwater. Looking at Pupuhuluena strangely, the two fishermen heeded his

words of the stranger and hauled up their net and to their surprise, it was filled with fish. The two fishermen asked Pupuhuluena for some *kukui* nuts and he haded them a few. The fishermen used some nuts for fishing and a few were kept to be planted and it is said that this is how the *kukui* was introduced to the districts of Kona and Ka'ū. In exchange, Poopalu and Ieiea gave some cooked *kalo* and *'uala*, to which Pupuhuluena placed in his calabash. Poopalu asked, "why do you put them in the calabash?" to which Pupuhuluena replied, "[t]o save them for planting" (ibid.). Po'opalu remarked:

> They will not grow as they are already cooked. The gods have charge of the food and all else, and we can only get it after it is cooked. If you wish to get some for the purpose of planting then obey this instruction: You must first hew out an image from a **wiliwili** tree and then braid a basket of ie ['ie'ie]. (ibid.:572)

Pupuhuluena consented and followed out the instruction of Po'opalu. After the items were made, Po'opalu said to Pupuhuluena, "[p]lace the image behind you on the canoe while I will get into the basket and then we will sail to the land of the gods" (ibid.). The two men loaded into the canoe and sailed for Ka Lae, where the gods were living. As they were approaching Ka Lae, the began calling out to the gods, who responded with instruction to land at a particular spot. From within the basket, Po'opalu told Pupuhuluena not to land there because that place was a refuse pile and that the proper landed spot was elsewhere. Using their power, the gods had caused the water at the refuse place to become calm and the proper landing place to be rough. Pupuhuluena called out once more to the gods, telling them "[t]hat is a refuse heap; here is the landing place where the surf is breaking, for I am a native son of this place." Upon hearing the words of Pupuhuluena, the gods calmed the waters of the proper landing place and Pupuhuluena paddled his canoe ashore. The gods came down to the shore to help lift the canoe out of the water. At this Pupuhuluena said to the gods, "[t]he stern of my canoe is kapued. I will lift that part myself while you can lift the forward part." The canoe was carried onshore and the gods brought all different kinds of tubers to Pupuhuluena.

The first tuber was brought down and shown to Pupuhuluena. Po'opalu, still hidden in the basket spoke quietly, informing Pupuhuluena that the tuber was *hoi* and was poisonous. Pupuhuluena conveyed this information to the gods and another tuber was brought down and the gods asked Pupuhuluena of its nature. Again, from within the basket, Po'opalu whispered, "[i]t is a yam [uhi], it is a life-giving food," which Pupuhuluena conveyed to the gods. The gods continued showing Pupuhuluena all types of tubers and after, the gods invited him to join them in some of their games. While playing a certain game, Pupuhuluena managed to shame the gods by standing them up on their heads. So ashamed they were, that they gave each of the different tubers to Pupuhuluena. Having acquired an assortment of tubers, Pupuhuluena returned to his lands in east Kohala and planted the *uhi* at the bottom of the cliffs, where they can still be seen growing.

Grove of Wiliwili in Mānoa Valley, O'ahu as Noted in the Legend of Kahalaopuna

Set in Mānoa Valley on O'ahu, the legend of Kahalaopuna tells of a beautiful and sacred maiden who lived with her attendants at Kahaiamano on the path that led to the pool known as Waiakeakua. She was betrothed at a young age to Kauhi, the young chief of Kailua in Ko'olau, who up until their purported marriage, provided her with fresh *poi* and fish from his district. Having heard rumors from two disfigured men that Kahalaopuna was madly in love with them, Kauhi, filled with rage set out to kill Kahalaopuna. In describing that portion of the story that references a grove of *wiliwili*, Thrum writes:

> He started for Manoa at dawn, and proceeded as far as Mahinauli, in mid-valley, where he rested under a hala (*Pandanus odoratissimus*) tree that grew in a grove of **wiliwili** (*Erythrina monosperma*). He sat there some time, brooding over the fancied injury to himself, and nurshing his wrath. Upon resuming his walk he broke off and carried along with him a bunch of hala nuts. It was quite noon when he reached Kahaiamano and presented himself before the house of Kahalaopuna. The latter had just awakened from a sleep, and way lying on a pile of mats facing the door, thinking of going to the spring, her usual bathing-place, when she perceived a stranger at the door. (Thrum 1907:121)

Wiliwili Referenced in Ka Mo'olelo No Hi'iakaikapoliopele

A tale of perseverance, bravery, and spite is recounted in *Ka Mo'olelo O Hi'iakaikapoliopele*, initially published in the Hawaiian language newspaper *Ka Na'i Aupuni* between the years 1905-1906 by Ho'oulumāhiehie. Throughout the early 21st century, Hawaiian language scholar, Puakea Nogelmeier compiled the chapters written by Ho'oulumāhiehie, translated each page of text, and published it in a double volume (one in Hawaiian and the other in the English). Nogelmeier notes that Ho'oulumāhiehie's version is one of twelve known published accounts of *Ka Mo'olelo O Hi'iakaikapoliopele*.

This tale describes the challenge-filled journey undertaken by Hi'iakaikapoliopele, the youngest sibling of the Pele clan, while in search of her sister's dream lover, Lohi'au. Her journey begins in Puna on Hawai'i Island and while passing through the various parts of the islands, Hi'iaka encountered a number of characters and obstacles, which are described in both text and in chant form. Through these challenges, Hi'iaka ultimately learns about her family and her personal powers as a rising goddess. References to the *wiliwili* are noted when Hi'iaka is constructing a canoe as well as when traveling through the arid plains of 'Ewa, O'ahu. The use of *wiliwili* in the many chants presented throughout this account is also riddled with *kaona* or "hidden meanings" (Pukui and Elbert 1986:130), that hint at the *wili* or torturous feelings of love felt by Hi'iaka (Andrews 1865). Those portions of the story that mention *wiliwili* are briefly contextualized and transcribed below.

While preparing to depart Ka Lae O Ka'ena on O'ahu's northwesternmost point, Hi'iaka solicits the help of her brothers in preparing a canoe which she and her companions were to use to travel to Kaua'i. The brothers provided her with all the parts needed to make their canoe, including a *paukū wiliwili* (section of *wiliwili*) which they used for their *ama*.

> Ki'i akula nō kēia a ka paukū **wiliwili**, lālau ke ko'i kālai a nā kaikunāne, 'o ko ia nei kālai ihola nō ia a lo'a ka iama o ka wa'a. Kāhea akula kēia i ke 'aikāne, "E Wahine'ōma'o ē! Ma kēlā po'o mai ho'i 'oe o ka iama o ka wa'a o kāua, ho'opili nō ho'i 'oe i kāua 'ao'ao i kāu 'iako, hauhoa nō ho'i a pa'a i ka 'aha, a pēlā nō ho'i ka'u 'ao'ao. E hana wahine a'e nō ho'i kāua i ko kāua wa'a! (Ho'oulumāhiehie 2006a:177)
>
> She fetched a piece of wiliwili wood, seized the brothers' adze, and carved until the canoe had an outrigger float. She called to her friend, "Hey Wahine'ōma'o! You take up that end of the canoe float, connect your end to the boom on your side, lash it firmly with the cordage, and I will do the same with my side. We women will make our canoe." (Ho'oulumāhiehie 2006b:166)

In a latter part of this saga, while passing through the heights of Pōhākea in the Wai'anae mountains and down to the plains of Keahumoa, Hi'iaka observed some women stringing *lei* of *ma'o* flowers, which Hi'iaka greatly adored. After an exchange with the women, Hi'iaka proceeded to the coast of 'Ewa to the shore near the calm lochs of Pu'uloa. Hi'iaka watched as the canoe carrying her dear friend, Wahine'ōma'o and their husband Lohi'au sail along the coast. Overcome by emotions for her companion and for the destined fate of Lohi'au, Hi'iaka called out in chant to them:

Ku'u kāne i ke awa lau i Pu'uloa	My dear man of Pu'uloa's branching lochs
Mai ke kula o Kānehili ke noho ē	From the plans of Kānehili to reside
E noho kāua i ke kaha	Let us dwell in the strand, you and I
I ka 'ōhai, i ka **wiliwili**	Amid the 'ōhai shrubs and the **wiliwili** trees
I ka pua o ka lau noni	With the blossoms of the noni trees
'O ka ihona i Kānehili lā	On the descent to Kānehili
Ua hili au ē.	I have gone astray, ah.
(Ho'oulumāhiehie 2006a:288)	(Ho'oulumāhiehie 2006b:269)

Carrying along in her journey, Hi'iaka arrived at the plains of Honouliuli and observed two women, Pu'ukapōlei and Nāwāhineokama'oma'o resting under some *'ōhai* shrubs. Hi'iaka acknowledged them and offered up a chant. The women encouraged Hi'iaka to carry along in her journey because the heat of the sun would soon overwhelm her. The kind women informed Hi'iaka that the land had become so parched that there were but very few plants and no water from which they could sustain themselves. After her encounter, Hi'iaka moved once again towards the sea, searching for the canoe of her dear companion and Lohi'au. Filled once again with emotion, Hi'iaka chanted out:

Ku'u kāne i ke awa lau o Pu'uloa	My dear man of the branching lochs of Pu'uloa
Mai ka kula o Pe'ekāua ke noho	From the plans of Pe'ekāua to dwell
E noho kāua i ke kaha o ka 'ōhai	Let us stay where the 'ōhai grows
I ka **wiliwili**, i ka pua o ka lau noni	Amid the **wiliwili** trees and the blossoms of abundant noni
'O ka ihona i Kānehili lā	On the descent to Kānehili
Ua hili au ho'i ē.	I have strayed, ah.
(Ho'oulumāhiahie 2006a: 290)	(Ho'oulumāhiahie 2006b:271)

Continuing to search for her companion and Lohi'au, Hi'iaka crossed the stretch of Pu'uloa. After recalling the edict, put forth by Wahine'ōma'ō that forbid Lohi'au from talking to her Hi'iaka chanted once more. The young goddess continued on over the expanse of Kaupe'a, and seeing that it was only her and the blazing heat of the sun, Hi'iaka put forth the following chant:

ʻAʻole au e hele i ke kaha o Kaupeʻa	I shall not tread Kaupeʻa's expanse
Kēlā kaha kūpā koili a ka lā i ke kula	That stretch where the sun beats down on the plain
Ua kūpono aʻela ka lā i ka piko o Wākea	The sun is right overhead, at the naval of Wākea
Ola i ke ahe a ka makani Māunuunu	I am spared by the Māunuunu wind
I ka hapahapai mai a ka makani ʻAoʻaoa	By the uplifting ʻAoʻaoa breeze
Ke koi lā i kea o o ka Nāulu e hanini i ka wai	Urging the Nāulu storm clouds to pour down their waters
Ola ihola nā kupa kamaʻāina i ka wai a ka ʻōpua	The native here survive on water from the clouds
Ke halihali aʻela nā ʻōpua i ke awa lau	Which billowing clouds carry along to the branching lochs
E koi mai ana iā Hiʻiaka e kūoʻe hele i ke kula	Compelling Hiʻiaka to trudge that open stretch
I kuleana i lāhui ai ka moe i laila	Duty making rest forbidden there
I laila au lohe i ke kani leo leʻa a ka ʻōʻō i ke kula	There I head the happy trill of the ʻōʻō bird on the plain
Hoʻāikane ana lāua me ke kai o Wāwaemoku	Befriending the sea of Wāwaemoku
Mokumokuāhua loko, kupākupā koili i ka ʻino	By heart grieves, thrashed by harm
I ʻino hoʻi au i kēia kanaka i ka hiki ʻana mai	I may be harmed by this person upon arrival
I kāhela aʻela ka ʻai a ka manu	Leaving the birds to feed expansively
I ka pua o ka **wiliwili**	On the blossoms of the wiliwili trees
Wili aʻela nā ʻōpua i luna	The clouds spin above
No luna wau	I am from above
Wili aʻela ka ʻōpua i lalo	The clouds spin below
Lalo ē!	Below indeed!
Lilo i lalo ka hele ʻana a ke kanaka	The movement of mankind is cast down
Kalakala kea o no Hawaiʻi	Craggy are the clouds from Hawai'i
I ka pā ʻia mai e kēia makani	Blown here by this wind
ʻAʻole au makana i ka lā o ka hilahila	I have no gift to offer on this day of shame
E hili hewa paha auaneʻi au	I shall perhaps end up astray
Wilia i naʻe, wilia i lalo	Spiraling windward, or to the lee
Wilia i kai, wilia i uka	Spinning towards the sea, toward the highlands
ʻO kauhale a ka ʻōlelo	O house made of words
Hoʻohiki ihola i kānāwai	Utter as an edict
Kau ihola i kānāwai	Place as a law
He kānāwai ʻokia	An order of separation
ʻĀlina ihola kā o Puʻuloa	Thus Puʻuloa is branded by epithet
He ʻāina kauā.	A land of outcast and slaves.
(Hoʻoulumāhiehie 2006a:294–295)	(Hoʻoulumāhiehie 2006b:275–276)

While at ʻEwa, Hiʻiaka had learned from some of the area residents that the ruling chiefess Peleʻula was hosting a large celebration at Kou (the ancient name of present-day Honolulu). Delighted by the invitation, Hiʻiaka desired to attend the festivities. After reuniting with her beloved companion, Wahineʻōmaʻo and Lohiʻau, they set out in their canoe towards the coast of Kalihi. Here Hiʻiaka saw Peleʻula surfing the waves of Kapuʻuiki and called out to the chiefess. The chiefess declined to board their canoe, so Hiʻiaka put a spell on the chiefess, which caused her to enter into a deep sleep. Laid out on her surfboard, Hiʻiaka's canoe floated near the sleeping chiefess and at Hiʻiaka's command, Lohiʻau picked up the chiefess and her board and placed them on the canoe. They continued sailing down the coast until the reached Waikīkī, where Hiʻiaka raised her voice in chant:

Kuʻu kāne i ke kaha o Puʻuloa	My husband of the strands of Puʻuloa
Mai ke kula o Peʻekāua ke noho	From the plains of Peʻekāua, there to abide
E noho kāua i ke kaha, i ka ʻōhai, i ka **wiliwili**	Let us dwell on that stretch amid the ʻōhai and wiliwili
Ka pua o ka lau noni o Kaiona i Kānehili	And the blossoms of Kaiona's noni grove at Kānehili
Ua hili hoʻi au ē.	I have strayed
(Hoʻoulumāhiehie 2006a:300)	(Hoʻoulumāhiehie 2006b:280)

After playing an exciting game of *kilu*, Hiʻiaka's desire for Lohiʻau continued to grow, despite the rules Pele had proclaimed to her sister. Unable to hide their feelings towards each other, and in an act to propose a private courtship, Hiʻiaka and Lohiʻau continued to chant to each other. While the two lovers were hidden in a *milo* tree in Honolulu, Kauakahiapaoa, the companion of Lohiʻau called out in chant likening the two lovers to the various places they had journeyed through. A portion of this eleven stanza chant again makes references to the *wiliwili*, which reads:

...Ke kuhi maila ke kai o Kuhia
E pae ko'u wahi wa'a i Kapua
'O ku'u pua i mālama pono ai nāu
Ho'omaoe ka **wiliwili** hele lā
Ka lupalupa o ka pua 'ōhai...
(Ho'oulumāhiehie 2006a:442)

...Assuming it to be the sea of Kuhia
My little canoe shall land at Kapua
That dear blossom that I watched over for you
The **wiliwili** trees gnarl in the sun
Where the 'ōhai flourishes...
(Ho'oulumāhiehie 2006b:413)

Traditional Uses of *Wiliwili*

As Hawai'i's early inhabitants transported their most important food, medicinal, and utilitarian crops over the vast Pacific Ocean, their ability to adapt and grow their culture was dependent upon the available natural resources of each island. Over time, Hawaiians had become well-versed in the different ecological niches and productive in foraging and experimenting with a plethora of plants that had established themselves prior to human contact. Continued adaption allowed them to discern which plants were most suitable to meet life's basic needs and pleasures, and which ones aided in enhancing the complexity of their society. These highly evolved plant practices were observed and recognized by many early Western explorers (Abbott 1992).

The use of native plants was woven within every aspect of their lives, from subsistence, *hula*, ceremonies, attire, wayfaring, and ocean activities. The knowledge to utilize these plants became an integral part of maintaining a sophisticated lifestyle. The extent to which plants permeated daily life and gave rise to a uniquely Hawaiian culture cannot be understated. These factors helped to shape a thriving and unique collection of traditions exclusive to Hawaiian society and to these islands. In the face of great change to both their culture and environment, many Hawaiian today strive to reclaim their ancient traditions and live according to the principles of their ancestors. The preservation and perpetuation of Hawaiian culture is contingent upon the restoration and preservation of native plant habitats. This sentiment is echoed in the words of the respected Hawaiian educator and ethnobotanist, Isabella Aiona Abbott, who in 1992 wrote, "[t]here is no time to lose in protecting these plants, upon which the authentic revival of many Hawaiian cultural elements depends" (Abbott 1992:xii).

One of the many plants that maintained that quality of sophistication, even though contemporary times, is *wiliwili*. According to early missionary, William Ellis, the ancient people also referred to this plant as *"oviriviri, or viriviri"* (Ellis 1917:166). Endemic to the Hawaiian Islands, *wiliwili* is a soft-whitish wood and is considered one of the lightest of the Hawaiian woods (Kent 1986; Lilleeng-Rosenberger 2005). Its lightness and buoyancy made it a favored wood for the construction of surfboards, net and fishing floats, and canoes. Additionally, this plant maintained a highly valued quality due to its rareness. As noted in the book, *The Hawaiian Canoe* (Holmes 1981), *wiliwili* was not abundant and grew in very few places, thus suggesting that objects built or made of *wiliwili* were unique and exclusive, as proof of its use and favor by certain royal families.

Wiliwili Used In the Construction of Wa'a (Canoes)

Wa'a or canoes played an important part in the settling and political expansion of Hawai'i's chiefs during the Precontact and early Historic Periods. *Wa'a* were vital to accessing near-shore and deep-sea fisheries and reduced long-distance travel time. These practices relied heavily on vessels that could sustain this way of life and because of its significance, was cherished and cared for like a person would their home (Holmes 1981). Commonly referred to as *wa'a*, these boats were of various sizes and constructed from different plant materials depending on its intended purpose. The *kahuna kālai wa'a* (master canoe carver) oversaw the entire process, which was inclusive of harvesting the appropriate plant material, the physical construction of the canoe as well as the spiritual and ceremonial aspects that accompanied such an undertaking. *Wa'a* were generally designed as a single or double-hull and sometimes contained a mast and sail. To build a vessel designed to fit one's needs, careful consideration and customs were undertaken in the selection of a tree. Although *koa* (*Acacia koa*) was the preferred wood for canoe building, *wiliwili* was also known to be highly favored by many, including the *ali'i* (Holmes 1981). Other woods including *kukui* (candlenut) and *'ulu* (breadfruit) were also used in canoe construction (Fornander 1918–1919). One of the earliest documented account describing the use of *wiliwili* as a make-shift canoe appears in the legend of 'Ai'ai, Son of Ku'ulu, which was published in Thrum's *Hawaiian Folk Tales A Collection of Native Legends* (Thrum 1907). In relating that portion of the story describing the use of wiliwili, Thrum writes:

> The first time that Aiai tested this station and caught a fish with his noted hook, he saw a fisherman in his canoe drifting idly, without success. When he saw Aiai, this fisherman, called Kanemakua, paddled till he came close to where Aiai was floating on an improvised canoe, a wiliwili log, without and outrigger,—which much surprised him. Before the fisherman reached him, Aiai felt a tug at his line and knew that he had caught a fish and began pulling it in. When Kanemakua came within

> speaking distance Aiai greeted him and gave him the fish, putting it into his canoe. Kanemakua was made happy and thanked Aiai for his generosity. (Thrum 1907:236)

Wa'a made from the *wiliwili* wood was built as a single-man canoe and rarely exceeded twenty feet in length but were typically between ten to fifteen feet long. Canoes constructed from a single *wiliwili* trunk were deemed rare, provided that a tree was large enough to make the vessel and the wood was seasoned (not green in color) before being carved. In 1937 Kenneth Emory, a Pacific anthropologist, documented the cultivation of the *wiliwili* for the purpose of canoe making and gathered that in order for the *wiliwili* to grow tall and straight, the side branches were pruned consistently before the tree began to crown (Emory in Holmes 1981).

Around 1794, during Kamehameha I preparations to invade Kaua'i a certain *kaukauali'i* (lesser chief) by the name of Waipa constructed both canoes and a ship for the king. According to Kamakau (Kamakau 1992:187), this was the first ship "...put together by a native builder..." and that "the ribs were *koa* and *hau* wood, the flooring *wiliwili* wood, the nails of *kauila* wood from Napu'u [near Pu'uwa'awa'a]. This ship was amongst Kamehameha's famed fleet of *peleleu* war canoes which were said to have numbered around eight hundred (ibid.).

Canoe's made of *wiliwili* were lightweight, thus were preferred for near-shore, play, or training, particularly for young aspiring canoeists (Holmes 1981). In the book *Fragments of Hawaiian History*, John Papa 'Ī'ī, a 19th-century Hawaiian historian, noted that as a young boy he had learned how to paddle a canoe made of *wiliwili* which was gifted to him by his parents ('Ī'ī 1959). The wood of the *wiliwili* was, however, the preferred material used for the construction of the *ama*, or outrigger float. Holmes (1981:48) notes that "when a man found the *wiliwili* for his floater, he cared for it as he would his own child." The lightweight of the *wiliwili* allowed the *ama* to be effectively buoyant and incapable of sinking.

Wiliwili served various other purposes in the construction of a canoe, and as described in *Lā'au Hawai'i, Traditional Hawaiian Uses of Plants*, the king's canoes were often painted in red but the use of black paint was most common for other vessels, with tests showing that "the best paint was made by blending juices from the inner bark of *kukui* roots with charcoal from the base of *lauhala* or from *wiliwili* branches" (Abbott 1992:81). While passing through the Ka'ū District on Hawai'i Island in 1823, early missionary, William Ellis (1917) noted that *wiliwili* branches were used as fencing and sections of *wiliwili* were carved into stools that were placed under the canoe when they were drawn on the beach or stored in the canoe shed. Although *wiliwili* wood lacked in durability, it was favored because of its moldability and buoyancy. Yet, many did not prefer this type of wood because of the concern for "greater vulnerability of the light wood canoes to occasional shark attacks" (ibid.)

Wiliwili's Association with Manō (Sharks)

Traditionally and even today, many adhered to a famous proverb, "*pua ka wiliwili nanahu ka manō*," whose literal translation means "when the *wiliwili* tree blooms, the sharks bite" (Pukui 1983:295). While this saying has been applied metaphorically to "a beautiful woman [who] attracts young men—sharks—who become fierce rivals over her with," this saying also speaks truth to the astute observation and seasonal correlations made by Hawaiian. Having such a keen understanding of their environment and as a people who moved according to seasonal changes, Hawaiians identified a correlation between the blooming *wiliwili* and increased shark activity in nearshore waters. In recent years, historical shark attack data collected by the Department of Land and Natural Resources, Division of Aquatic Resources (DAR) has been compared to the *wiliwili* blooming season which occurs during the dry summer months (Department of Land and Natural Resources 2016). The data compiled from 1980 through 2015 showed that there were 122 unprovoked shark attacks with 26 of those, or 21% occurring during the month of October (ibid.). Some researchers have proposed that the increase in shark activity correlates to shark pupping season, combined with the female sharks need to feed to replenish lost energy (Papastamatiou et al. 2013). Today, this proverb has been adopted by some Hawai'i government agencies to warn of the increase in shark activity during the dry summer months.

Papa He'enalu (Surf Board)

Surfing or *he'e nalu* is indisputably the best known of all the Hawaiian recreational activities and one of the most esteemed pastimes. The use of a board was widely popular and was commonly referred to as a *papa he'e nalu* (surfboard). There were several types of traditional *papa he'e nalu*, but the two most popular is the short, thin board, usually made of wood from *koa* or *'ulu* (breadfruit) trees, called *alaia*, which measured about two meters long and forty centimeters wide with a convex on both sides of the fore-end (Abbott 1992). A larger board, measuring an average of six meters in length, and cigar-shaped, was called *olo*. Due to its large size, the *olo* boards were preferably made with *wiliwili* weighing about 44 to 132 pounds (Abbott 1992; Fornander 1919–1920). In 1823, Ellis (1917:166) commented that "[t]he best kinds of surf-boards are also made of this wood [*wiliwili*], which is lighter than any other the natives possess." Due to the difficulty in finding *wiliwili* trees of sufficient size such boards were made and

reserved for Hawaiian royalty (ibid.). However, the larger boards were most commonly made from *koa*, as *wiliwili* of sufficient diameter were scarce (Abbott 1992).

Wiliwili Woods Used in the Kōheoheo Style of Fishing

Fornander briefly describes a traditional fishing style known as *kōheoheo*, which was carried out canoes and for the purposes of catching *mahimahi* (*Coryphaena hippurus*). In this fishing style, the *wiliwili* served as a floater that was attached to a line and baited with a live *malolo* fish. Fornander writes:

> 10. Koheohoe. He laau *wiliwili* ke koheoheo, a he malolo ola no hoi. Elima anana ka loa o keia aho. O keia hana he hoowalewale i ka mahimahi, a hae ka mahimahi, alaila kuu kea ho me ka makau. A ai ka ia, alaila pau ka hoe ana o ka waa. He ia hae ka mahimahi ke pa ai ka makau, he ia ahai, a he ia puoho e lele ai i luna. He anana a puehu ka ia nui, a he muku ka ia liilii. He lapalapa ka ia nui, a he ao kekahi, he Iwilei ka palahalapa mai ka lae a ka waha. Eia na inoa o ka mahimahi: He lapalapa, he ao, papaohe. O ka ai a keia ia o ka mahimahi, o ka malolo, o ka lelepo, o ke puhukii. (Fornander 1919–1920:185)
>
> [Translation]
>
> 10. The *koheoheo*. *Koheoheo* is a piece of ***wiliwili*** wood with a live flying-fish attached. The line is five fathoms long, the object is to allure the dolphin, and when it becomes ferocious the line and hook is thrown. When the fish bites the paddling of the canoe ceases. The dolphin is a very game fish when caught with a hook, it is a great struggler and snorts when leaping up. A large fish is a fathom and over, long, a small fish is *muku* (four and a half feet). A large fish is called a *lapalapa*, also *ao*, having a breath of a yard from the forehead to the mouth. Here are the different names of the dolphin: *Lapalapa*, *oa* and *papaohe*. The principal food of this fish, the dolphin, are flying-fish, *lelepo* and *puhikii*. (ibid.:184)

Lei Wiliwili

The purpose and use of the *lei* (garland, necklace) in contemporary times has changed significantly from the Precontact era. Nonetheless, *lei* are still an adornment worn frequently by many. Strict customs were observed when a *lei* was made and worn because of the belief that personal items contained a person's *mana* (power). Additionally, since *lei* are typically made by one person and gifted to another, the belief that the crafter imparted their *mana* into the lei which was to be worn by another warranted extra spiritual precaution. These beliefs coupled with the unique materials that were carefully selected to match the appropriateness of the occasion make wearing and crafting a *lei* highly significant. A *lei* was either made with materials that were highly perishable such as flowers and foliage or were made with long-lasting and durable material. The method that was employed was dependent on the purpose and intent of its creation. One such adornment is the infamous *lei niho palaoa* (ivory pendant necklace), made of braided black human hair for the necklace, and a curved tongue-shaped pendant made of ivory both of which were held together by cordage made of *olonā* (*Touchardia latifolia*). According to Malo (1951), this style of *lei* was one of the most prized possessions of an *ali'i*. Although the *niho palaoa* (ivory tooth of a sperm whale) was considered the choice material for such a necklace, historical accounts indicated that wood from the *wiliwili* was also used for the tongue-shaped pendant with all other attributes remaining the same. In *Fornander's Collection of Hawaiian Antiquities and Folklore* (1916), the use of *lei wiliwili* (*lei* made of *wiliwili*) is described in the *mo'olelo* (story) of 'Umi-a-Liloa during his provocative visit to Hilo. Fornander writes:

> When Umi was living with the daughter of Kulukulua he noticed that she had on a royal necklace, an imitation ivory necklace made of wiliwili, brided with jet-black hair securely tied together. One night there was a grand entertainment for all the chiefs of Hilo at Kanukuokamanu, in Waiakea; there was dancing and games of papuhene, kilu and loku. Umi noticed that the daughter of Kulukulua was adorned with bird feathers on her body and on her head, and on her neck was a wiliwili ornament necklace. At the close of the chief's entertainment, after they had gone home, Umi asked his wife, the daughter of Kulukulua, for the necklace, which she let him have. Umi asked her: "Is this your necklace of royalty?" "Yes," answered the woman; "yes, that is our royal necklace, which is not commonly used by the people." "Those things are plentiful and common with the children of our place, and owned by many, from young people to old women. The necklace of our chief is of ivory, made of whale's teeth: that is the royal necklace and securely tied with cords of hair." And, saying this, Umi then broke the wiliwili necklace of the daughter of Kulukulua. (Fornander 1916–1917:220, 221)

Fornander's account implies that *lei wiliwili* was a commonly worn adornment for the chiefs of Hilo, however, this was not true for the chiefs of his homeland in Hāmākua, who favored the ivory pendant. This narrative also suggests that *lei wiliwili* was used by the *maka'āinana* of Hāmākua. Ultimately, 'Umi's disrespectful act led to a revolt against 'Umi-a-Liloa, and his men, which resulted in Kulukulua's daughter gaining possession of 'Umi's *lei niho palaoa*, a gift that he received from his high-ranking father and chief, Līloa.

Abbott (1992), describes the *lei wiliwili* which was fashioned into a *lei hua*, or seed *lei*. The origin of this style of *lei* is uncertain but may have been influenced by adornments made of beads introduced by European visitors (ibid.). The bright red seeds sourced from the *wiliwili* tree had a unique gathering process. The seeds needed to be gathered and immediately pierced using a thorn, fishbone or fine twig, as soon as the pods opened, lest the seeds harden making them very difficult to penetrate (ibid.). Once all the perforations were made, the seeds were gathered and strung into a *lei*.

Hula Ki'i

Hula, a traditional art form is intrinsically tied to Hawaiian storytelling, beliefs, and genealogy and can be performed in various ways and styles. *Hula* is most commonly perceived as dance, however, there are other less common forms of *hula*, one of which included the use of *ki'i*, or doll-like images that were carved from the softwood of either *kukui* (*Aleurites moluccanus*) or *wiliwili* and dressed to resemble humans (Figures 22 and 23). In Emerson's (1909:92) published work, *Unwritten Literature of Hawai'i*, he explains that the performer "stood behind a screen, by insinuating his hands under the clothing of the marionette" while simultaneously chanting. Emerson (ibid.) goes on to add that "its usual instrument of musical accompaniment was the ipu..." which "...was handled by that division of the performers called the hoopa'a [*ho'opa'a*], who sat in full view of the audience manipulating the ipu in a quiet, sentimental manner..." In describing the physical characteristics of these *ki'i* Emerson writes:

> The makeup and style of these *ki'i* are so similar that a description of one will serve for all six. This marionette represents the figure of a man, and was named *Maka-kū*. The head was carved out of some soft wood—either *kukui* or *wiliwili*—which is covered, as to the hairy scalp, with a dark woven fabric much like broadcloth. It is encircled at the level of the forehead with a broad band of gilt braid, as if to ape the style of a soldier. The median line from the forehead over the vertex to the back-head is crested with the *mahiole* ridge. This, taken in connection with the encircling gilt band, gives to the head a warline appearance, somewhat as if it were armed with the classical helmet, the Hawaiian name for which is *mahi-ole*. The crest of the ridge and its points of junction with the forehead and back-head are decodated with fillets of wool dyed of a reddish color, in apparent imitation of the *mamo* or *o'o*, the birds whose feathers were used in decorating helmets, cloaks, and other regalia. The features are carved with some attempt at difelity. The eyes are set with mother of pearl. (Emerson 1909:91–92)

Emerson (ibid.:91) initially hypothesized that the *hula ki'i* was an adaption of Euro-American puppet shows, however, additional research yielded no evidence "other than what might be inferred from general resemblance..." Emerson went on to explain that "...the words used as an accompaniment to the play agree with report and tradition, and bear convincing evidence in form and matter to a Hawaiian antiquity.

Figure 22. Drawing of the marionettes, Maile Pakaha (left) and Nihi-Au-Moe (right). From Emerson (1909:91).

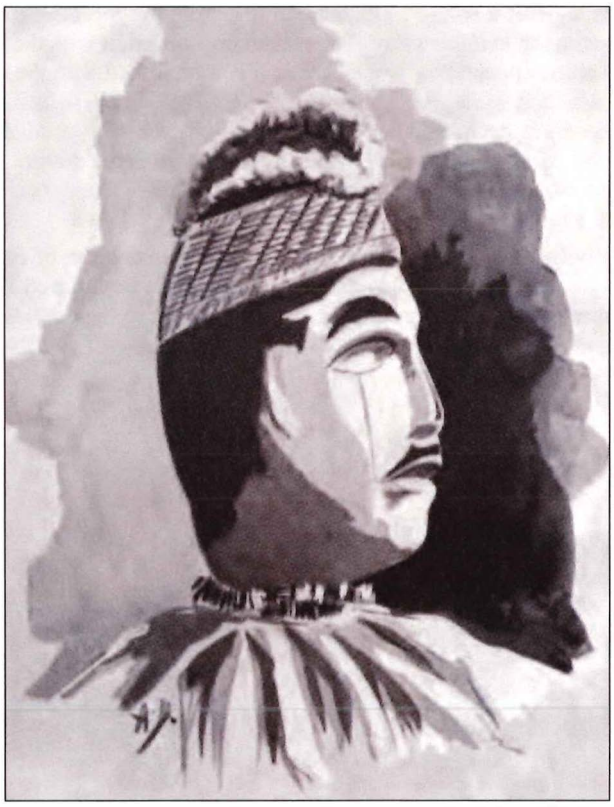

Figure 23. Emerson's sketch of the marionette Maka-Kū.From Emerson (1909:93)

Medicinal Uses of Wiliwili

Wiliwili was also known for its medicinal properties and a review of historical *lā'au lapa'au* (healing using plants) literature indicate that the flowers were used to treat venereal diseases, and the bark was used to reduce swelling. During Hawai'i's Territorial years (1898-1959), Reverand David Kaluna Kaaiakamanu, who was considered a "qualified expert", joined the Territorial Board of Health to study native herbs and medicines (Chun 2016:187). Many of Kaaiakamanu's articles were later translated by Reverend Akaiko Akana, a pastor of Kawaiaha'o Church (ibid.). One such article, written by Kaaiakamanu describes the herbal mixture made with *wiliwili* flowers:

> This tree grows in dry places and in stony or rocky ground. When dried, the wood becomes very light. The flowers are effective for venereal diseases. The tea from it is very helpful for diseases of the sexual organs. The bark is pounded and mixed with spring water and taken as a drink. When mixed with the chili pepper and with the *Pelea cinerea* and then taken with the *Piper methsticum*, it becomes a very strong dose. It is taken every evening. The *Impomea dissecta* should be taken every morning. (Kaaiakamanu and Akina 1922)

In describing one of the herbal concoctions used to treat swelling, one such reference notes the use of *hoi* leaves (*Dioscorea bulbifera*), that were pounded and mixed with other plant parts including *wiliwili* bark:

> Pound leaves with twisted bark of kukui, 5 'ama'u shoots, 4 hau shoots, & wiliwili bark; bathe in the sea, then apply, allow to dry before smearing again, 5x/day. Patient can only eat kalo until skin is "loose" and given koali to eat. (Edith Kanaka'ole Foundation 2003:XII.4a)

Wiliwili Used in the Construction of Water Troughs

In the more arid regions of Hawai'i, particularly in the lava-ridden landscapes of North Kona, Hawai'i Island, procuring the scarcely available freshwater was a difficult task and because of this, knowledge of these water collection areas was closely guarded. In 1886, during the founding of Hu'ehu'e Ranch, Eliza Maguire (daughter of John A. McGuire the founder of Hu'ehu'e Ranch) reported that many old *kama'āina* shared stories and legends associated with specific places (Maguire 1926). One such account concerns Mākālei, the name give to a water cave. The more complete story of Mākālei has been published in the May 29th, 1924 edition of the Hawaiian language newspaper *Ka Hōkū O Hawai'i* (Kihe 1924) as well as by Eliza Maguire (Maguire 1926). Handy (1940) on account of Mrs. Pukui provides a succinct version of this story, which describes the use of *wiliwili* wood for water troughs. Handy writes:

> On the southern side of the hill of Akahipuu in Kona, Hawaii, lived Koamokumokuohueia. He came from Koolau and lived at Akahipuu with his wife, two daughters, and his son, Makalei. He was a farmer and raised sugar cane, taro, sweet potatoes, bananas, and awa. He was told by the natives that this was a waterless land and if any one dared to steal water from any of the natives who had a little, that persons would be killed by them. He dug a hole in the rock and when the rains fell the hole was filled with water.
>
> One day Makalei went behind their house to answer the call of nature; he felt a sharp gust of wind under him, and when he looked he saw that it came out of a small hole. He told his father, who removed some of the stones around the hole. They thus found a big cave with water dripping from the top, and were glad to have a water supply. None of the natives knew of the existence of this cave, and these two did not mention it to the rest of the family. Later they went down into the cave and saw that it was very large, enabling them to walk upright. Koamokumokuohueia took some *ohia* and *wiliwili* logs into the cave at night and there he made boat-shaped troughs to hold the water that dripped from the roof, until he had covered the floor with troughs. The natives wondered at the way his plants thrived, but he never told them that he watered them at night from his secret cave. The water of this cave is very cold and the cave itself has been named Makalei's cave.
>
> When Mr. McGuire went to Huehue to live he built a tank in the cave and laid pipes from the cave to the house. (Handy 1940:35–36)

Descriptions of *Wiliwili* in the Hawaiian Language Newspapers

The following section features articles with explicit reference to *wiliwili* trees that were published in the Hawaiian language newspapers in 1922 and 1930. While many other articles exist that references the famed proverb, *pua ka wiliwili, nanahu ka manō*, only two articles were identified that described traditional uses of *wiliwili*. These articles have been transcribed and translated by the lead author and all mentions of *wiliwili* have been bolded for emphasis. The first article was written by W. J. Kahopukahi on August 24th, 1872, and published in the September 4th, 1930

edition of *Ke Alaka'i O Hawai'i*, and details various traditional uses of *wiliwili*. The second is an excerpt from an article that was part of a series published by Z. P. K. Kawaikaumaiikamakaokaopua concerning the various stages of canoe building.

He Wahi Moolelo No Ka Wiliwili

*O ka **wiliwili** oia kekahi o na laau maikai o Hawaii nei, aole nae i like kona ano me na laau e ae, a eia na me ai loaa mai ia'u ma o ko'u ninau ana aku i na hoa. Ua ha'i mai lakou no Hawaii nei no keia laau, aka, aole i hoikeia mai kahi i hoomaka ai o keia laau e ulu. O ke ano o keia laau he ooi.*

O KA HANA A KA WILIWILI

*O ka **wiliwili**, he laau hana nui ia keia ma Hawaii nei i mea e kuai aku ai me kekahi poe, a i mea ama waa no hoi kekahi. Aole oia wale no, i mea wahie no hoi kekahi i mea e mo'a ai o ka ai.*

O kahi ulu nui o keia laau ma na kualono a ma na kula hauliuli e waiho mai nei. Ua kiiia i mea hooholo moku e na kamalii a me na kanakamakua no hoi, ua kiiia i mea hana aniani no kahi poe, aia a naha ke aniani, alaila, hookomo iho.

*Aole oia wale no, he hanaia no i waa, i na he **wiliwili** nui e kupono ana i na kanaka elua a ekolu o piholo i ke kai, aole nae i ka manawa e kalai ai, aia a waiho aku a maloo alaila, lawe mai, ua like no ka hana ana o kea ma me ka waa koa, a hiki mai i ka manawa e ike ia ai o ka i'a, o ka inoa oia ano i'a he auau, holo aku la kahi waa **wiliwili** holo pu me ka nui o na waa koa, a loaa mai la kai'a, alaila, hoi mai kanaka haawi ia iho la kahi i'a na kahi kanaka nona ka waa **wiliwili**, no ka mea, he laka loa keia ano i'a i keia ano waa **wiliwili** me he laau makalei ala ka muimui a ka i'a.*

Aole oia wale no, he hanaia e kekahi poe i pulupulu i mea pulupulu-ahi i mea e hoomau ai i ka a i mea puhi paka no kekahi poe.

Oia iho la na me ai loaa mai ia'u ma o ko'u hele ana aku e ninau i na hoa, a ua hai mai no lakou e like me ka me ka mea i loaa ia lakou a wili iho la me kahi me ai loaa ia'u a mahuahua iki he nui wale aku no paha na mea i koe, aole nae i loaa aku ia'u.

*A no keia ano laau no ka oleloia, Pua ka **wiliwili**, nahu ka mano* (Kahopukahi 1930).

[Translation]

A STORY ABOUT THE *WILIWILI*

Wiliwili is one of the best plants of Hawai'i, but it does not look like other plants, and here are some of the things that I have collected by asking my friends. They have told me that this plant is from Hawai'i, but it was not revealed to me where this plant first grew. This tree is prickly.

USES OF THE *WILIWILI*

The ***wiliwili*** is a wood which was prepared here in Hawai'i for sale to others and used as *ama* [outrigger float] for canoes. That is not all, it was used by some as firewood to cook food.

This tree was most commonly found near the mountain ridges and on the forested plains. It was collected by children and adults to make toy boats and it was collected by some people to make glass/mirror, and when it shattered, then ***wiliwili*** was inserted.

That is not all, it was also made into canoes, only if the ***wiliwili*** was sizeable and suitable for two or three people, lest it sinks in the ocean. A canoe made of ***wiliwili*** was never craved when it was freshly cut, only after it had been dried, then it was brought and carved in the same manner as that of a *koa* canoe. And when the fish was observed, the fish called *a'ua'u* [young marlin], the ***wiliwili*** canoe sailed with a large number of *koa* canoes, and located the fish, and then, when the men returned, fish was given to the owner of the ***wiliwili*** canoe, because, this kind of fish was attracted to the ***wiliwili*** canoe in the same manner as the wood of the *makalei* tree attracted fish.

That is not all, some people used it as kindling to keep the fire for the tobacco burning.

That is what I have obtained from asking my friends, and they have told me what they knew and I have combined that with what I know. There are probably many other uses, which I have not obtained.

And it is from this plant that this saying is derived, *pua ka **wiliwili**, nahu ka mano* (when the ***wiliwili*** blooms, the shark bites). (Kahopukahi 1930)

Ke Kalaiwaa Ana A Me Kona Ano (The Nature of Canoe Carving)

A series of articles written by Z. P. K. Kawaikaumaiikamakaokaopua described the various stages of canoe carving. These articles were published in *Ka Nūpepa Kū'oko'a* between October 26th, 1922, and February 15th, 1923. In the article appearing in the February 1st, 1923 edition, the author described the use of *wiliwili* during the finishing stages of canoe construction, particularly the painting and construction of the ama or outrigger float of the canoe. In relating knowledge of the preferred paint color, the author described the use of black paint, which was said to better conceal the shadow of the fisher. Those portions of the article describing the use of *wiliwili* are transcribed and translated below.

> *...Aole o ka* ***wiliwili*** *wale no ke pena e hanaia ai, i hanaia no paha ka* ***wiliwili*** *ma na Kona nei, no ka mea, o ka laau nui ia manawa ma Kona nei. O ke akaakai o na lo'i, o ia ka mea oi loa aku o ka maikai, ame ka na-ku, no ka mea, he hikiwawe ko laua pau i ka a ia e ke ahi...*
>
> *Apau keia mau mea i ka makaukau, o ke ama aku ia mea hana nui i ka huli; no ka mea, o ke ama makemake loa ia, o ia no na ama* ***wiliwili*** *no ka hoe ana, aole e komo iloko o ke kai ke hoe a pupu hoi, no ka mea he lana loa iluna, a he oi loa aku hoi ma ke kukulu pe'a ana, o ia mau ia.* (Kawaikaumaiikamakaokaopua 1923a)
>
> [Translation]
>
> ***Wiliwili*** was not the only type of paint made, ***wiliwili*** was likely used here in Kona, because there are many trees here in Kona. The *akaakai* (bulrush) found in the *lo'i*, is, however, far more superior as well as the *naku* (bulrush), because they burned rapidly in the fire...
>
> And when these things were prepared, great effort was made to find an *ama* [outrigger float], because the most preferred wood is an *ama* made of ***wiliwili***, to paddle with; when in the water it does not move slowly because it floats high on the water, and far more superior when sailing, and so forth.

In the February 8th edition of the article, the Kawaikaumaiikamakaokaopua further described the places in Kona that were known to for its *wiliwili*, which the canoe carvers of that time used to make their *ama* and *'iako*.

> *No ke ama o ka waa; aole i makemakeia na laau e ae i ka wa kahiko i ama no ka waa. O ka laua* ***wiliwili*** *wale no; a he kakaikahi wale no na aina i uluia e keia laau. Ua olelo ia mai ka poe kahiko ma ka apana o Kona Hema, ma Kapua e loaa ai na ama* ***wiliwili*** *maikai, a ma Kona Akau hoi, mai ke a aku o Kahilinai ahiki i Napuu.*
>
> *Oia hoi o Puuwaawaa ame Puuanahulu. Ia mau ama e hele ai ka poe huli ama. Aia ma na kula a-a e ulu ai keia ano laau. He kakaikahi loa ka ulu ma na aina lepo. A ua hele aku kekahi poe i Kau, a ua olelo mai kekahi poe kahiko i hele i Kau, he oi aku ia o ka aina wiliwili i ka wa kahiko, a i keia wa, ke nalowale loa aku nei keia laau; mamua he ike aku oe i ka laau* ***wiliwili****.*
>
> *O ka loaa ana o ke ama* ***wiliwili*** *i kekahi kanaka, like ia me he keiki hanau maoli ana nana. E malama loa ana oe i ke kaikai ana; elike no me ke kaikai ana o ka waa, no ka mea, he minamina loa lakou o uluulu a manumanu. I makemake loa ka poe kahiko no ka holo ana i kahi loihi no ke kukulu pea ana...*(Kawaikaumaiikamakaokaopua 1923b)
>
> [Translation]
>
> For the *ama* of the canoe, no other wood was preferred in the ancient times for the *ama* of the canoe. Only the wood of the ***wiliwili***; and there were only a few places where this tree grew. According to the old people, in South Kona, at Kapu'a was the best place for an *ama* ***wiliwili*** and in North Kona, from the north of Kahilinai all the way to Napu'u.
>
> That is, Pu'uwa'awa'a and Pu'uanahulu. These *ama* were sought after by the *ama* seekers. These trees could be found growing on the *'a'ā* plains. It grew very sparsely in well-soiled lands. And some people have traveled to Ka'ū and these old people that traveled to Ka'ū reported that there were far more ***wiliwili*** lands in the old times, but now, this tree is disappearing; before ***wiliwili*** was commonly seen.
>
> According to some people, procuring an *ama* ***wiliwili*** for them was like giving birth. Great care is given, just as was done for a canoe because they grew irregularly. The people of old greatly preferred *wiliwili* for long distance sailing.

Changing Uses of *Wiliwili*

In summary, the abundance of literature describing the traditional cultural uses of *wiliwili* as well as the locales that were famed for this tree highlights its usefulness and significance in Hawaiian culture. Many of the traditional legendary accounts describe extensive groves of *wiliwili* in the arid regions of both Hawai'i, Maui, Moloka'i, O'ahu, and Kaua'i islands. While historical accounts describing its abundance are somewhat conflicting, it is evident that the *wiliwili* populations were in decline by the late 19th-century as a result of the changing political economy of the islands, particularly the shift into large scale ranching and commercial agriculture which severely impacted Hawai'i's dryland forest habitat. The reduction in Hawai'i's dryland forest habitat and the privatization of land have undoubtedly affected access to and therefore, use of this plant in its traditional manners. Additionally, the introduction and adoption of modern technologies such as western medicine, contemporary fishing equipment, fiberglass, and resin technology provided an alternative from which many of these traditional items could be made. While some of the traditional uses of *wiliwili* appear to have ceased with the changing lifeways of the people, many of the more popular items that were once crafted from *wiliwili* such as canoes and surfboards continue to be an important part of maintaining aspects of traditional Hawaiian culture.

Although many of the canoes and surfboards used in Hawai'i continue to be manufactured from wood and mostly of fiberglass technology, practitioners today continue to seek ways in which traditional woods such as *wiliwili* can once again be utilized (Bornhorst 2010). Since at least the early 2000s, concerted efforts to reconstruct the traditional Hawaiian surfboards using both native woods such as *wiliwili* and non-native woods has gained worldwide attention. However, some practitioners in Hawai'i continue to maintain the traditional customs and ceremonies associated with felling, hewing, and carving traditional surfboards (Stevens 2011). Some people today favor a more environmentally friendly approach to making these timeless cultural objects, coupled with the move to revitalize dormant traditions, the need for suitable native woods continues to be realized. Conservation and stewardship of critically endangered dryland forest habitats have also gained momentum and many of today's conservation groups have an in-depth understanding of both the ecological and cultural value of Hawai'i's dryland forest ecosystems. Traditionally, as a people who relied exclusively on healthy and thriving resources of the land and ocean, many Hawaiians and other Hawai'i residents alike understand the interconnectedness of Hawai'i's host culture to the environment. The cultural and ecological significance of *wiliwili* is further discussed in the following section of this study.

3. CONSULTATION

Gathering input from community members with genealogical ties and long-standing residency or relationships to the affected areas and with cultural experience with the target species 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 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 *wiliwili* or the habitat in which this plant is found, 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, Ka'ū Preserve, Hawai'i	3/6/2019	See summary below
John Repogle	Retired from The Nature Conservancy, Ka'ū Preserve, Hawai'i	3/6/2019	See summary below
Nohealani Ka'awa	The Nature Conservancy, Ka'ū Preserve, Hawai'i	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, Hawai'i	4/3/2019	See summary below
Robert Yagi	Waikōloa Dry Forest Initiative, Hawai'i	4/3/2019	See summary below
Wilds Brawner	Ho'ola Ka Manaka'ā at Ka'ūpūlehu, Hawai'i	4/9/2019	See summary below
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 below
Wili Garnett	Cultural practitioner, Moloka'i	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."

Table 1 continues on next page

Table 2. continued.

Name	*Affiliation, Island*	*Initial Contact Date*	*Comments*
Emily Grave	Laukahi Network, O'ahu	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, Hawai'i	5/30/2019	See summary below
Talia Porter	Honolulu Botanical Gardens, O'ahu	6/3/2019	Responded to interview request but was unable to secure an interview.
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 below
Iliahi Anthony	Cultural practitioner, Hawai'i	8/30/2019	See summary below

End of Table 1

SHALAN CRYSDALE, JOHN REPLOGLE, AND NOHEALANI KA'AWA

On March 6th, 2019, Lokelani Brandt and Matt Clark interviewed Shalan Crysdale, John Replogle (retired from the Nature Conservancy), and Nohea Ka'awa of The Nature Conservancy (TNC) Ka'ū Preserve regarding DOFAW's proposed action and to gather any known cultural knowledge of *wiliwili*. When asked about any known cultural uses of *wiliwili*, Shalan spoke about some of the known past uses which included its use in the traditional construction of surfboards and other traditional aquatic equipment as well as *lei* made from the seeds. Shalan emphasized that although there are many known traditional uses of this plant, he was not familiar with anyone who continues to use the plant in any traditional manner but emphasized that there may be practitioners that continue to work with *wiliwili*. They explained that *wiliwili* is common in the district of Ka'ū and that intact groves are still found throughout the drier parts of the district. Shalan also described its preference for growing on the rocky *'a'ā* lava. Shalan and John spoke specifically about the grove of *wiliwili* in Kawela Ahupua'a, which they recalled being the site of the 2006 release of the wasp parasitoid *Eurytoma*. Shalan stated that when news of the EGW was made public, some people from the Ka'ū community responded and set out to personally collect as many seeds from various *wiliwili* trees. He believes that this public outcry demonstrates its value and significance to these communities.

The crew from the Nature Conservancy then took ASM staff on a tour to visit a stand of *wiliwili* trees that were impacted by the EGW. As evidenced by the field visit and emphasized by TNC staff, many of the *wiliwili* trees in Ka'ū are being encroached upon by Christmas Berry (*S. terebinthifolia*) and other invasive species including ungulates. Shalan noted that because many of these invasive species grow at a much quicker rate, they rapidly spread over an area and compete with the *wiliwili* for habitat. Shalan also described the episodic wildfires that burn rapidly through the drier portion of the district that further threatens the remaining populations of *wiliwili*.

Shalan noted that after the 2006 release of the wasp parasitoid (*Eurytoma erythrinae*), he has observed the recovery of many *wiliwili* trees, which Shalan stated, is not to overshadow the demise of many other *wiliwili* in Ka'ū. 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 tree's 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, Ho'ōla Ka Makana'a at Ka'ūpūlehu Dryland Forest, was interviewed by Lokelani Brandt on April 18th, 2019. Since 2008, Wilds has worked at the 70-acre Ka'ūpūlehu Dryland Forest preserve performing a variety of duties including management and education.

When asked if he knew of any traditional practices, uses, or beliefs associated with the *wiliwili*, Wilds stated that the wood was used for floaters, surfboards, *wa'a*, and *'ama*, and that the seeds and flower are used for *lei*. He has also seen other traditional implements made of *wiliwili*, such as a *hohoa* (*kapa* beater), but alluded that due to wood's lightness, this type of *hohoa* may have been used in the final stages of *kapa* making. Wilds also spoke about the famed *'ōlelo no'eau*, "*pua ka wiliwili, nanahu ka manō*." He explained that one interpretation of this *'ōlelo no'eau* describes male behavior when vying for a female, which is likened to a fierce shark. He further explained that the literal translation is in reference to increased shark activity, which coincides with the tree's flowering season. He stated that this traditional observation is backed by scientific evidence shared with him from marine-based project partners.

He also spoke of the *mo'olelo*, *Nā Wiliwili O Pā'ula* (The *Wiliwili* Trees of Pā'ula), that was shared with him by Aunty Ku'ulei Keakealani, a storyteller and cultural practitioner from the North Kona and Waimea area. Wilds explained that this *mo'olelo* describes the physical attributes that are unique to the *wiliwili*, such as "weird nodules" and "crooked branches." He also described the *wiliwili* to be one of the very few truly deciduous trees in Hawai'i. He also illuminated that when the tree is in full bloom it is a magnificent sight. he has learned that the Kohala Mountains, as well as areas on Maui, had extensive *wiliwili* forests and that during the flowering season created a stunningly beautiful sight. He recalled that those fortunate observers often described this flowery scene as a "fire on the mountainside" due to the flowers vibrant orange color.

When asked of his knowledge and experience with *wiliwili*, he noted that Ka'ūpūlehu Dryland Forest does not contain any wild mature *wiliwili* trees but has a small thriving population of *wiliwili* trees that were planted prior to his employment. Wilds has, however, seen *kupuna wiliwili* (ancient *wiliwili*) trees in the area of Pu'ukawaiwai, Palamanui, Makalei, and 'O'oma. He added that *wiliwili* in a thriving forest is considered a keystone species, which is evidenced through research for areas near Ka'ūpūlehu, Pu'uwa'awa'a, Kūki'o, Awake'e, Makalawena, and Mahai'ula. Although *kupuna wiliwili* are present in these areas, their preferred habitat is now occupied by exotic grasses, silk oak, Christmas berry, and Jacaranda. Wilds noted that other keystone native plants species are also found in these areas including *lama*, *'ohi'a*, and *alahe'e* but emphasized that like the *wiliwili* these are becoming increasingly uncommon. He described the *wiliwili* as a "famed lowland dry forest species" and has observed and seen remnants of these forests in nearby areas such as Pu'uwa'awa'a and the leeward side of Kohala mountain. He remarked that the color of the *pua wiliwili* (*wiliwili* flowers) is regionally based, with gradations of white, green, and orange. Wilds shared that traditionally, enormous forests of *wiliwili* served as a major food source for pollinators such as birds, and insects, as *wiliwili* flowers contain a "pouch of nectar." He suspects that larger mature *wiliwili* produced a multitude of flowers and that these formerly forested areas, would have provided the necessary support for a thriving habitat. Additionally, these former *wiliwili* forests would have provided an abundant food source for wildlife as well as a windbreak or physical buffer for the forest, shade for new growth, and healthy ground soil.

Wilds deduced that the introduction of feral ungulates, wildfire, exotic grasses, habitat loss due to human development, powdery mildew fungus and exotic pests (including EGW, red spider mites, and non-native seed weevils), has heavily impacted many of the older trees and severely inhibited the growth of new *wiliwili*. He added that although *wiliwili* is extremely easy to grow, these threats, particularly the EGW, are affecting its ability to thrive. Wilds described the EGW to be very host specific and observed the distinct damage it causes to the *wiliwili*, which is auspiciously not seen on other native trees. To manage these threats, the Ka'ūpūlehu Dryland Forest staff has utilized a combination of manual clearing, chemical treatment, and biological control practices. Wilds shared that conducting chemical control practices has proven to have adverse effects as it kills, not only the EGW but other naturally occurring potential biocontrol species as well. He added that the sole use of insecticides is not a viable method because the manpower needed to administer the insecticide is costly and it does not make sense to treat entire forests or patches of forest. He recommended that in order to prevent "killing our beloved *wiliwili* tree" the habitat must be ideal for successful regeneration and management methods. Wilds 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.

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. 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 *wiliwili* on Kaua'i, Mike stated that there are people who continue to utilize the flowers and seeds for *lei*. Mike also noted that he has seen *wiliwili* floats on outrigger canoes but expressed that he has not observed the actual making of the float. He did share that *wiliwili* still grows on Ni'ihau and was traditionally used for *lei* making, oftentimes strung together with the infamous *pūpū o Ni'ihau* (Ni'ihau shells). Mike added that the people of Ni'ihau greatly valued the *wiliwili* tree and were able to distinguish a native *erythrina* from non-native varieties based on its distinctive colors. He also shared that with the decline of *wiliwili* populations, due to ranching, the people of Ni'ihau have had to adapt their traditional and cultural practices to their changing environment, such as replacing native plants with "weedy non-native" species for medicinal purposes.

Mike described that at the NTBG, they had a large collection of *Erythrina* species that were collected from all over the world and that with the arrival of the EGW, they had lost half of their collection. He noted that the native *wiliwili* have been severely impacted by the EGW and specifically referenced the area of Kahikinui and Kaupō on Maui, where thousands of *wiliwili* were affected. When the EGW began its assault on the native *wiliwili*, Mike was a part of a statewide effort to collect as many *wiliwili* seeds as possible. As a result, he was able to see many *wiliwili* populations on Kaua'i and discovered that many of the remote populations, in the areas of Waimea Canyon, Kalalau, and Polihale, had no presence of EGW and were never affected. Mike stated that the first release of the wasp parasitoid played a critical role in helping to get the EGW populations under control.

When asked about any potential cultural impacts that 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. Therefore, he is pleased to learn that the Department of Agriculture and DOFAW are considering more releases as it has been over a decade since the release of the *Eurytoma* parasitoid wasp. He is particularly impressed 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 26th, 2019, Lokelani Brandt and Aoloa Santos met with Executive Director, Jen Lawson and Preserve Manager, Robert Yagi, of the Waikōloa Dry Forest Initiative. The Waikōloa Dry Forest Initiative manages 275 acres of dryland forest located near the Waikōloa community. The 275-acre preserve is home to sixty-two *wiliwili* trees plus over a thousand planted and *keiki* (young) trees, which Jen described as a fraction of the *wiliwili* trees that once grew in the area.

When asked if they were familiar with any traditional customary practices or beliefs associated with the *wiliwili,* Jen mentioned that people have visited the forest for traditional or customary practices, such as gathering seeds or for wood. She noted that community members, including practitioners, have asked and collected fallen branches for *ama* as well as surfboards. Jen also added that people continue to collect seeds but do so without permission. She further explained that the forest is underutilized probably because people are unaware or *kama'āina* have other areas they source from. Due to the fragile state and with a small population of *wiliwili* in the preserve, they highly discourage the collection of the seeds until the threat of the EGW can be controlled. Although the seeds are vital to their reforestation efforts, the organization's long-term goal is to reduce and eventually eradicate the threats to increase tree population so that the forest can continue to be used for traditional and customary practices.

Jen and Robert both shared their experience with working with the wasp parasitoid, *Eurytoma erythrinae*. Jen shared that in 2008, the State of Hawai'i, Department of Agricultural conducted preliminary research and informed communities of their intent to release a biocontrol agent to control the EGW. Following the release of the wasp parasitoid, the Waikōloa Dry Forest staff saw a significant decrease in the EGW population which lent to the recovery of many *wiliwili* trees. Despite this success, Jen noted that they did lose a number of *wiliwili* trees. However, in a continued effort to be good stewards of the biocontrol and to better manage the trees within the preserve they developed in-house strategies and practices to further combat the remaining EGW populations. Robert explained that he has experimented with raising, breeding, and releasing the *Eurytoma* during the flowering season when EGW populations peak. Jen shared that a healthy population of *Eurytoma* is needed to combat EGW but their observations have shown that as *Eurytoma* eliminates the EGW it also eliminates their food source resulting in a population decline. Subsequently, an influx of EGW returns during the flowering season and outnumbers the *Eurytoma*, thus causing a resurgence in the EGW populations. Robert stated that the *Eurytoma* are raised during the non-flowering season to ensure a vigorous population necessary to combat the EGW. Jen added that the challenge with this effort is the lack of follow up and limited continued monitoring from the Department of Agriculture.

When asked about indicators of an infested *wiliwili*, Jen explained that after the EGW deposits its eggs in the stems and leaves of the tree, as the larvae develop it forms a gall. When the wasp emerges, they burrow out of the leaves and stems leaving behind small holes. If a *wiliwili* is prodigiously infested with the EGW, it will then undergo a series of stages before perishing, which includes galling, loss of leaves, decrease in seed production, and discoloration of the branches and trunk. Although the EGW is the main threat to *wiliwili,* Jen and Robert noted that there are a variety of other pests that also affect the *wiliwili.* Smaller insects such as spider mites, lace bugs, thrips, and scales are seen on the flowers, leaves, and branches of the tree. Prior to fencing the preserve, Jen noted that goats were a serious pest as they eat the leaves and branches of healthy *wiliwili.* Jen recalled that since the removal of these ungulates, *wiliwili* canopies have improved and the branches of the tree can sprawl outward over lava. Another concern that was shared includes the threat to the *wiliwili* seeds which are eaten by rats and other insects.

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 their knowledge of traditional cultural uses of *wiliwili*, Forest and Kim shared that people utilize the seeds for *lei* and use the wood for floats. Forest stated that over the years, concerns have been raised regarding the impacts that biocontrol agents may have on other native plants all of which are of ecological importance and some of which are extensively utilized in a Hawaiian cultural context. In their dedication to perpetuating native Hawaiian flora, which they cultivate on their property, Forest and Kim shared that *hālau hula* and other native Hawaiian groups visit their garden to gather plants for medicinal and ceremonial uses, *lei* and dye-making, and as *hula* adornments. The ongoing traditional practice of gathering native plants for an array of cultural uses are some of the reasons they desire having an environment dominant with native plants. Forest also stated that cultural practices and traditions drive necessary actions to help protect these plants and that the loss of native plant habitat from invasive species affects the "sense of place and endemism that makes Hawai'i unique."

Forest and Kim also spoke about the past biocontrol efforts to combat EGW. Forests stated that the initial release, in his opinion, "did an amazing job" and since then, Kim stated she has not recently seen galling on the trees by the EGW. Forest also shared about the first time they detected the EGW on Kaho'olawe Island and observing a *wiliwili* tree that was just beginning to bloom. He recalled telling a group of students that this may be the last time this tree will ever flower, to which a Hawaiian student in the group replied, "that's one of the saddest things I've ever heard." Forest reminisced that this statement stressed the cultural significance of the *wiliwili* and the deep connection between the native people of these islands and their native plants. He added that if these plants were no longer in existence, it would remove that cultural connection for future generations. Forest and Kim also highlighted the increasing threat of the seed beetle that drills holes into the *wiliwili* seeds which renders the seeds unpropagatable. Therefore, they both agreed that this threat will need to be dealt with very soon or the *wiliwili* may suffer much larger consequences than the damage done by EGW.

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 the course of many years they have seen limited success where biocontrol has resulted in complete eradication.

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 his knowledge of traditional cultural uses and beliefs associated with the *wiliwili*, Manai explained that the *wiliwili* is a *kino* (embodiment) of Kapō'ulakīna'u. When asked if he could further explain the Hawaiian cultural understanding of Kapō'ulakīna'u, Manai stated that this female deity is a sibling to Pele and that her volcanic form is the *'a'ā* lava, which he described as the slow-moving and crumbly type of lava. In referencing the genealogy of Haumea and Moemoe'a'ali'i, Manai illuminated that Kapō'ulakīna'u is a younger sister of Pele who was born from her mother's (Haumea) *kuli* (knees). Manai explained that he has observed in the Ka'ū District as in other parts of Hawai'i Island, the *wiliwili's* preference for growing in the *'a'ā* lava fields. Manai noted other attributes of Kapō'ulakīna'u, which associates her with life forms that are parasitic, semi-parasitic, and toxic. He noted that part of Kapō'ulakīna'u's role in the natural environment is related to the cultural understanding of *noho* (possession), so many of her physical forms share the same attribute. Manai explained that other plant forms that share a semi-parasitic relationship with other plants could be considered embodiments of Kapō'ulakīna'u. He added that old proverbial sayings, such as *pua ka wiliwili, nanahu ka manō* further emphasizes this plant's importance to *kupuna* (elders or ancestors), who made astute observations (*kilo*) between the blossoming *wiliwili* and increased shark activity in near-shore waters.

Manai also spoke about some of the cultural uses of the seeds, which were strung into brightly colored *lei*. He noted that although the preparation of this type of *lei* is labor-intensive while growing up, he frequently saw this *lei* being worn by dancers and *kupuna*. He added that unlike *lei* made from natural foliage—which is typically worn once, then returned to the forest—the *lei wiliwili*, if preserved well, could be worn multiple times, if not throughout one's lifetime. He expressed that today, these types of *lei* are less frequently seen, much less worn.

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 'Ōhi'a Death (ROD), which has significantly impacted *hula* practices. He noted that culturally, *'ōhi'a* is an important part of *hula* adornments and rituals, since becoming aware of ROD, he no longer gathers *'ōhi'a* nor does he condone the gathering of this plant. He explained that not being able to utilize *'ōhi'a* 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 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 that 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 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 Hawai'i'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 entry 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 Hawai'i Island is now widespread and unmanageable. He believes that rapidly responding to invasive species, especially when populations are far more contained, could be far more effective.

DENNIS KANA'E KEAWE

On August 13, 2019, Aoloa Santos conducted an interview with Dennis "Kana'e" Keawe, a retired Commercial Services Consultant for Hawaiian Electric Light Company (HELCO) and former lecturer at the University of Hawai'i at Hilo (UH Hilo). Born and raised on O'ahu, Kana'e moved to Hawai'i 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. Kana'e stated that when he was asked to teach the course, his botanical vocabulary and knowledge were 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, Kana'e learned that many varieties of Hawai'i's native plants "exist within the tropical belt around the world" and 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, Kana'e 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), *i'e 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 *wiliwili*, Kana'e mentioned the use of the wood for surfboards and canoe outriggers. He added that he was aware of cultural practitioners who still utilize *wiliwili* for surfboards but believes it may be a rare practice due to rising concerns of the dwindling *wiliwili* populations and the desire for more durable materials such as polyurethane foam. He is unsure if *wiliwili* is still used today for canoes, noting that the wood weathers easily and is extremely delicate. Kana'e further shared that *wiliwili* is not ideal for *hula pahu* and *i'e kuku* because the wood is "too soft." He also pointed out that the seeds which are commonly used *lei*, produces four different colors: purple, orange-red, yellow, and white. In other parts of the Pacific, particularly in Rapanui, Kana'e shared that "the people use the flower and stems" of their native *wiliwili* as spacers in *lei,* similar to the straw and paper *lei* that children make. He is, however, unaware of that practice being used for *lei* in Hawai'i.During his visit to the Smithsonian, Kana'e viewed and photographed several of the *hula ki'i* that were part of the Nathaniel B. Emerson collection. *Hula ki'i* was a style of *hula* performance that used puppet dolls whose heads were made of *kukui* or *wiliwili*. Kana'e described the *hula ki'i* as if he were "seeing small people in their coffins" dressed in modern clothes. He observed that the clothes were possibly sewn using a sewing machine, as evident by the seams near the wrist and neckline (Figures 24 and 25). He strongly agrees that the dolls' wooden components, such as the head, were made of *wiliwili* or *kukui*, as described by Emerson since the wood is "soft and easy to carve, as well as lightweight to manipulate during the show or presentation." Additionally, Kana'e revealed that there is possibly a space in the back of the dolls that were large enough to fit a hand, suggesting that it was used as puppets and possibly in the same fashion as ventriloquism. In comparing the drawings and narratives published by Emerson to Kana'e's photographs, he infers that only four of the six *hula ki'i* are currently at the Smithsonian (Figures 26 and 27), reasoning that Emerson may not have been able to purchase the entire marionette collection. Kana'e imparted that "it was a good collection and a small part of the *hula* culture, but the puppets are just a small part of that segment where the language was the key to the entire presentation."

When asked about his thoughts on the cultural appropriateness of biocontrol, Kana'e 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.

Figure 24. Top---Emerson's (1909:90) drawing of two marionettes named Maile Pakaha (left) and Nihi-Au-Moe (right). Bottom—Original marionettes of the above drawing at the Smithsonian Museum,photos by Dennis Kana'e Keawe.

Figure 25. Close up of seams near the hand of Emerson's marionette collection at the Smithsonian Museum. Photo by Dennis Kana'e Keawe.

Figure 26. Left—Emerson's (1902:92) drawing of the marionette named Maka-Kū. Right—Original Maka-Kū marionette at the Smithsonian Museum, photo by Dennis Kana'e Keawe.

Figure 27. Original marionette from Emerson's collection at the Smithsonian Museum. Photo by Dennis Kana'e Keawe.

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 'Umeke Kā'eo 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 Hawai'i plant life comes from years of gathering foliage (primarily indigenous and endemic species) and other natural resources for their *'a'ahu* (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* (*Alyxia spp.*). 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. Although Ili is familiar with *wiliwili*, she shared that this is not a plant that she frequently interacts with because it is not found in the area in which she lives and is therefore not readily accessible to her.

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 have not 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, and Significance Assessment

The use of *wiliwili* in Hawaiian culture and its appearance in traditional legendary accounts are both extensive and well-documented. According to the *Kumulipo*, a Hawaiian cosmogonic chant, the *wiliwili* emerged as a forest dweller alongside its paired aquatic counterpart the *wili*, a sea boring animal. The story of *Nā Wiliwili O Pā'ula*, which was also described by Wilds Brawner associates the distinguishing characteristics of this tree with three sisters from the Ka'ū District. According to Wilds Brawner, this *mo'olelo* is still shared with student learners who visit the dryland forest at Ka'ūpūlehu, North Kona. The legend of the demi-god, Māui, tells of how this determined youth secured the legs of the sun to a large *wiliwili* growing on Haleakalā to slow its daily progression through the sky. Description of native *wiliwili* habitat is expressed in the legend of Kawelo and in the epic saga of Hi'iakaikapoliopele. The legend of Kawelo describes the *wiliwili* on Kaua'i, which grew alongside the *lama* (*Diospyros sandwicensis*), another important dryland forest species, while the account of Hi'iakaikapoliopele describes the *wiliwili* that grew in arid 'Ewa plains of O'ahu alongside the *'ōhai* (*Sesbania tomentosa*). Reference to an extensive *wiliwili* forest in the Kohala District of Hawai'i Island is found in the account of Kapunohu, a hero, who, in a test of strength, is said to have forced his spear

with a single thrust through some eight hundred trees. Wilds Brawner described observing many *kupuna wiliwili* (ancient *wiliwili*) trees in the North Kona District of Hawai'i Island. Consultation with Wilds Brawner and Mike DeMotta also indicates that an extensive *wiliwili* forest was also present in the Kahikinui and Kaupō areas of Maui Island—an area that has been severely devastated by the EGW in more recent years. The account of another Kohala hero, Pupuhuluena, depicts the use of *wiliwili* wood, which was carved into an image and used to appease the gods who had taken and concealed all of the food plants at Ka Lae, in the Ka'ū District of Hawai'i Island.

Wiliwili clearly played a vital role in enhancing and maintaining the traditional lifestyle of the Hawaiian people. Its availability to those who settled in the leeward parts of the islands proved most useful as this lightweight and highly buoyant wood was carved into small fishing canoes but more commonly fashioned into *'iako* (outrigger booms) and *ama* (outrigger floats) for larger canoes. All of the consulted parties spoke about the past and continued use of *wiliwili* wood for both the *'iako* and *ama* of canoes. Jen Lawson and Robert Yagi both described practitioners harvesting fallen *wiliwili* logs from the Waikoloa dryland forest preserve which they reported were made into surfboards and *ama*. Although considered rare, canoes carved entirely of *wiliwili* were held in high regard as the wood was said to have effectively attracted the *a'ua'u* fish (juvenile *Istiophoridae* sp.). Traditional canoe carvers also blended the charred remnants of the *wiliwili* wood to make a plant-based smear that was painted onto the canoes during the finishing stages. The black-colored paint was said to have absorbed the shadow of the fisher, allowing him or her to remain out of sight of the fish. Following western contact, a chief named Waipa was said to have constructed a western-style vessel for Kamehameha I and utilized the *wiliwili* wood for the ship's deck flooring. *Wiliwili* wood was also crafted into fishing floaters and used in the traditional fishing style known as *kōheoheo*, a method that was employed when catching large *mahimahi* (*Coryphaena hippurus*) fish. An early missionary account from the Ka'ū District also notes the use of *wiliwili* wood for fencing as well as "stools" for the canoe, which is likely a reference to modern-day canoe cradles.

While fishing was an occupational pillar in traditional Hawaiian society, *he'enalu* or surfing using carefully shaped wooden boards was a popular and esteemed pastime. For the larger *olo* or cigar-shaped surfboard, *wiliwili* was the preferred wood because of its buoyancy and lightweight. While most of the traditional uses of the *wiliwili* wood describe its use in fishing and other aquatic gear, an account written in the Hawaiian language newspapers also indicate that it was used as firewood by some people. Other accounts describe the wood being carved into wooden images that were ornately displayed in traditional *hula ki'i*. Manaiakalani Kalua added that in certain *hula* traditional, particularly those associated with the Pele family, *wiliwili* could be associated with the goddess Kapō'ulakīna'u. In the dry North Kona region of Hawai'i Island, *wiliwili* wood was carved into water troughs and placed into water collection caves.

Historical accounts and as described by several of the consulted parties, the brightly colored seeds and flowers were also utilized in traditional *lei* making. Freshly collected seeds were pierced and sewn together, while freshly picked flowers were strung together. Manaiakalani Kalua added that *lei* made from the *wiliwili* seeds if preserved well, could be worn repeatedly. On Ni'ihau, Mike DeMotta noted that this tree was particularly prized as the *wiliwili* seeds were sometimes strewn together with the rare and delicate *pūpū o Ni'ihau* (Ni'ihau shells). Although the seeds and flowers were most commonly used to make *lei*, historical accounts also describe the use of the *wiliwili* wood, which was carved into a tongue-shaped pendant and threaded onto strands of carefully woven human hair to resembled the *lei niho palaoa* (ivory tooth pendant). While the *lei niho palaoa* was a status item most commonly worn by those of the ruling class, the use of the *wiliwili* was associated with the royal families of the Hilo District. The brightly hued flowers of the *wiliwili* which blooms in stunning beauty during the dry summer months was and continues to be used as an indicator for the increasing presence of sharks in nearshore waters. Several of the consulted parties spoke about the famed proverb, "*pua ka wiliwili nanahu ka manō,*" which captures the seasonal changes unique to Hawai'i and serves as a cautionary reminder to ocean goers. The bark and flowers of the *wiliwili* were also employed in traditional healing practices. A plant-based concoction using the flowers was used to treat venereal diseases, and the bark was utilized to reduce swelling.

It is evident from culture-historical background research and from the consultation efforts that *wiliwili* was widely used in various traditional Hawaiian cultural practices. While historical accounts describing its abundance are somewhat conflicting, it is evident that *wiliwili* populations were in decline by the late 19th-century as a result of the changing political economy of the islands, particularly the shift to large scale ranching and commercial agriculture which severely impacted Hawai'i's dryland forest habitat. The overall decline in dryland forest habitat coupled with the impacts of private property rights are likely the key factors that have contributed to the decline in the cultural uses of this plant. Although the cultural uses of *wiliwili* may have waned during the 20th century, as evident in the consultation efforts, knowledge of the cultural and ecological significance of this plant have remained deeply embedded in the hearts and minds of Hawai'i's people. Though the arrival of the EGW has decimated thousands of *wiliwili* trees, it has also generated more public awareness about this plant's importance to Hawai'i's dryland forest ecosystem and to Hawaiian culture.

Identification of Cultural Impacts and Recommendations

Based on the synthesis of cultural uses described above, it is clear that *wiliwili* is a culturally significant floral species and the primary habitat (Dryland forest) in which it is found could be considered a traditional cultural property that is significant under Criterion e—because it has an important value to the native Hawaiian people. For these reasons protecting all remaining populations of *wiliwili* is imperative as this will help to ensure that its environmental and cultural significance is not diminished. It is likely that increasing populations of *wiliwili* may help in the revitalization of certain Hawaiian cultural practices.

Based on the information presented in the culture-historical background and from the insights shared by the consulted parties, it is the assessment of the current study that the release of the proposed biological control agent, *Aprostocetus nitens* will not result in impacts to any valued cultural, historical, or natural resources. Conversely, cultural impacts are anticipated if no action is taken to further reduce remaining populations of the EGW from further decimating the remaining *wiliwili* trees.

While no specific cultural impacts have been identified, the consulted parties shared valuable insights, 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 plant populations, 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 the EGW population. 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 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 release of the *E. erythrinae*, Jen Lawson felt that the public meetings held by 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 authors' 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 'Ōhi'a 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 Hawai'i's natural resources, it was noted by Manaiakalani Kalua that the State of Hawai'i 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 *A. nitens* as a biocontrol agent for the EGW 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 Hawai'i, specifically DLNR, DOFAW, and HDOA in being mindful of the cultural, social, and environmental uniqueness of Hawai'i. 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 'Āina*, a contemporary movement founded on traditional practices and beliefs that emphasize the intimate relationship that exists between Native Hawaiians and the *'āina* (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 *A. nitens*.

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APPENDIX A.
KA WAI OLA PUBLIC NOTICE

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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)

APPENDIX 2: COMMENTS RECEIVED DURING DRAFT ENVIRONMENTAL ASSESSMENT PUBLIC COMMENT PERIOD

Five letters of correspondence were received during the 30-day public comment period for release of *Aprostocetus nitens* for biological control of *Quadrastichus erythrinae* in Hawai'i. All letters supported the release of *A. nitens*, and therefore no significant changes were made to the draft EA in the composition of the FEA.

From: biocontrol form
To: Wideman, Kylee K
Subject: biocontrol form
Date: Tuesday, December 31, 2019 11:07:09 AM

You've got a new comment:

Comment on a Project

Target: Erythrina gall wasp (Quadrastichus erythrinae)

Name

Carol Kwan

Email

carol@carolkwanconsulting.com

Address

PO Box 893953
Mililani, HI 96789
United States
Map It

Comments/Questions

I support the release of Aprostocetus nitens to complement Eurytoma erythrinae for the biological control of Quadrastichus erithryinae (Erythrina Gall Wasp). As a consulting arborist, I have seen the positive impact in the field of Eurytoma erythrinae on our native wiliwili; however, some damage is still occurring. I am hopeful that Aprostocetus nitens will provide the additional support needed to ensure the long term survival of this important native tree.

Do you wish to be notified during early consultation for future biocontrol projects?

- Yes

From: biocontrol form
To: Wideman, Kylee K
Subject: biocontrol form
Date: Tuesday, January 07, 2020 1:53:58 PM

You've got a new comment:

Comment on a Project

Target: Erythrina gall wasp (Quadrastichus erythrinae)

Name

Fern Duvall

Email

fern.p.duvall@hawaii.gov

Address

Hawaii DLNR Division Forestry & Wildlife
685 Haleakala Hwy
Kahului, HI 96732
United States
Map It

Comments/Questions

I am so impressed by the thorough vetting of the EGWpredator agent for proposed release, and the noting of cultural importance of wiliwili in the document. I look forward to the EA and the culmination of planned work on the Schinus thrips and miconia lepidopteran releases. God speed with the process.

Do you wish to be notified during early consultation for future biocontrol projects?

- Yes

From: biocontrol form
To: Wideman, Kylee K
Subject: biocontrol form
Date: Wednesday, January 22, 2020 11:10:32 AM

You've got a new comment:

Comment on a Project

Target: Erythrina gall wasp (Quadrastichus erythrinae)

Name

Shelley Gustafson

Email

shelley.gustafson@hawaii.edu

Comments/Questions

The Hawaii Association of Watershed Partnerships (HAWP) supports the proposed release of the biological agent, Aprostocetus nitens, to facilitate control of the invasive Erythrina Gall Wasp (EGW). Aprostocetus nitens will complement existing biocontrol by Eurytoma erythrinae, which has been partially successful at limiting EGW impacts to our native flora. Aprostocetus nitens has been proven to infect smaller galls than those infected by E. erythrinae, such as those found on flowers, seed pods and young seedlings. Extensive testing also shows A. nitens as host specific, and without impacts to native Hawaiian flora and fauna. Through their complementary actions, both agents should afford greater and more comprehensive protection to important trees such as our native wiliwili, which has significant value in Hawaii as both a cultural and ecological resource. In general, HAWP strongly supports continued testing and implementation of biocontrol methods, such as the strategic release of A. nitens, as a means to mitigate the harmful effects of invasive species throughout Hawaii.

Do you wish to be notified during early consultation for future biocontrol projects?

- Yes

From: biocontrol form
To: Wideman, Kylee K
Subject: biocontrol form
Date: Wednesday, January 22, 2020 11:30:33 AM

You've got a new comment:

Comment on a Project

Target: Erythrina gall wasp (Quadrastichus erythrinae)

Name

Franny Brewer

Email

fbrewer@hawaii.edu

Address

23 E. Kawili St.
Hilo, HI 96720
United States
Map It

Comments/Questions

Aloha,
On behalf of the Big Island Invasive Species Committee (BIISC) I would like to state our support for this biocontrol release. We have reviewed the proposal and feel that adequate research has been done to ensure there is very low risk for non-target impacts from this introduction, and that the threat to our native wiliwili trees is extremely high without this action. Thank you for the opportunity to comment on this matter.

From: biocontrol form
To: Wideman, Kylee K
Subject: biocontrol form
Date: Wednesday, January 22, 2020 2:01:31 PM

You've got a new comment:

Comment on a Project

Target: Erythrina gall wasp (Quadrastichus erythrinae)

Name

Andrea Buckman

Email

andrea@lhwrp.org

Address

1058 Maohu St.
Makawao, Hi 96768
United States
Map It

Comments/Questions

Aloha no,

As a practitioner of native forest restoration, I strongly support the release of a second biocontrol to help reduce the impacts of the Erythrina gall wasp on our native wili wili. Out staff assisted with the release of the first biocontrol agent for the fall wasp, and I'm hopeful this second species will complement the positive impacts the initial release had. I support further research, funding, and utilization of biocontrol as a non-chemical tool to support our native species and restore resilience and function to Hawaiian ecosystems. Mahalo.

Andrea Buckman

Do you wish to be notified during early consultation for future biocontrol projects?

- Yes

ATTACHMENT 5

INSECT CONTAINMENT FACILITY

STANDARD OPERATING PROCEDURE
November 2020

Hawaii Department of Agriculture
Division of Plant Industry
Plant Pest Control Branch
Biological Control Section
1428 South King Street
Honolulu, Hawaii 96814

Telephone: (808) 973-9544
Facsimile: (808) 973-9533

TABLE OF CONTENTS

INTRODUCTION

Background

The Hawaii Department of Agriculture (HDOA) Insect Containment Facility (ICF), formerly referred to as the HDOA Insect Quarantine Facility (IQF), is under the management and direction of the Biological Control Section of the Plant Pest Control Branch, Plant Industry Division.

Mission Statement

The HDOA-ICF was designed and constructed in 1964 for study of arthropods, primarily insects, and other organisms, imported into Hawaii as potential natural enemies for use in classical biological control of plant pests. Plant pests include phytophagous or plant-feeding insects, mites, snails and slugs, and noxious weeds. HDOA-ICF precludes the escape of organisms brought into the facility as biocontrol agents or hitchhiking contaminants that may have been inadvertently collected and shipped with purposely introduced organisms from overseas or elsewhere.

Location

The HDOA-ICF is located on the grounds of the Hawaii Department of Agriculture Main Office Complex (HDOA-MOC) at 1428 South King Street, City & County of Honolulu, Island of Oahu (Attachments 1 & 2). The boundaries of the HDOA-MOC are Young Street on the north, Keeaumoku Street on the west, King Street on the south and Pawaa Park on the east. The area is largely a commercial district where small business establishments and residential buildings are located.

PHYSICAL CONTAINMENT STANDARDS

SITE DESCRIPTION

Location

The HDOA-ICF is located in Honolulu equidistant from the major landmarks of the city. It is approximately 1.24 km west of Neal S. Blaisdell Civic Center in Downtown Honolulu and the major tourist resorts in Waikiki on the east; 2.9 km southwest of Honolulu Harbor; 1.6 km northwest of the Punchbowl National Cemetery of the Pacific and approximately 12.9 km southwest of the Honolulu International Airport. The nearest

major commercial crop production areas are west of Pearl City, at least 24 km away. The University of Hawaii (UH) Lyon Arboretum is located in Manoa Valley, 5.8 km to the northeast. There are various greenhouses on the UH campus in the lower Manoa valley, 3.7 km from the HDOA. The Foster Botanical Garden is 3.4 km west of the facility.

Security Fencing

The perimeter of the HDOA-MOC is secured with galvanized chain link fence, 6 feet high; with 3 strands of barbed wire that extends a foot above the top of the fence. Besides the front entrance door to the main office, there are two gates by which entrance to and exit from the complex is facilitated. Each of the gates is equipped with a combination lock with a numeric code available only to HDOA-MOC staff. Office hours commence at 6 AM and ends at 5 PM, Mondays through Fridays. The office is closed on Saturdays, Sundays, and holidays.

DESCRIPTION OF THE FACILITY

The HDOA-ICF is an insect containment building designated strictly as a high security facility. The building is a single-story structure with masonry tile walls reinforced with steel bars and concrete and steel roof joists with aluminum roofing. The concrete slab floor has a smooth finish. All interior walls except those in the two vestibules are coated with multiple layers of flat white latex paint. The walls of the vestibules are painted flat black.

The facility consists of seven (7) rooms, namely, two Vestibules, Anteroom, small Storage Room, Main Rearing Room, Screen Room and Back Room (2^{nd} rearing room) [Attachment 3]. A moat, 20 cm wide and 10 cm deep, which surrounds the perimeter of the ICF, also extends and runs around the HDOA Insect Propagation Facility, an adjacent building, which is a non-security area. The moat, filled with water, serves as a physical barrier to prevent entry of predators, particularly ants, which could interfere with colonization of biocontrol agents and their hosts (plants or insects).

Exterior Door

The front door is the only entry and main access to the ICF. It is 4.5 cm thick with a vinyl veneer on the exterior surface to resist weathering. The door is fitted with a dead bolt lock and a pneumatic device that shuts all the time. The door is kept locked at all times and can only be opened either by unlatching the lock with a key from the outside or by turning a button from the inside. The door opens inward to the first vestibule.

Vestibules

Access to the main rearing room is through two vestibules and an anteroom. The first vestibule (V1) is approximately 9 ft long while the second vestibule (V2) is half smaller in size with an inside dimension of 4 by 4 ft. The two doors through V2 are 3.5 cm thick around the perimeters and along the center panel. All the vestibule doors are fitted with felt gaskets to seal any space or clearance between the doors and their jambs. V2 can only accommodate one person at a time.

Anteroom

The room is painted white and partly illuminated with a black light to trap and capture insects that may have inadvertently escaped from the Main Rearing Room. For emergencies, the anteroom is furnished with a telephone and a fire extinguisher. In addition, the Anteroom serves as a dressing room for workers and authorized visitors who must wear laboratory coats and shower caps prior to entering the Main Rearing Room.

Main Rearing Room

This is the largest room within the ICF where rearing and propagation of insects are undertaken. Insects are colonized in rectangular screen cages, small cubical cages or glass jars on counter tops that run the length of the room along the windows. Risk assessment evaluation (non-target studies) of potential natural enemies is likewise done in this room using glass jars, one-gallon jars, or cubical / rectangular cages.

Screen Room

The Screen Room is located on the far-right hand corner of the Main Rearing Room. Inside the room, on the left-hand side, is a tightly sealed wooden containment box where consignments of biocontrol agents collected from overseas are opened, processed, and inventoried. The ceiling and the upper halves of the entry side and the right side that face the Main Rearing Room are fitted with an 80-mesh insect screen. The left wall forms the Back Room while the far wall with a glass window makes up the outer wall of the building.

Back Room

Initially, the room was designed as a greenhouse within the ICF but the plan was shelved because of recurring leaks in the glass roof as a result of weathering. Consequently, prior to 1970, the glass was replaced with aluminum as roofing material. Since then, the back room was used as an alternate rearing room for insects that require higher and warmer conditions. The room faces the afternoon sun and there is no AC to cool it except for a fan that is turned on as needed to circulate warm air.

Windows

All windows are translucent glass reinforced with wire. The panes are held in place with aluminum frames. All crevices are sealed with silicone caulk.

Ceiling

The ceiling consists of canec fiberboard painted over with flat white latex paint. All crevices are sealed with white acrylic latex caulk. The single air vent next to the air handler unit of the AC system is securely covered with a double layer of cotton fabric that is finer than 80-mesh screen.

Electrical Features

Gaps or empty spaces around electrical fixtures, service outlets, and equipment, e.g., autoclave, installed through the wall are sealed with acrylic latex caulk to prevent access and escape of insects and other arthropods from the facility. All light fixtures are fixed and sealed to the ceiling.

Emergency Exit

The HDOA-ICF has only one front door through which entry and exit from the building is facilitated. The building, being a highly secured insect containment facility, does not have an emergency exit. In the event of an emergency where escape from the building becomes a priority but the only way through the Anteroom and Vestibules is unsafe or inaccessible, a masonry hammer and a 2-prong sledge hammers, one of which is located on the wall next to the fire extinguisher and another mounted on the opposite side of the wall just to the left of the doorway to the Back Room, are used to breach the windows.

EQUIPMENT STANDARDS

Main Rearing Room

Twin stainless steel sinks with counters, 61 cm x 122 cm, are located to the left of the doorway upon entry into the Main Rearing Room. Off to the right of the doorway is the double door, pass-through autoclave sterilizer for treatment and disposal of all discarded materials. A small portable autoclave which serves as a back-up sterilizer is nearby. Adjacent to it is a laundry washer on casters that can easily be rolled near the sink where it is run to wash laboratory coats and other clothing materials used in insect rearing. A refrigerator and a plant growth chamber are at the far end of the room, just to the left of the Screen Room and doorway to the Back Room. Work counters nearly run the length of the room on the left side. These are made of wood, supported on galvanized pipes, and covered with chemical-resistant white Formica. Formica work counters are also located over the storage cabinets along the right side of the room from where the sterilizers are located to the Screen Room. Eight wooden racks, painted white and on casters, are in the middle of the room where insect holding containers, such as, jars and small aluminum cages of various sizes, glass wares, and other rearing supplies for easy access are kept. Wooden and metal screen cages, 46 x 46 x 61 cm, are routinely used to rear and colonize the insects on the counter tops.

Back Room

White Formica counter tops also line three walls of the Back Room along the windows. Two portable fans are occasionally used in the room to help circulate the air and facilitate exchange with the cooler air in the Main Rearing Room. A hose bib with the length of a garden hose attached to a faucet is used to wash cages and other rearing equipment/tools. Just to the right of the entry doorway are the electrical circuit breakers and panels. A step ladder stationed in the room is used primarily to check and maintain the air handler and air vent systems above the Screen Room.

Screen Room

The room has a full-size worktable that extends from the wall of the entry door to the main wall of the building. A wooden containment box with a sleeve opening for unpacking shipments is on the worktable along with a lamp. A rack for small cages and jars is on the wall opposite the worktable. A metal tank containing compressed carbon dioxide is securely chained to the wall next to the rack for use in anaesthetizing insects. A variety of supplies and equipment for unpacking shipments and collecting insects is stored on a wooden shelf by the wall above the worktable.

Vacuum Cleaning System

The HDOA-ICF is not equipped with a centralized vacuum cleaning system. A vacuum cleaner is used to clean the facility. All refuse collected with the vacuum cleaner is emptied into trash containers lined with plastic bags commercially sold for autoclaving.

Insect Aspiration System

A centralized system for insect aspiration was not included when the facility was constructed. Instead, a Kenmore Hepa Filter vacuum cleaner hooked to a modified insect aspirator or a simple aspirator hand-made from rubber tubing and glass pipette are used.

OPERATIONAL STANDARDS

Containment Director

The HDOA-ICF is under the direction of the Quarantine Director (QD) and the Quarantine Officer (QO). The QD, who is the Biocontrol Section Chief, oversees the overall operation of the containment facility. Under the general supervision of the QD, the QO, who is the Insectary Supervisor, oversees the daily operation of the ICF, including access to the facility and the development of quarantine procedures. The QO coordinates the operation of the facility by collaborating with regulatory agencies, cooperators, and project leaders. By working closely with the Plant Pest Control (PPC) Insect Taxonomist, the QO facilitates the determination of natural enemy identification. The QO is responsible for keeping accurate records of all shipments into or out of the facility and for compiling databases of all quarantine activities. The QO ensures that all standards for the HDOA-ICF are being adhered to and that the security of the facility is ensured and maintained at all times.

Authorized Personnel

Access to the HDOA-ICF is highly restricted to prevent escape of organisms from the facility. As indicated on the sign by the main door, only authorized personnel are permitted entry into the ICF. The door always remains locked and secured.

The facility is used primarily by the Insectary Staff to undertake research activities on the biocontrol projects of PPC. Other PPC entomologists and support personnel (technicians) who assist the biocontrol project entomologists are allowed entry into the facility as needed. Researchers from outside entities who undertake joint cooperative biocontrol projects with PPC staff are allowed access into the facility.

The UH project cooperators and other visiting personnel can only enter the ICF during normal HDOA working hours (7:45 AM to 4:30 PM), Mondays through Fridays. Except for authorized personnel and other than normal business hours on week days, there shall be no entry to HDOA-ICF on Saturdays and Sundays. On holidays, non-ICF workers, namely, authorized cooperators, may be granted access only if an Insectary Unit professional staff is present to address facility issues and emergencies. The gates to the HDOA complex are equipped with combination locks for security purposes. Cooperating researchers are not given the combination number to the locks. They shall enter the complex through the Front Office for purposes of identification and registration. Once inside the complex, they can only access the ICF by signing up and borrowing the key to the facility from the Insectary (Insect Propagation) Building.

Project Leaders

The project leaders are the HDOA insectary entomologists who have been assigned specific projects on classical biological control. Occasionally, researchers from the state, federal or non-government entities whose projects have been approved and accepted by the QD and/or QO as official cooperative projects may likewise be designated as project leaders. However, before the project is approved, the project leader must provide the QD with a brief description of the work including a timetable, identification of the organisms, literature on their biology and behavior, and if available, voucher specimens of the organisms. All cooperating project leaders shall provide the HDOA QD or QO a copy of a current USDA-APHIS-PPQ import permit (PPQ Form 526) for the appropriate organism before any consignment from overseas or elsewhere is brought into the ICF.

The project leader is responsible for providing the required personnel, equipment and supplies for their project. During the course of the work, the Project Leader shall immediately report any discrepancies or any other significant occurrences to the QO. These may include, but are not limited to, diseases, hyperparasitoids and other

contaminants, and any unexplained loss of colonies. The project leader is responsible for providing voucher specimens to the QO for submission to the HDOA Insect Taxonomist. On a routine basis, the Project Leader shall ensure that strict sanitation is practiced in assigned and common work areas. Upon conclusion of the project, the Project Leader is responsible for the proper cleanup of all areas and equipment used and shall restore areas in the facility back to their condition at the start of the project.

Facility Visitors

Entry into the containment facility is restricted to visitors who are directly involved and actively participating in on-going biocontrol projects. Occasionally, service and repair technicians are allowed entry to undertake routine inspection / maintenance work of appliances or electrical fixtures for which they have been contracted or summoned during emergencies. All visitors must abide by the guidelines specified in the protocol and are always accompanied by authorized personnel.

User's Agreement

All authorized users of the ICF who are not staff members of the HDOA Biocontrol Section are initially given an orientation and "in-house training" to acquaint them with the standard operating protocol before they are allowed entry into the facility. In addition, they must sign their names on the HDOA-ICF User's Agreement Form to acknowledge that they have read and understood the ICF standard operating protocol and will abide by its provisions. Any user who does not and can not comply with said protocol will be denied entry to the facility. Cooperating researchers from outside agencies who are authorized to undertake biocontrol projects within the facility have to sign the ICF Log Book to indicate the date and time of entry and exit from the facility on every visit. All users shall plan their schedule in advance to facilitate access to the facility and complete their work within a reasonable period.

Visitor Orientation

A floor plan of the containment facility is attached to familiarize visitors with the general layout of the rooms and other features of the facility (Attachment 3). First-time users are given an orientation session by the QO during their initial visit.

ACCESSING THE FACILITY

Preparation for Entry

Before entering the facility, users shall leave all outer garments, such as hats, coats, sweaters, jackets, backpacks, in the Insect Propagation Building (Insectary) or, if not possible, in the Plant Pest Control Branch Office area. Research cooperators shall sign-in their names and log in their entry and exit times in the HDOA-ICF Log Book located in the Insectary where they can borrow and return the door key to the ICF.

Entering the Facility

A diagram is included to show how access to the facility may be facilitated (Attachment 4). The entryway to the ICF consists of two vestibules which require opening and closing three doors. No two doors shall be opened at the same time. Each door has a threshold which one must carefully step over so as not to trip. The deadbolt on the main entry door shall be locked immediately after entry into Vestibule # 1 (V1). Then, by tapping the wall in V1, anyone who might be exiting the facility from the opposite direction is alerted. The person leaving the facility shall yield to the one entering because V1 is much larger than Vestibule # 2 (V2), so more time is required to move through V1 than through V2. The person entering shall knock on the second door to alert anyone who might be coming out otherwise he can open the door and access V2 by stepping over another threshold. Once inside the room, the door is closed quickly and the third door that swings inward V2 is open in order to get inside the Anteroom. Again, another threshold is stepped over. Once inside the Anteroom, the door is shut and properly secured. The Anteroom is partly illuminated by a black light that emanates from an insect light trap. Designated as a dressing place, it is in this room where white laboratory coats and shower caps are stored and put on. Only then will access to the Main Rearing Room through another door is allowed. The door is immediately secured and closed behind upon entering the Main Rearing Room.

Preparation for Exit

When done and before leaving the facility, the worker must ensure that his/her work area is thoroughly cleaned and neatly organized. Prior to exiting, he/she must wash hands and forearms in the sink with a hypochlorite/detergent solution the plastic bucket to make sure that no undesirable organisms are inadvertently taken out of the facility. The worker rinses off the solution under the sink faucet and dries hands with a paper towel. Then, a brush hanging by the wall next to the door is used to brush off the lower part of his/her legs, footwear, and shower cap so as to dislodge unwanted "hitchhikers". Moreover, the worker double checks his/her laboratory coat before access to the Anteroom. He/She closes the door behind then takes off and hangs the coat and shower cap in the coat rack.

Except those in the Vestibules and Anteroom no lights, which are on automatic timer, are turned off inside the facility. Although lights in the Vestibules and Anteroom have manual switches they are always in the off positions and may only be turned on during emergencies.

Exiting the Facility

The protocol to exit the facility is the same when one enters the building but in reverse. Either way the worker makes sure that every door is secured shut behind before the next door is opened. Again, he/she must exercise caution in stepping over the thresholds so as not to trip. Once inside Vestibule # 1, the door is pulled behind firmly to shut it. While still facing this door, one orients toward the main front door by walking slowly toward it and touching the wall to the left as a guide. At waist level is the door handle. Above it is a turn button for the dead bolt that is twist clockwise to unlock the door. Exit is facilitated by pulling the handle and stepping over the threshold. The entry door is locked immediately with a key to secure the deadbolt in the shut position. In the Insect Propagation Facility, the exit time from the facility is logged in the HDOA-ICF Log Book and access key returned.

EMERGENCIES

Fires

The HDOA-ICF does not have a fire alarm or a sprinkler system or an emergency exit. However, there is a communication system and fire fighting tools within the facility. The Anteroom and Main Rearing Room has one telephone each. One fire extinguisher is in the Anteroom and a second one is located at the far rear end of the Main Rearing Room by the doorway to the Back Room. Two sledge hammers are mounted above it while another one hangs behind the wall on the left hand side past the doorway to the Back Room. These tools can be used to break the glass windows inside the facility during an emergency. In addition, a garden hose in the Back Room attached to a faucet can also be used in case of a fire.

Should a fire break out in the ICF, trapped workers inside the facility should make every effort to put it out with the fire extinguishers and /or water hose. If unsuccessful and fire is at the rear of the building, workers shall immediately vacate the ICF by exiting through the Anteroom, Vestibules, and the main front door. Use of the phone in the Anteroom should not be attempted. The first person to exit must go directly to the Plant Industry Office to make a 911 emergency call. Then, a warning to all the workers on the premises of the HDOA Main Office complex is sounded off by activating the fire alarm system. A

fire alarm switch is located just inside the main entry doors to the Plant Industry Office at each end of the building. To activate the alarm, follow the instructions on the small, red, alarm unit on the wall by pulling down the switch. Before evacuating to designated assembly areas along bordering streets, check to ensure that all the workers in the adjacent laboratories, particularly, the Insect Propagation Facility (Insectary) and the Plant Pathology Facility have been alerted.

If the fire is at the front end of the building, the telephone in the Anteroom would not be accessible to the workers as they are prevented from exiting the facility through the Anteroom and Vestibules. To facilitate a quick exit, an escape route should be made at the rear of the building, preferably on the south side (King Street) of the Back Room, by breaking a window with the hammers. A metal ladder is in the room and can be used to reach the breached window. Trapped workers should help and assist each other during evacuation. Ensure that all the workers have been accounted for before making a 911 call and activating the fire alarm system in the Plant Industry Office.

CAUTION: Do not attempt to extinguish chemical fires.

If a fire breaks out in another building within the HDOA complex, fire alarms will get activated in most of the buildings except the Insectary, ICF, and Plant Pathology Facility. There are no fire alarm systems in these buildings and workers should be alerted during an emergency either by calling them on the telephone or by designated individuals as specified in the HDOA Emergency Preparedness and Response Plan. In the case of the ICF workers, and if safe to do so, they shall immediately vacate the ICF by passing through the anteroom, vestibules and out through the front door. If this is not possible, exit from the facility should be made in the Back Room through a window breached with a sledge hammer as described above. After vacating the facility, workers shall proceed directly to the assembly areas on the south side (King Street) of the HDOA Main Office Complex.

One each of the schematic diagrams for evacuation of facility during emergencies are posted in the Anteroom, back of the door to the Main Rearing Room and behind the wall on the left hand side past the doorway to the Back Room.

Medical Emergencies

A first aid kit is located on the left side of the doorway as one enters the Main Rearing Room. Should there be a medical emergency; a 911 call is made using the telephone in the Main Rearing Room or Anteroom. Concurrently, the supervisory personnel in the Plant Industry office are alerted about the incident. Meanwhile, the general area around the person who needs medical attention is assessed to determine if nothing further will put him at risk. If deemed safe, everything possible should be done to ensure the comfort of the injured person. However, he should not be moved at all unless absolutely

necessary. If at all possible, the cause or extent of the problem is likewise determined. If the person attending the injured person is properly trained, first aid or CPR should be administered as appropriate. During the process, the injured person is comforted and kept calm by reassuring him that help is on the way. As soon as emergency medical personnel have assisted the injured person, a report detailing the incident and what transpired thereafter is provided to the appropriate supervisors.

Hurricanes and Other Natural Disasters

All natural disasters, including man-made catastrophes, are covered by the HDOA Emergency Preparedness and Response Plan. The plan was put in place to serve as general guidelines and procedures for employees to follow during an emergency caused by but not limited to earthquakes, hurricanes, tidal waves, lava flows, floods, and fires. The intent is to minimize the threat of the impending disaster and prevent unnecessary loss of human lives and properties.

There are natural disasters that can be tracked down and their occurrence forecasted with precision. During the hurricane season, the Hawaiian Islands occasionally lie in the path of this weather disturbance. More often than not, evacuation of the facility is not immediately issued because the course and arrival of the hurricane can be predicted with accuracy. Nevertheless, various procedures are specified in the emergency plan to deal with an emergency of this nature. Thus, when an official notification to prepare for evacuation is received during normal working hours, all Biocontrol Section personnel shall pitch in to secure all the windows of the ICF. The windows on the outer walls of the building are shielded with sheets of treated plywood (3/4 inch A/C) that have been pre-cut to fit their dimensions. Anchor bolts have been placed on the walls to secure the plywood over the windows with screws. All the pieces of plywood as well as positioning of the anchor bolts on the wall matched perfectly to facilitate ease of installation.

After the plywood pieces have been installed over the windows, all authorized personnel shall access the ICF in order to secure their work areas. Electrical equipment and appliances are turned off and unplugged. Equipment as well as files are covered or stashed inside plastic bags to protect them from potential water and moisture damage. After ensuring that all the rearing cages and containers have been properly sealed, workers shall exit the facility and secure loose objects in outdoor areas surrounding the ICF and adjacent buildings. When done, they shall assist other workers in securing the Insectary and the Plant Pathology buildings. The last facility to be secured is the Plant Industry office.

SANITATION

Cleanup of Work Area

At the end of the day or after work is completed, the ICF user shall ensure that the work area is clean and free of dust, debris, plant materials, frass, propagation media, and other kinds of refuse. Thrash is discarded into a large receptacle near the sink in the Main Rearing Room. The trash receptacle is lined with a large autoclavable bag. Used items, such as glass wares, plastic vials, plastic cups, jars, and small rearing containers, are soaked overnight in a dishpan by the sink containing 5:100 sodium hypochlorite solution mixed with ca. 5 ml of a dishwashing detergent. These are washed the next day. The larger insect rearing cages are washed in the Back Room with the same cleaning solution and dishwashing detergent. Finally, the user wipes the surface of the workbench or counter with ethyl alcohol (70% or higher concentration) using paper towels.

Solid Wastes Handling

Solid waste collected in the Screen Room, including those from incoming shipments, shall be discarded into a plastic bag in the wastebasket in the room. When full, the plastic bag is secured by tying both ends then dumping it in an autoclave bag. The bag is sealed and stored under the work table in the Screen Room. The trash is given the highest priority for autoclaving. Meanwhile, trash collected in the Main Rearing Room and Back Room shall be secured in autoclave bags provided in the trash receptacles located near the sink. At the end of the week or as needed, the trash are autoclaved for 30-60 minutes at 122°C (= 250°F) and 15 PSI. Discarded containers or boxes made up of paper materials are autoclaved for 30 minutes. However, soil (potting media), discarded plants and parts including leaves, stems, leaves, and roots and other kinds of wastes are autoclaved for no less than 60 minutes. When autoclaving is completed, treated trash is taken out from the facility. Trash removal is facilitated by opening the rear door of the pass-through (double door) autoclave located outside the building then emptying them into a common dumpster for disposal. Operation of the autoclave is currently handled by a trained Pest Control Technician.

Soil Handling

Used soil, brought inside the ICF with potted host plants, shall be autoclaved then taken out of the facility through the double-door pass-through autoclave for storage and recycling. Prior to autoclaving, the soil is processed by removing plant stumps and/or roots left in the pot. The soil is emptied from the pot by dumping it through a metal grill that sits on top of a large plastic receptacle. The soil is collected and stored in the receptacle until ready for autoclaving. Wet soil with too much moisture is set aside to dry before it is processed for autoclaving. Soil is laid out in thin layers in stainless steel

pans (or cloth sacks) then autoclaved for 60 minutes at 122°C (= 250°F). After the treatment, the soil is taken out from the facility as described above.

Removal of Objects from the Facility

Equipment, tools, and other objects shall not be removed from the ICF without prior clearance from the QO. Small objects or tools used routinely in insect rearing, such as scalpel, scissors, dissecting needle, spatula, etc., can be sanitized with a sodium hypochlorite solution or alcohol (70% or higher) before these are taken out of the facility. Complex and sensitive equipment, such as cameras, computers and other special equipment which cannot be treated with liquid sanitizers shall be stored and secured in plastic bags. Bulky objects, such as insect rearing cages, refrigerator, growth chamber, etc., once brought inside, are not allowed to be taken out from the facility.

Trapping Escaped Insects within the Facility

Occasionally, colonized insects could inadvertently escape from the rearing cages despite efforts by the workers to handle them with care and extra precaution. Black light traps, one in the Anteroom and two in the Main Rearing Room, are employed to catch loose insects and preclude their escape from the facility. The traps are serviced once a week to check and maintain the soap solution in the collection container which kills trapped insects by drowning.

The insects which are reared in the Main Rearing Room and Back Room have already shown some potential as biocontrol agents of various target plant pests. Hence, these insects are considered fairly safe for mass propagation and final evaluation. On the other hand, very little is known about the insects that are still being held inside the Screen Room. In this case, handling of said insects and any other associated organisms must be carefully observed. Thus, in the event that their holding container is accidentally breached, efforts shall be made by the workers to catch and retrieve the insects that have escaped. Under these circumstances, the door in the Screen Room is immediately closed and secured. A search to collect the escapees is initiated. First on the worktable, followed by the window panes and then the light fixtures. After a careful determination and when satisfied that all escapees have been retrieved back, the concealed areas, tight spaces or dark corners in the room that are difficult to access shall be treated thoroughly with a light spray of detergent solution to dispose of any strays that might have been missed during the search.

Use of Pesticides within the Facility

The use of most pesticides within the facility is not permitted. The only insecticide that is approved for routine use is insecticidal soap. Occasionally, bait which consists of a mixture of sugar, boric acid and water is used to control ants. Detergents and other cleansing solutions such as sodium hypochlorite or alcohol (70% or higher) are used as disinfectants.

General Cleaning of the Facility

Floors are swept and mopped with a surface disinfectant once a week. More frequent cleaning is left at the discretion of the QO.

INCOMING SHIPMENTS

All incoming consignments that originated from overseas or elsewhere must be taken directly inside the Screen Room of the HDOA-ICF where they are quarantined and processed. In the Screen Room, the shipment is placed inside a sleeved containment box where the QO and/or project leader inspects and opens the container to unpack the contents. Having done so, the shipping container and packing materials are discarded and taken out of the containment box. The discarded materials are emptied into a plastic bag then stashed into another bag, which is autoclavable, before it is stored under the worktable for autoclaving. The contents inside the consignment are usually packaged in a cloth or plastic bag or secured in a paper/plastic carton container. Regardless, before the package is opened, it is thoroughly inspected to check for any organism that might have escaped while the shipment is in transit. If safe to proceed, the security seal of the container is broken and the insects or infested plant materials, as the case maybe, are removed and transferred into a glass jar or a small cage prepared earlier inside the containment box. When the transfer is done, the containment box is double checked within to ensure that no organism has strayed during the transfer. Otherwise, every effort should be made to catch and retrieve back any loose organism. Subsequently, the container holding the newly acquired organisms is taken out of the containment box and placed on the shelf opposite the worktable in the Screen Room. The container is labeled properly and entrusted to the project leader. Once the process is completed, the containment box is cleaned of any waste or refuse that was left behind. The discarded materials are once again secured in an autoclavable bag for subsequent autoclaving.

All appropriate information concerning the consignments including dates of shipment/collection, origin of shipment, sender/recipient, description of specimens/materials, condition of materials when received, etc., are recorded and filed.

PROPAGATION AND COLONIZATION OF ORGANISMS

Authorized users of the HDOA-ICF shall ensure that all their cages and other insect rearing containers are secured properly to preclude the escape of any organism. Moreover, these containers, which may likewise include jars, vials, tubes, etc., whether they contain dead or living organisms, shall be properly labeled for accurate identification and inventory. In addition, all users shall maintain and upkeep their work areas as well as the facility as a whole at all times. The tools, supplies, and equipment that the workers routinely used shall be taken care of and kept in proper working order. Should there be incidents of cross-contamination of insect cultures, occurrences of disease infections or any unusual event that may put colonies of organisms at risk, the QO must be informed accordingly as soon as possible.

RELEASE OF ORGANISMS FROM THE CONTAINMENT FACILITY

The release of an organism from the HDOA-ICF requires that the colony is disease-free and to the satisfaction of the QO. Once these requirements are satisfied, the release process goes through a protocol as follows:

The applicant shall request an approval from the State of Hawaii Board of Agriculture for the release of the organism from the ICF. The request, which includes a permit application for Restricted Commodities into Hawaii (Form PQ-7) and an Environmental Assessment (EA) report, is submitted to the Board through the HDOA Plant Quarantine Branch (PQB). At the same time, the EA is forwarded to the Office of Environmental Quality Control (OEQC), Hawaii Department of Health, for publication in *The Environmental Notice*, a semi-monthly periodic bulletin published by OEQC. Voucher specimens and authoritative identification of the organism are likewise required. After a review through the Entomology subcommittee and the Committee on Plants and Animals, the Board makes a final decision based on the input made by these advisory committees. If the request to release is approved, a permit is issued by the PQB. The applicant then submits a PPQ Form 526 (Permit to Move Live Plant Pests, Biological Control Agents, Bees, Parasitic Plants or Federal Noxious Weeds) with all the supporting documents to the USDA-APHIS-PPQ Scientific Services in Riverdale, Maryland by logging to their electronic or ePermit system. An in-depth review is initiated by the USDA. If a Finding of No Significant Impact (FONSI) holds, a section 7 Consultation with the U.S. Fish and Wildlife Service (USFWS) follows. If a favorable opinion is received from the USFWS, APHIS-PPQ will issue a news release to the wire services for a 30-day comment period. After which APHIS-PPQ shall determine if a permit to release the organism is justified. A PPQ Form 526 is then issued for the release of the organism from the HDOA containment facility.

ATTACHMENT 6

USDA APHIS PPQ Biological Control

Biological Control Work Plan Fiscal Year 2019

Cooperator:	**Hawaii Department of Agriculture**	
State:	**Hawaii**	
Project Title:	**Pre-release Field Evaluation of a New Natural Enemy for Biological Control of Erythrina Gall Wasp**	
Project Coordinator:	**Juliana A. Yalemar**	
Agreement Number		
Contact Information:	**Address: 1428 South King St., Honolulu, Hawaii 96814**	
	Phone: 973-9544	**Fax: 973-9355**
	Email Address: Juliana.A.Yalemar@hawaii.gov	

I. BACKGROUND INFORMATION

A. Provide a brief description of the issue

The arrival of the Erythrina Gall Wasp (EGW), *Quadrastichus erythrinae* Kim, 2004 (Hymenoptera: Eulophidae), in April 2005 devastated *Erythrina* spp. (Family: Fabaceae) in the Hawaiian Islands. EGW was first found on the Island of Oahu and spread to all the other islands in a matter of months killing hundreds of *Erythrina* trees including the native wiliwili, *Erythrina sandwicensis* O.Deg. 1932.

In December 2005, a natural enemy of the EGW, *Eurytoma erythrinae* Gates & Delvare, 2008 (Hymenoptera: Eurytomidae), collected from Tanzania underwent rigorous testing to ensure its specificity to the target pest and was released in November 2008. *Eurytoma erythrinae* is an ectoparasitoid that attacks EGW by feeding on several of the immatures in large galls to complete its development. Six months after the first release, *E. erythrinae* established successfully in the pest habitat and wiliwili trees began to recover.

Although *E. erythrinae* was successful in saving the Erythrina trees, damage by EGW on flowers, seed pods, and seedlings of the endemic wiliwili persists. Galls formed by EGW on flowers and seedling are usually small and scattered but the Eurytomid parasitoid fares well only on large galls. Furthermore, the formation of seed takes approximately three months and all flower stages are susceptible up to mature seed formation. Seedlings are likewise vulnerable and easily succumb to EGW damage. Hence, the future survival of *E. sandwicensis* remains threatened.

Hawaii Department of Agriculture (HDOA) has proposed the release of a second biocontrol agent, *Aprostocetus nitens* Prinsloo & Kelly, 2009, (Hymenoptera: Eulophidae), to tackle this

dilemma. *A. nitens* is a eulophid ectoparasitoid that was collected in Africa, the native region of EGW, has completed risk assessment and is proven to be host specific to EGW. *A. nitens* can complete its development on a single EGW and survives well on small and large galls. Therefore, it can complement biocontrol by the first parasitoid. Applications for release of *A. nitens* are underway.

B. Indicate

Is this a new project? ☒ YES ☐ NO

Is this a continuation of a previously funded agreement? ☐ YES ☒ NO. If yes, have all progress reports been submitted? Explain.

II. OBJECTIVES, NEED FOR ASSISTANCE, BENEFITS EXPECTED

A. Specific Objectives of the Project (List if more than one)

1. To select release and monitoring sites for *Aprostocetus nitens* when it is approved to be released.

2. To survey, evaluate and update the status of extant natural enemy (*E. erythrinae*) and *E. sandwicensis* in the field to use as baseline comparison with the impacts of *A. nitens* after it is released.

B. Justify how the funding will facilitate the cooperator in carrying a Biological Control Project that targets a pest of concern to APHIS

Funding will allow the research staff to survey and preselect sites for release of *Aprostocetus nitens* in the event it is approved to be released. Moreover, funding will enable researchers to re-evaluate, collect and update data on the impact of previously released biocontrol agent on the pest. This data will be crucial in determining if there are beneficial impacts of multiple parasitoids on reducing EGW population on Erythrina trees.

C. Indicate the economical or environmental impact of the pest (i.e., economic losses caused by the pest, mitigation costs, cost of the invasive species)

Several species of Erythrina trees which are affected by the pest are used mainly for landscaping in Hawaii but of utmost concern is the endemic species, *E. sandwicensis*. *E. sandwicensis* is a predominant tree in Hawaii's dry forests and plays an important role in the Hawaiian culture as well. Persistent damage of EGW on its flowers, seed pods, and seedlings threatens its future survival.

D. Describe the expected benefits of conducting the activities in the work plan

Surveying and pre-selecting release sites will enable researchers to choose optimal sites for the survival and establishment of the new parasitoid, *A. nitens*. In addition, to evaluate the status of *E. sandwicensis* after the release of first biocontrol agent, this study will provide the information needed to determine the comprehensive impacts of *A. nitens* after it is released in the field.

III. RESULTS

A. What are the anticipated results and successes?

1. Selected pre-release and monitoring sites
2. Created maps of pre-release and monitoring sites
3. Updated data on pest and biocontrol agent populations and the overall health of *E. sandwicensis*

B. Describe how results will:

1. Reduce mitigation costs of managing the pest

N/A

2. Minimize negative impacts on non-targets

N/A

3. Establish biocontrol agents

N/A

4. Reduce pest densities

N/A

C. Select which of the following OUTPUTS will be achieved by the termination date: (Select YES, NO, or N/A for each output) * *N/A is non-applicable.*

• New rearing techniques	☐ YES	☒ NO	☐ N/A*
• Effective or improved rearing techniques	☐ YES	☒ NO	☐ N/A
• New potential BC species identified, studied, or collected	☐ YES	☒ NO	☐ N/A
• Effective or improve field site evaluation techniques	☐ YES	☒ NO	☐ N/A
• Effective or improve surveying techniques for pest or agent	☐ YES	☒ NO	☐ N/A
• Effective or improve monitoring techniques for pest or agent	☐ YES	☒ NO	☐ N/A
• Publications or educational material	☐ YES	☒ NO	☐ N/A
• Training	☐ YES	☒ NO	☐ N/A
• Other	☐ YES	☒ NO	☐ N/A

Explain here for Other:

For OUTPUTS selected as YES, provide a description:

IV. APPROACH

A. Plan of Action for the proposed objectives - Describe the work to be performed under this work plan. The narrative is to include any information or data that will be shared with APHIS.

Two to four pre-release sites will be selected on each of the four major Hawaiian Islands, Oahu, Kauai, Big Island and Maui. Ten trees will be selected from each site to be evaluated and monitored every other month. Canopy coverage will be rated, EGW damage on leaves and petioles will be rated on 10 selected branches from each tree. During flowering season, ten racemes from each tree will be tagged and evaluated monthly from flower buds to mature seeds. All information and data collected will be submitted to APHIS in the semiannual and annual reports.

B. Indicate which of the following activities will be performed:
(Select YES, NO, or N/A for each output) * *N/A is non-applicable.*

• Survey of pests	☒ YES	☐ NO	☐ N/A*
• Survey of BC agents	☒ YES	☐ NO	☐ N/A
• Environmental release of BC agents	☐ YES	☒ NO	☐ N/A
• BC agent collection – offshore	☐ YES	☒ NO	☐ N/A
• BC agent collection – field	☒ YES	☐ NO	☐ N/A
• BC agent distribution from lab or insectaries	☐ YES	☒ NO	☐ N/A
• Monitoring of pest	☒ YES	☐ NO	☐ N/A
• Monitoring of BC agents	☒ YES	☐ NO	☐ N/A
• Pre-release evaluation, development, or screenings of agent	☒ YES	☐ NO	☐ N/A
• Pre-release site selection and evaluation	☒ YES	☐ NO	☐ N/A
• Post-release site evaluation	☐ YES	☒ NO	☐ N/A
• Post-release evaluation of impacts on non-targets	☐ YES	☒ NO	☐ N/A
• Post-release evaluation of agent's efficacy	☐ YES	☒ NO	☐ N/A
• Rearing of BC agents	☐ YES	☒ NO	☐ N/A
• Mapping of pest or BC agent	☐ YES	☒ NO	☐ N/A
• Outreach or education	☐ YES	☒ NO	☐ N/A
• Training	☐ YES	☐ NO	☒ N/A
• Partnering or Networking	☐ YES	☐ NO	☒ N/A
• Techniques or methods development	☐ YES	☐ NO	☒ N/A
• Technology transfer	☐ YES	☐ NO	☒ N/A
• Other	☐ YES	☐ NO	☒ N/A

Explain here for Other:

For Activities selected as YES, provide a description:

~ Pest population and damages will be surveyed and evaluated in each site every other month during non-flowering season and monthly during flowering season.

~ BC agents likewise, will be surveyed in each site and rates of parasitism will be determined

~ Samples will be collected in the field to be held for parasitoid's emergence and for dissection to determine parasitism rate

~ EGW and its damages will be monitored every other month in each field

~ Existing Biocontrol agent will be surveyed and evaluated

~ The work plan is aimed for pre-release evaluation activities

C. Contingencies - Include other approaches that will be considered if the work plan produces results sooner, later, or different than what you anticipate.

If selected sites and trees become unavailable due to natural causes, alternate sites and trees will be selected.

D. What is the quantitative projection of accomplishments to be achieved?

The project anticipates creating quantitative information of the impact of the existing biocontrol agent on the pest and trees by determining parasitism rate and rating pest damage on trees.

1. By activity or function, what are the anticipated accomplishments by month, quarter, or other specified intervals?

The project anticipates carrying out the selection of sites in the first quarter but all other activities per our project objectives will be on-going throughout all quarters.

2. What criteria will be used to evaluate the project?

Field data and relevant information collected in the pest survey will be documented in the HDOA survey program database and reported in the HDOA Annual Report and journal publications.

3. What methodology will be used to determine if identified needs are met?

Documented results will show that the project needs have been met. Documentation includes local HDOA weekly updates and HDOA annual reports.

4. What methodology will be used to determine if Results and benefits are achieved?

Periodic reviews by the Project Coordinator and the PPC entomologists assigned to manage

project will ensure that work plan and activities are implemented and carried out.

V. RESOURCES

A. What resources are required to perform the work?

- Project leader and existing HDOA Staff

-Travel funds to neighbor islands (Maui, Kauai, Big Island) to survey and monitor trees

- Funds to purchase supplies to conduct field surveys and monitoring

1. What numbers and types of personnel will be needed, and what will they be doing?

The HDOA staff that will undertake various aspects of the project are as follows:

-Biological Control Section Chief shall serve as the Project Leader. The Section Chief will manage the financial administration of the agreement, manage data in coordination with the CAPS Entomologist and CAPS Technician into appropriate databases and oversee all reporting.

-Insectary Supervisor Entomologist will oversee the survey and evaluation of the pest and existing biocontrol agent in the field and processing of samples collected in the field.

-Insectary Entomologists (2) will assist in the field survey and laboratory examination of material collected from the field.

-Pest Control technicians (2) will assist in the field survey and laboratory examination of material collected from the field.

2. What equipment will be needed to perform the work? Include major items of equipment with a value of $5,000 or more.

a. What equipment will be provided by the cooperator?

- Vehicles
- Microscopes
- Weather stations

b. What equipment will be provided by APHIS?

None

c. What equipment will be purchased in whole or in part with APHIS funds?

None

d. How will the equipment be used?

The vehicles will be used to transport personnel to and from work sites in the field, microscopes for identifying the pests, and weather stations to monitor the weather.

e. What is the proposed method of disposition of the equipment upon termination of the agreement/project?

Equipment will remain with the Hawaii Department of Agriculture.

3. Identify information technology equipment, e.g., computers, and their ancillary components. *All information technology supplies (e.g., small items of equipment, connectivity through air cards or high speed internet access, GPS units, radios for emergency operations etc.) should be specifically identified.*

- Network servers
- Local area network
- Internet access
- Desktop/Laptop/Tablet Computers
- Printers/Plotters
- Scanners
- Software including Microsoft Office, statistical analysis software, and ARC MAP
- GPS Units

4. What supplies will be needed to perform the work? Identify individual supplies with a cumulative value of $5,000 or more as a separate item.

a. What supplies will be provided by the Cooperator?

None

b. What supplies will be provided by APHIS?

None

c. What supplies will be purchased in whole or in part with APHIS funds?

Cages, GPS units, cameras, and field survey and collection supplies

d. How will the supplies be used?

To collect, process, record, and manage pest survey information

e. What is the proposed method of disposition of the supplies with a cumulative value over $5,000 upon termination of the agreement/project?

N/A

5. What procurements will be made in support of the funded project and what is the method of procurement (e.g., lease, purchase)?
(Cooperator procurements shall be in accordance with OMB Circulars A-102 or A110, as applicable.)

Cooperator procurements shall be in accordance with OMB Circulars A-102 or A110, as applicable.

Supplies, manuscript fees, and consumables related to pre-monitoring studies of *A. nitens* will be purchased with State of Hawaii credit card (pCard) or through purchase order(s) in accordance, Departmental and State of Hawaii procurement rules and regulations.

6. What are the travel needs for the project?

a. Is there any local travel to daily work sites? Who is the approving official? What are the methods of payment? Indicate rates and total costs in the Financial Plan.

None

b. What extended or overnight travel will be performed (number of trips, their purpose, and approximate dates). Who is the approving official? What is the method of payment? Indicate rates and total cost in the Financial Plan.

There will be 8 interisland trips to each county (Hawaii, Maui, and Kauai) for a total of 24 trips for 2 employees. The approving official is the HDOA plant pest control branch manager and administrative services officer. Payments will be made with a State of Hawaii purchasing card or with purchase orders.

7. Are there any other contributing parties who will be working on the project?

☐ YES ☒ NO
If YES, answer below:

a. List Participating Agency/Institution:

N/A

b. List all who will work on the project:

N/A

c. Describe the nature of their effort:

N/A

d. Contribution:

N/A

VI. GEOGRAPHIC LOCATION OF PROJECT

A. Is the project statewide or in specific counties, townships, and/or national or state parks? (List all that apply)

The project is statewide

B. What type of terrain (e.g., cropland, rangeland, woodland) will be involved in the project?

Paved and dirt roads in various areas, forests, hilly sites and woodland

C. Are there any unusual features which may have an impact on the project or activity such as rivers, lakes, wild life sanctuaries, commercial beekeepers etc? (list all that apply)

None

D. Are there tribal lands in proximity to the project area that may be impacted, positively or negatively, by the project?

None

VII. DATA COLLECTION AND MAINTENANCE

A. What type of data will be collected and how will it be maintained?

Ratings of pest damage on test trees, pest and biocontrol agent population fluctuations, parasitism rate, GPS coordinates of survey and monitoring sites, dates, survey method, county

B. Address timelines for collection, recording, and reporting of data.

All field data will be collected and recorded every other month and entered in a master data file. Periodic update and progress of work is provided in HDOA weekly reports and staff meetings. Semi-annual and final written reports will be submitted to APHIS within six months after the start and termination of the project.

C. How will APHIS be provided access to the data?

Data will be provided in the semiannual and annual reports submitted to APHIS.

D. Identify if the data collected relate to the following measures.
* *N/A is non-applicable.*

• The number of BC species that become established and sustainable	☐ YES	☒ NO	☐ N/A*
• The number of BC programs that are developed, implemented, or transferred to States or others	☐ YES	☒ NO	☐ N/A
• Total number of sites that are managing targeted pests using biocontrol	☐ YES	☒ NO	☐ N/A
• Total number of new agents identified, studied, or imported	☐ YES	☒ NO	☐ N/A
• Total number of pre-release and site evaluations, or surveyed	☒ YES	☐ NO	☐ N/A
• Total number of sites monitored	☒ YES	☐ NO	☐ N/A
• Successful development of rearing and release technology	☐ YES	☒ NO	☐ N/A
• Number of eligible sites with targeted pests participating in biocontrol	☒ YES	☐ NO	☐ N/A
• Number of targeted pests managed using biocontrol	☐ YES	☒ NO	☐ N/A
• Number of publications, presentations, databases, and educational material	☐ YES	☒ NO	☐ N/A
• Number of agent colonies or insectaries created	☐ YES	☒ NO	☐ N/A
• Time of monitoring released BC agents in the field	☐ YES	☒ NO	☐ N/A
• Cost operating rearing laboratories	☐ YES	☒ NO	☐ N/A
• Total number of BC individuals reared	☐ YES	☒ NO	☐ N/A
• Total number of BC individuals released	☐ YES	☒ NO	☐ N/A
• Cost of BC individual reared	☐ YES	☒ NO	☐ N/A
• Cost of BC individual released	☐ YES	☒ NO	☐ N/A

For data variables selected as YES, provide a description:

- The number of pre-release and survey sites will be recorded and mapped
- Total number of sites monitored will be recorded
- The number of eligible sites with targeted pests participation in biocontrol will be recorded and mapped as well

E. All survey data from federal cooperative agreements involving pest surveys, will be entered into an APHIS, PPQ approved database. The State Plant Health Director, or his/her designee, is responsible for assuring data quality.

1. If using NAPIS database.

   a. First record for the State and/or County will be entered within 48 hours of confirmation of identification by a qualified identifier.

   b. All other required records, both positive and negative survey data, must be entered within two weeks of confirmation.

VIII. Reporting instructions:

All Reports will be completed in ezFedGrants. Reports include:

A. Narrative accomplishment reports in the frequency and time frame specified on the Agreement Award Face Sheet.

B. Federal Financial Reports, SF-425, in the frequency and time frame specified on the Agreement Award Face Sheet.

IX. APHIS Will:

1. Include any significant Agency collaboration and participation
   - Provide funds to the cooperator to cover costs as outlined in the financial plan.
   - Provide additional guidance and/or technical assistance to the project coordinator, as requested.
   - Assist in clarifying survey methods and detection, as well as, identification resources, as needed.
   - Support the work and financial plan development by the cooperator.
   - Ensure that cooperator receives survey supplies, as provided by the program.

2. Project oversight and performance management
   - Notify the project coordinator of reporting deadlines.
   - Provide guidance in the compilation and submitting of reports and other administrative matters.
   - Maintain data spreadsheets showing due dates for reports, requests for allocation, forms submitted, tracked by the survey specialist.
   - Provide general oversight and quality assurance of the program.

SIGNATURES

8-10-18
Phyllis Shimabukuro-Geiser, ROAR Date

8-13-18
Vernon Harrington, ADODR Date