

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

January 11, 2019

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

PSF No.: 18HD-136

HAWAII

Issuance of Right-of-Entry Permit to United States Department of Agriculture, Agriculture Research Service, Pacific Basin Agriculture Research Center, for Removal of Rapid Ohia Death Diseased Trees from State Lands Encumbered by General Lease No. S-5374 to Kapapala Ranch, situate Kapapala, Ka`u, Hawai`i, Tax Map Key: (3) 9-8-001:010 por.

APPLICANT:

United States Department of Agriculture, Agriculture Research Service, Pacific Basin Agriculture Research Center (USDA ARS PBARC), a federal government agency.

LEGAL REFERENCE:

Section 171-55, Hawaii Revised Statutes, as amended.

LOCATION:

Portion of Government lands of Kapapala, Ka`u, Hawai`i, identified by Tax Map Key: (3) 9-8-001:010 por, as shown on the attached map labeled Exhibit A.

AREA:

Five (5) acres, more or less. See exhibit A for reference.

ZONING:

State Land Use District: Agriculture
County of Hawaii CZO: A20a

TRUST LAND STATUS:

Section 5(b) lands of the Hawaii Admission Act
DHHL 30% entitlement lands pursuant to the Hawaii State Constitution: YES___ NO X

CURRENT USE STATUS:

Encumbered by General Lease No. S-5374, Kapapala Ranch, Lessee, for pasture, ecotourism, and family & employee residential purposes. Lease to expire on November 30, 2029.

CHARACTER OF USE:

Cut and Removal of Rapid Ohia Death (ROD) diseased trees.

TERM OF RIGHT-OF-ENTRY:

One (1) year from date of approval.

CONSIDERATION:

Gratis.

CHAPTER 343 - ENVIRONMENTAL ASSESSMENT:

Please see attached, Ch. 343 Exemption Memorandum (Exhibit B).

DCCA VERIFICATION:

Not applicable, as applicant is a government agency and, as such, is not required to register with DCCA.

APPLICANT REQUIREMENTS:

Applicant shall be required to:

- 1) Obtain written concurrence from all users of the subject land (Exhibit D, attached).

REMARKS:

USDA ARS PBARC, also referred to as "the Applicant," is requesting an after-the-fact Right-of-Entry (ROE) to remove, treat, and study Rapid Ohia Death (ROD) diseased ohia trees (*Metrosideros polymorpha*) from State lands currently encumbered by General Lease No. S-5374 to Kapapala Ranch. The subject trees are located mauka (towards mountain) of Hwy 11 near mile marker 39 in the district of Ka'u. The request includes two parts, 1) the removal of five recently ROD wilted ohia trees with main stem diameters (DBH)¹ from fourteen (14) to twenty (20) inches planned for removal between mid-January and late February 2019 to be used in the vacuum steam treatment study; 2) removal of four (4)

¹ DBH = Diameter at breast height; measured diameter at 4.5 feet above the ground.

recently wilted ROD trees from eight (8) to twelve (12) inches DBH planned for removal between mid-May 2019 and mid-June 2019 to be used in the kiln-heating treatment study.

As mentioned above, the Applicant will utilize two (2) different heat-treatment methods as scientific trials designed to test the ability of each method, kiln heating and vacuum steam process, for killing all viable propagules of the ROD pathogens, *Ceratocystis lukuohia* and *C. huliohia*, in the naturally infected and well-colonized logs. Please see Exhibit C, attached.

Efficient phytosanitary protocols are recommended by both the Hawaii Department of Agriculture HI (DOA) and Hawaii forest products industry as an alternative to extensive sampling and lab testing of ohia logs awaiting shipment off-island for commercial trade. Listed below are the phytosanitary protocols recommended by the HI DOA and HI forest products industry that the Applicant will utilize.

- Dr. Jennifer Juswik, Research Plant Pathologist, USDA Forest Service, and Dr. Marc Hughes, Postdoctoral Researcher, University of Hawaii-Manoa, will oversee the logging of the trees by certified foresters or arborists.
- The five larger diameter trees used in the vacuum steam study will be felled with chainsaws and bucked in to approximately twelve (12) logs removed from site by Tree Works, Inc., working under contract with USDA Forest Service to provide a five member logging crew to perform the work. A National crane on six-wheel drive truck (55,000 GVW), and a standard skid steer and dump/transport truck (33,000 GVW) will be used to collect and transport logs. Logs will be transported to the USDA ARS PBARC in Hilo where the vacuum steam trial will be conducted. All work would be completed during one ten (10) hour day between mid-December 2018 and late January 2019.
- The four (4) smaller diameter trees used in the kiln-heating study will be felled and cut into nine 10-foot logs with chainsaws by Big Island Invasive Species Committee (BIISC) crews working under the direction of Bill Buckley, or by Tree Works, Inc. The logs will be transported to the USDA ARS PBARC using the same collection & transportation method and resources as with the five larger trees and will be completed in one day between mid-May 2019 and mid-June 2019.
- Standard sanitation procedures used by Hawaii DOFAW and BIISC will be followed by certified forester or arborist performing the work. These include the following:
 - 1) Collection of chainsaw chips on tarps, placement into autoclave bags, and subsequent autoclaving at PBARC.
 - 2) Use of ROD-designated chainsaws for felling trees and bucking logs and/or high pressure wash of chainsaw chains following final cut.
 - 3) Tarping of residual stem material on-site if ambrosia beetle activity warrants (under advisement from Dr. Bob Peck, Research Entomologist, USGS).
 - 4) Pressure washing of tires and undercarriage of all heavy machinery used in collection and transport of trees (logging truck, crane, etc.) before removal from site.

The subject State land is currently encumbered by General Lease No. 5374 to Kapapala Ranch. The Applicant has been maintaining contact with the Lessee and has received written concurrence to authorize the request (Exhibit E).

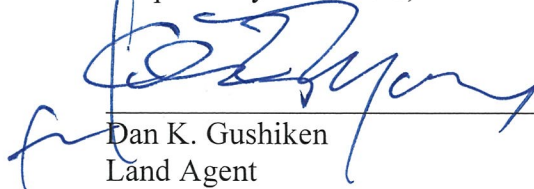
The Hawaii State Departments of Agriculture (DOA) and Land and Natural Resources Forestry & Wildlife Division (DOFAW) have been solicited for comments. Please see Exhibit D. DOA did not respond and DOFAW responded with no objections and is in full support of the request, as they are working closely with the Applicant on the subject project.

The consideration for this request is gratis, as USDA ARS PBARC is a governmental agency.

RECOMMENDATION: That the Board

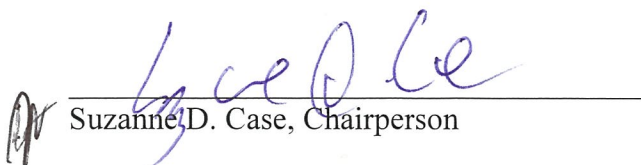
1. Declare that, after considering the potential effects of the proposed disposition as provided by Chapter 343, HRS, and Chapter 11-200, HAR, this project will probably have minimal or no significant effect on the environment and is therefore exempt from the preparation of an environmental assessment.
2. Authorize the issuance of a right-of-entry permit to USDA ARS PBARC covering the subject area under the terms and conditions cited above, which are by this reference incorporated herein and further subject to the following:
 - A. The standard terms and conditions of the most current right-of-entry permit form, as may be amended from time to time;
 - B. Such other terms and conditions as may be prescribed by the Chairperson to best serve the interests of the State.

Respectfully Submitted,



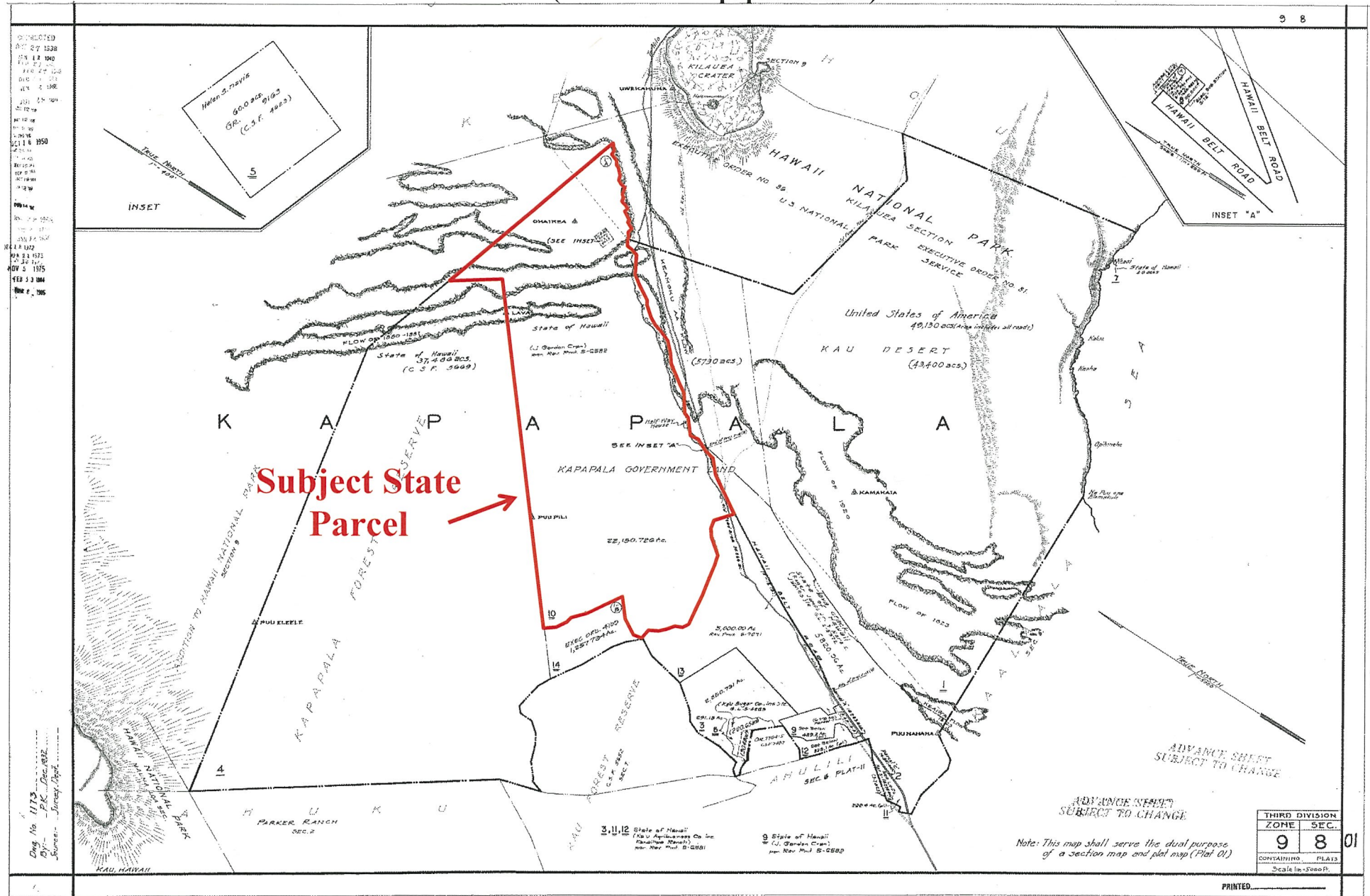
Dan K. Gushiken
Land Agent

APPROVED FOR SUBMITTAL:



Suzanne D. Case, Chairperson

Exhibit A
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ROE to USDA ARS PBARC
Kapapala, K`au, Hawai`i; TMK: (3)9-8-001:010por
(GLS-5374: Kapapala Ranch)

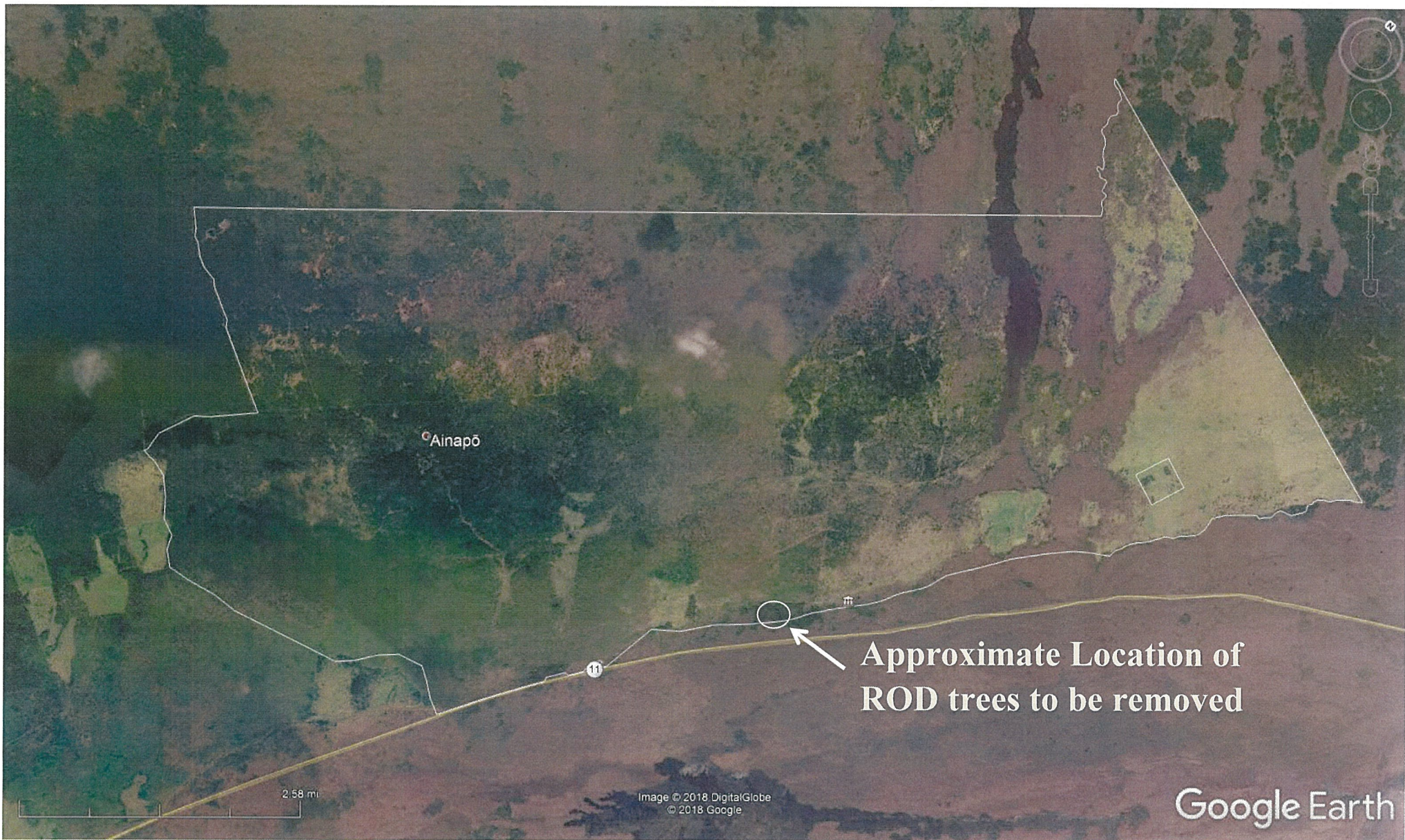
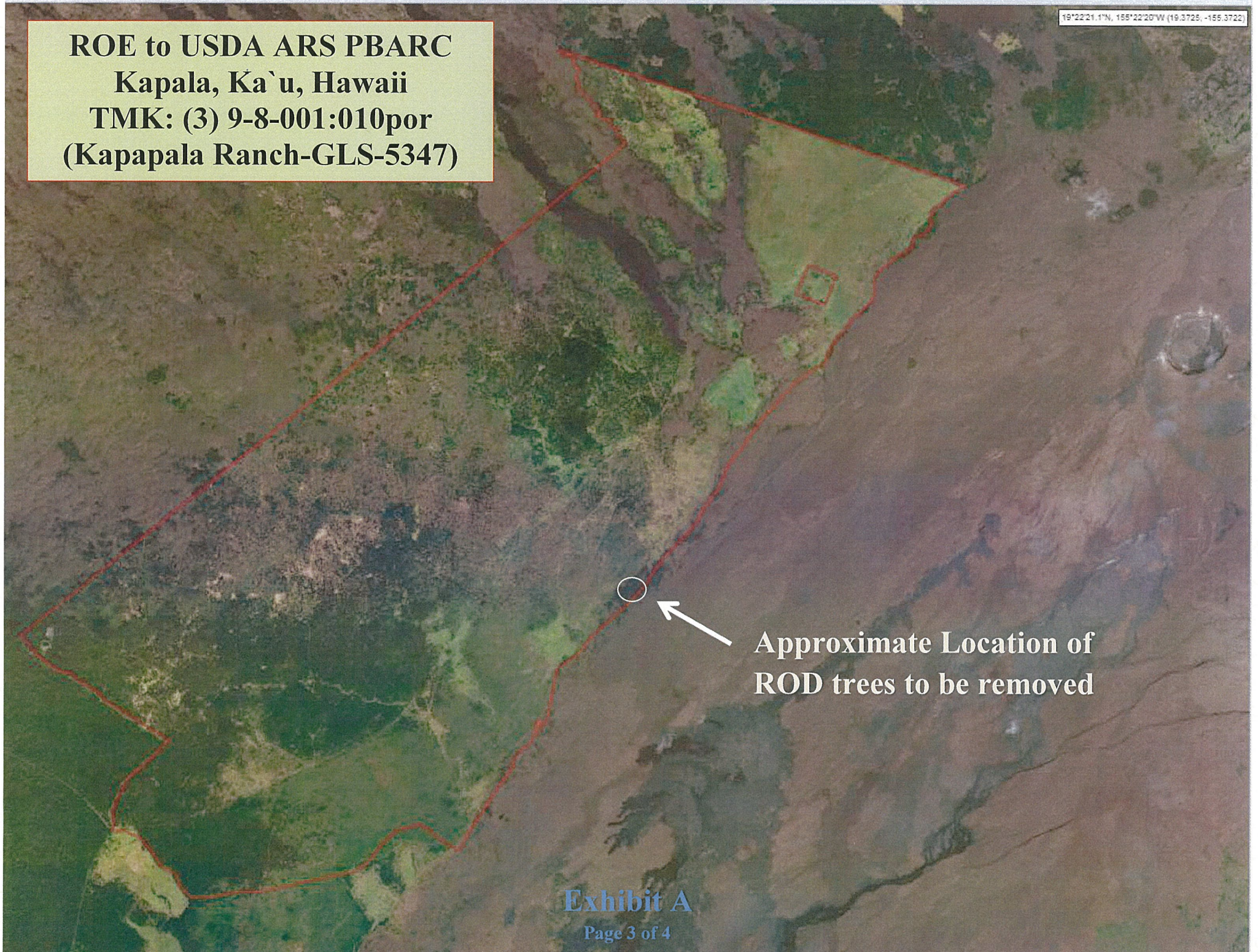


Exhibit A

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**ROE to USDA ARS PBARC
Kapala, Ka'u, Hawaii
TMK: (3) 9-8-001:010por
(Kapapala Ranch-GLS-5347)**



A satellite map of a rural area in Hawaii. A large, irregularly shaped area is outlined with a red line, representing the Kapapala Ranch. Within this red-outlined area, there is a smaller, roughly rectangular area outlined in red. A white circle is drawn on the red boundary line, and a white arrow points from the text 'Approximate Location of ROD trees to be removed' to this circle. The terrain is a mix of green vegetation and brownish, cleared or rocky ground.

**Approximate Location of
ROD trees to be removed**



United States Department of Agriculture

Research, Education, and Economics
Agricultural Research Service

Kapapala Ranch, Ka'u HI

Trees to be fell are noted in green



Entry gate: 19°20'57.28"N, 155°23'10.59"W

Kau desert trail head: 19°22'7.81"N, 155°22'2.47"W

Felling area: 19°22'11.32"N, 155°22'20.20"W

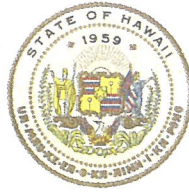
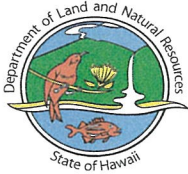
Daniel K. Inouye Pacific Basin Agricultural Research Center (DKI-PBARC)
Tropical Plant Genetic Resources and Disease Research Unit
64 Nowelo Street, Hilo, Hawaii 96720-2788
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USDA is an Equal Opportunity Employer

Exhibit A

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Exhibit B

DAVID Y. IGE
GOVERNOR OF HAWAII



STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

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

ROBERT K. MASUDA
FIRST DEPUTY

JEFFREY. T. PEARSON, P.E.
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

EXEMPTION NOTIFICATION

From the preparation of an environmental assessment under the authority of Chapter 343, HRS and Chapter 11-200, HAR

Project Title: Issuance of Right-Of-Entry Permit to United States Department of Agriculture – Agriculture Research Services – Pacific Basin Agriculture Research Center

Project Number: PSF No. 18HD-136

Project Location: Kapapala, Ka'u, Hawaii, Tax Map Key: (3) 9-8-001:010por

Project Description: Right-Of-Entry Permit to United States Department of Agriculture – Agriculture Research Services – Pacific Basin Agriculture Research Center (USDA ARS PBARC) for the cut/removal, treatment and study of Rapid Ohia Death (ROD) diseased trees from State Lands encumbered by GLS-5374 to Kapapala Ranch.

Exemption Class No.: In accordance with the "Exemption List for the State of Hawaii, Department of Land and Natural Resources, as Reviewed and Concurred Upon by the Environmental Council (approved on June 5, 2015), the subject request is exempt from the preparation of an environmental assessment pursuant to Exemption Class No.5, "Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. [HAR § 11-200-8]."

Exemption Item No. And Description: Item No.13: "Research or experimental management actions that the Department declares are designed specifically to monitor, conserve, or enhance native species or native species' habitat."

This exemption is appropriate because the permittee, USDA-ARS-PBARC has requested the use of a relatively small area for the removal, treatment and study of nine (9) Ohia trees that had been observed to show wilting that indicates ROD.

The grant of a Right-Of-Entry permit for the limited purpose will result in no material change or significant cumulative impact. If further actions are taken that result in a material change, USDA-ARS-PBARC will be required to be in compliance with Chapter 343.

Consulted Parties:

Hawaii State Department of Agriculture (DOA)
DLNR Division Of Forestry And Wildlife DOFAW)

Recommendation:

It is recommended that the Board find that the issuance of a Right-Of-Entry permit to USDA-ARS-PBARC will probably have minimal or no significant effect on the environment and is presumed to be exempt from the preparation of an environmental assessment.

Exhibit C1

STUDY PLAN

Evaluation of Kiln-Heating of Ohia Poles and Posts for Eradication of Viable *Ceratocystis lukuohia* and *C. huliohia*

Principal Investigators:

Jennifer Juzwik, Research Plant Pathologist, Northern Research Station, U.S. Forest Service

Marc Hughes, Postdoctoral Researcher, University of Hawaii – Manoa, Hilo, HI

Cooperators:

Hal Brauner, Brauner Molding Woodworks, Hilo, HI

Lisa Keith, PBARC, USDA Agricultural Research Center, Hilo, HI

Blaine Luiz, University of Hawaii-Manoa, Hilo, HI

Adam Taylor, University of Tennessee, Knoxville

Introduction

There is an urgent need for effective and practical phytosanitary treatment methods for poles and posts of ohia destined for off-island shipment from Hawaii Island due to wood colonization by the quarantined pathogens *Ceratocystis lukuohia* and *C. huliohia*. State-wide quarantine restrictions were established in 2016 for ohia products shipped from Hawaii Island. For shipment off-island, ohia material and/or associated soil must be kiln-heated to 133 F or determined to be *Ceratocystis*-free by rigorous assays. There is no currently no documented, effective treatment for eradicating viable propagules from roundwood (logs) of ohia although kiln-drying of ohia dimension lumber to achieve a target temperature of 133 F (56 C) and a final wood moisture content of < 18% has been suggested to be effective. In early December 2017, a preliminary trial was conducted with 4 foot long and 5 to 7 inches in diameter main stem sections of ohia obtained from recently wilted, *C. lukuohia*-inoculated trees. Five logs were included in a commercial kiln-drying run (23 days; max. chamber temp. of 133 F held for final two days) at Brauner Molding Woodworks (= treated) and two log were kept at ambient outdoor temperatures for comparison (= controls). Pre-treatment and post-treatment assays for detecting presence of viable pathogen propagules were conducted with wood samples taken from outer and inner wood of 8 cm wide disks from each study log. All of the sampled locations (four samples from each of two disks) for each of the seven study logs yielded *C. lukuohia* in culture (i.e. on

carrot-baits) at time of pre-treatment assessment (two assayed locations for each of two disks per log). In comparison, only one of twelve samples taken from one of the five treated logs (total = 1 of 60 samples positive) and four and six of twelve sampled locations on the two control logs (total = 10 of 24 samples positive) yielded the fungus at time of post-treatment assessment. Pre-treatment wood contents of all logs were > 45 % and post-treatment log wood content at ~ 11% based on moisture meter monitoring by H. Brauner. These promising results are the basis of this proposal to conduct a larger scale trial in the same facility with “in-log” temperature monitoring. The goal is to develop quarantine-approved, phytosanitary treatment schedules for ohia poles and posts that would allow for shipment of the products off-island without need for HI Dept of Agriculture directed assays for the pathogen.

Objectives

Operational trials will be conducted with ohia poles and posts to determine whether living propagules of *C. lukohia* and *C. huliohia* are rendered non-viable by kiln-heating using a step-increase heating schedule to reach a target temperature at log core of 60 F (140 F). Once target temperature is achieved, the kiln-setting will be maintained to achieve a minimum of 24 hour treatment.

Materials and Methods

Study trees. Thirty-two *M. polymorpha* (6.0 to 10.5 cm dbh) with healthy crowns and growing in locations known to have rapid ohia death will be used for two ohia pole kiln-heating trials. The same number of larger diameter ohia trees (23 to 28 cm dbh) meeting the same criteria will be used for kiln-heating trials with ohia posts. Main stems of study trees will have 3 meter portions of the bole suitable for pole or post production (e.g. no forked section, no significant defect, and straight to slightly curved form). Appropriate permits or permissions will be obtained from land managers or landowners providing trees for the study.

Fungus inoculation of study trees. Recently obtained cultures of *Ceratocystis lukuohia* (= “A”) and *C. huliohia* (= “B”) will be used to artificially inoculate portions of the tree stems from which the pole or post logs will be obtained. For *Ceratocystis* A, two inoculation holes on opposite sides of the stem will be made at 60 cm above the lower end of the pole or the post log to be cut from the stem. For *Ceratocystis* B, four inoculation holes will be made in a spiral pattern (4 different aspects) along the main stem at 60, 120, 180 and 240 cm above the lower end of the pole or the post log to be cut from the stem. Inoculation holes will be made with a hole

saw bit of appropriate size (~ 1.5 cm dia bit for pole logs; ~ 3.0 cm dia bit for post logs). The inoculum will be prepared by growing selected A and B isolates on 10% V8 medium for 10 days (24 C temp.; 24 hr light). Surface of each plate will then be covered with 3 ml sterile d H₂O, lightly scraped, and the liquid fungus propagule suspension will be evenly spread onto surface of 2% MYEA in Petri plates. Following 10 min of air drying in a laminar flow hood, sterile oil (6 ml) will be spread across the inoculated agar surface and plates incubated for 7 days (24 C; 24 hr light). Within 24 hr of tree inoculation start, plates with visible aleurioconidia will be added to 50 ml sterile dH₂O in a sterilized blender and blended for 30 sec to make an agar slurry. Sterile syringes (minus needles) (5 ml) will be filled with the slurry and stored at 4 C. Approximately 1 ml of agar slurry will be placed evenly on the exposed cambial surface of each cut inoculation hole. The cut hole plug will be put over the treated hole, center hole plugged with moldable putty, and the inoculated circumference of stem encircled with duct tape to keep plug in place. Ideally, all inoculations will be made 8 weeks prior to the anticipated log harvesting date.

Log processing and experimental design. Trees will be felled, the previously demarcated 3 m sections for pole or post logs cut, and logs transported to USDA PBARC. Bark will be removed as soon as possible. Two disks (7.5 to 8 cm thick) will be cut from the inner portion of 30 cm long sections from each end of the logs, labelled, and stored individually in poly bags at 4 C until assayed for *Ceratocystis* presence. Two additional disks will also be taken for wood moisture content determination. The length and end diameters of each ~ 2.4 m long logs will then be obtained. Logs will be separated into four groups (6 *Ceratocystis* A and 6 *Ceratocystis* B for kiln treatment; 2 *Ceratocystis* A and 2 *Ceratocystis* B for ambient temperature treatment) in preparation for each experiment. Two experiments will be conducted with each size category of logs, i.e. poles versus posts.

Following treatment, logs will be removed from the kiln and allowed to cool to ambient outdoor temperatures. Logs will then be moved to and stored in an enclosed space where risk of exposure to wind-borne *Ceratocystis*-laden sawdust or insect frass is minimal. Three pairs of disks (7.5 cm thick) will be cut with a band saw at approximately $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ along the length of each log. One disk for each length will be labelled, placed in poly bag, and stored at 4 C until assayed for *Ceratocystis* species. The remaining disks will be used to determine final wood moisture content. Control logs will be sampled and processed in a similar fashion at the same time treated logs are sampled.

Log disk subsampling and processing. Disks removed from poles or post logs before and after treatment will be used for either pathogen detection or wood moisture content determination.

Ceratocystis carrot-baiting assay – For carrot-baiting assays (Moller and DeVay, 1967), small wood pieces will be excised from systematically determined locations (n = 8 for poles; n = 12 for posts) of each disk using a chisel and hammer. Wood pieces for each location will be placed between two moist carrot disks, the “sandwich” wrapped in laboratory film, and placed in small poly bags. Carrot baits will be stored in plastic tubs at ambient laboratory temperature and lighting for 7 to 14 days. Each will be examined for perithecia of *Ceratocystis* for and presence/absence of the fruiting structures recorded. If no perithecia are observed by 15 days, any mycelial growth observed on the inner carrot surfaces will be sampled and assayed for *Ceratocystis* using qPCR methods (Heller and Keith, 201X).

Wood moisture content – Pre- and post-treatment wood moisture content will be determined for outer wood and inner wood at two opposite locations on each disk. Samples will be weighed before and after oven drying (~ 103 C) to constant weight. The average moisture content for the two wood depths of each log will be calculated on a dry weight basis.

Temperature monitoring. Temperature at the log surface and within the wood (log core for poles; ½ way to core and at core for posts) will be monitored using thermocouple wires and dataloggers. Holes will be drilled to appropriate depths, wires inserted and held in place with moldable epoxy putty (Chen et al., 2017). Thermal mapping of data and regular review of temperatures at the core will be used to determine start of threshold temperature exposure timing. Temperature monitoring will be done for two *Ceratocystis* A and two *Ceratocystis* B poles or posts per experiment. In addition, the center (length wise) core location of two logs of each inoculum type will be monitored with separate dataloggers (HOBO Tidbit) whose digital readout can be easily checked. Data from these later dataloggers will be used to determine when threshold temperature (60 C) has been reached.

Kiln-heating treatment. Pole or post treatment will be conducted in a commercial kiln at a local mill in cooperation with the mill owner. [Details on the kiln will be obtained and inserted here.] Either 12 poles or 12 posts will be placed on top of commercial loads of dimension lumber. The kiln will be operated by the mill owner and gradual temperature increases made based on his experience and knowledge. Target air temperature (wet bulb basis) is ~ 65 C (~ 150 F) measured

[insert where] in the kiln chamber. Once 60 F (or 140 F) is reached in the core of the four temperature-monitored logs, temperature setting will remain constant for about 3 days. Each treatment will be stopped when the specified treatment time is achieved for the threshold temperature at the log core. The kiln will then be shut off for the specified hold period, and doors opened when the kiln operator deems appropriate. Control logs (two *Ceratocystis* A and two *Ceratocystis* B) for each size category will remain at ambient outdoor temperature in a covered space at PBARC.

Pole and post quality assessment. An impartial or unbiased individual familiar with quality specifications of ohia poles and posts will evaluate and document observations for the control and treated logs following treatment, but prior to final sampling. Parameters of interest may include presence and degree of end-checking, log splitting, and degree of deflection.

Data summarization and analyses. Differences in viable pathogen presence in the outer and inner wood of each study log as determined by carrot-baiting will be analyzed using generalized linear effects models (Agresti 2002). The lsmean package in R (Lenth 2016) will be used to determine odds ratios and estimated probabilities of detecting viable *Ceratocystis* species from the two depth locations for the treated and the control logs. Temperature profiles for the two monitored logs of each *Ceratocystis* species during the course of each kiln-heating trial will be summarized graphically. Means and standard errors of inner and outer wood moisture contents for all study logs will be calculated for the pre- and the post-treatment assessment dates.

Literature Cited

- Agresti, A. 2002. Categorical Data Analysis. John Wiley & Sons, Inc. Hoboken, New Jersey.
- Chen, Z., White, M.S., and Mack, R. 2017. Evaluating vacuum and steam process on hardwood veneer logs for export. Eur. J. Wood Prod. 75: 911 – 918.
- Heller, W., and Keith, L. 201X. A molecular detection method for rapid ohia death. Phytopathology (in revision for re-submission).
- Lenth, R. V. 2016. Least-squares means: the R package lsmeans. J. Stat. Softw. 69:1-33.
- Moller, W.J., and DeVay, J.E. 1968. Carrots as a species selective isolation medium for *Ceratocystis fimbriata*. Phytopathology 58: 123 – 126.

Exhibit C2

STUDY PLAN

Evaluation of Vacuum Steam Treatment of Ohia Posts for Eradication of Viable *Ceratocystis lukuohia* and *C. huliohia*

Principal Investigators:

Jennifer Juzwik, Research Plant Pathologist, Northern Research Station, U.S. Forest Service
Marc Hughes, Postdoctoral Researcher, University of Hawaii – Manoa, Hilo, HI

Cooperators:

Zhangjing Chen, Virginia Polytechnic Institute and State University, Blacksburg, VA
James B. Friday, University of Hawaii – Manoa, Hilo, HI
Lisa Keith, PBARC, USDA Agricultural Research Center, Hilo, HI
Ron Mack, USDA APHIS PPQ, OTIS Laboratory, Buzzard's Bay, MA
Marshall S. White, Virginia Polytechnic Institute and State University, Blacksburg, VA

Collaborators:

William Stormont, ROD Coordinator, Hawaii Division of Forestry and Wildlife, Hilo
Michael Kraus, Certified Arborist, Tree Works, Inc., Hilo, HI

Introduction

An emerging disease Rapid Ohia Death (ROD) on Hawaii Island threatens the health and survival of a keystone forest tree species, i.e. *Metrosideros polymorpha* (= ohia), in the Hawaiian archipelago (Mortenson, et al. 2016). Following the first visual detection in 2011 of what is now known as ROD, the putative causal agent was determined to be *Ceratocystis fimbriata* in 2014 (Keith, et al. 2015). However, further observations and fungal phylogenetic analyses has led to differentiation of two distinct pathogens: *Ceratocystis lukuohia* and *C. huliohia* (Barnes, et al. 2018). The first is associated with a rapid wilt of the entire crown of an infected ohia while the second causes distinct, but often extensive, cankers on ohia. Multiple cankers caused by the latter are also capable of causing tree death, albeit over a longer time-frame than the wilt pathogen. Currently, *C. lukuohia* is only known to occur on Hawaii Island, while *C. huliohia* occurs on the Hawaii Island and was recently discovered on Kauai, HI.

In an early attempt to prevent spread of the pathogens from Hawaii Island, the Hawaii Department of Agriculture enacted quarantine regulations restricting inter-island movement of any ohia plant parts and soil associated with the plant species. Kiln-heating treatment of prohibited materials was suggested as an eradication treatment, but confirmatory trials had yet to be conducted at that time.

In response to the need, research efforts were initiated to evaluate three different phytosanitary treatments potentially suitable for de-barked ohia logs (including poles, 2 – 5 inches in diameter and ~ 5 to 12 feet long, and posts, > 6 inches in diameter and usually 8 to 16 feet long). Heat treatments under consideration include kiln-heating and vacuum steam. Chemicals applied using dip diffusion methods is the third approach being evaluated.

Vacuum steam was recently evaluated for use with large diameter (16 to 24 inches), 1.9 m long logs cut from *Quercus rubra* trees that had recently wilted due to infection by *Bretziella fagacearum* (syn. *Ceratocystis fagacearum*), the oak wilt fungus. Two treatment regimes (60 C for 60 min. and 56 C for 30 min) were both found to eradicate living propagules of *B. fagacearum*; furthermore, DNA of the fungus was also degraded by the treatments (Juzwik et al. 2018). Loads of three logs were tested in each run. Between 6 and 10 hours were required to achieve the temperature / time specifications of the administered regime. A previously published study (Chen et al. 2017) found vacuum steam process had minimal deleterious effect on product (i.e. veneer) quality of five hardwood species tested.

Because of similarities of *C. lukuohia*-caused wilt of ohia to *B. fagacearum*-caused wilt of oaks, vacuum steam holds promise for effective eradication treatment of *Ceratocystis* species of ohia.

Objectives

The objectives of the study are to evaluate 1) the ability of vacuum steam treatments (60 C / 60 min. and 56 C / 30 min.) to eradicate viable propagules of *C. lukuohia* and/or *C. huliohia* from wood of ohia posts, 2) temperature profile of the treated logs over the time-course of the experiments, 3) energy required for treating each load, 4) monitor for any changes in log quality (before versus after treatment), and 5) time required for each load run.

Materials and Methods

Study trees. Fifteen to twenty ohia trees currently wilting following natural *Ceratocystis* spp. Infection (ideally 12 to 16 inch diameter) in areas with confirmed ROD will be identified between early July and late September on state, federal, or other type of ownership lands where permission has been obtained to work. Shortly after at least 80% of the crown has wilted, wood samples will be obtained for detection of either, or both, *Ceratocystis* pathogens using qPCR methods (Heller and Keith 2018). For those trees found to be *Ceratocystis*-positive, the number of 2.1 m long main stem logs that can be obtained from each will be determined. Sufficient number of trees to yield 35 logs will be harvested during January 2019, main stems cut into 2.1 m lengths, bark removed on-site, and logs tagged. The study logs will then be transported to PBARC for the vacuum steam treatment.

Log description and experimental design. The logs will be sorted into treatment loads with attempts made to select three logs similar in diameter that had originated from different trees. Two treatment schedules (60 C / 60 min. and 56 C / 30 min.) will be run with five replicate loads per schedule. Within one day of running each load (but before treatment), the outer 14 cm will be trimmed from each end with a band saw. Then, two 8 cm wide disks will be successively cut from the ends for pre-treatment evaluation, including 1) wood moisture content, and 2) presence of viable *C. lukuohia* and /or *C. huliohia*.

Log disk processing. Following treatment, logs will be removed from the vacuum steam chamber and allowed to cool to ambient outdoor temperatures. Logs will then be moved to and stored in an enclosed space where risk of exposure to wind-borne *Ceratocystis*-laden sawdust or insect frass is minimal. Three pairs of disks (7.5 cm thick) will be cut with a band saw at approximately $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ along the length of each post-treatment log. One disk for each length will be labelled, placed in poly bag, and stored at 4 C until assayed for *Ceratocystis* species. The remaining disks will be used to determine final wood moisture content. Control logs will be sampled and processed in a similar fashion at the same time treated logs are sampled.

Log disk subsampling and processing. Disks removed from logs before and after treatment will be used for either pathogen detection or wood moisture content determination.

Carrot-baiting assays (Moller and DeVay, 1967) will be conducted to determine presence of viable *Ceratocystis* species. Small wood pieces will be excised from six systematically determined locations on each disk at each of two depths (2 cm and 5cm) (n = 12 total/disk) using a chisel and hammer. Wood pieces for each location will be placed between two moist

carrot disks, the “sandwich” wrapped in laboratory film, and placed in small poly bags. Carrot baits will be stored in plastic tubs at ambient laboratory temperature and lighting for 7 to 14 days. Each will be examined for perithecia of *Ceratocystis* for and presence/absence of the fruiting structures recorded. If no perithecia are observed by 15 days, any mycelial growth observed on the inner carrot surfaces will be sampled and assayed for *Ceratocystis* using qPCR methods (Heller and Keith, 2018). The latter distinguish between the two ROD *Ceratocystis* species.

Pre- and post-treatment wood moisture content will be determined for outer wood (2 cm depth) and inner wood (5 cm depth) at two opposite locations on each disk. Samples will be weighed before and after oven drying (~ 103 C) to constant weight. The average moisture content for the two wood depths of each log will be calculated on a dry weight basis. In addition, each log will be weighed before and after vacuum steam treatment to determine any increase in moisture content that may occur during treatment.

Vacuum steam treatment and temperature and energy monitoring. The portable steam / vacuum treating system from Virginia Tech will be moved to the Pacific Basin Agricultural Research Center in Hilo on the Big Island, Hawaii. This treatment equipment includes a 5w X 5h X 8.5 foot long vacuum chamber with a 7.5 hp vacuum pump and a 80 KW boiler and automatic controls and data acquisition.

Holes will be drilled into the logs from the bark. The temperature at the outer wood surface (bark has been stripped), and at 6 cm depth in the sapwood for three locations along the log length, log center and 2.5 inches deep from bark. In addition, a thermocouple will be placed at the log core at ½ the log length. Thermocouples will be placed into these locations and the holes will be sealed with plumber’s putty.

Proposed treatment schedules will include an initial vacuum of 100 mm hg and two temperature levels and treatment durations, 56 C for 30 min. and 60 C for 60 min. based on the thermocouple at 6 cm depth in the sapwood at ½ log length.

Electrical energy consumption and water consumption will be measured during each test. Condensate will be collected after test, and pH levels measured.

Data summarization and analyses. Differences in viable pathogen presence in the outer and inner wood of each study log as determined by carrot-baiting will be analyzed using generalized linear effects models (Agresti 2002). The lsmean package in R (Lenth 2016) will be used to determine

odds ratios and estimated probabilities of detecting viable *Ceratocystis* species from the two depth locations for the treated and the control logs. Temperature profiles for the two monitored logs of each *Ceratocystis* species during the course of each kiln-heating trial will be summarized graphically. Means and standard errors of inner and outer wood moisture contents for all study logs will be calculated for the pre- and the post-treatment assessment dates.

Literature Cited

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Exhibit D

DAVID Y. IGE
GOVERNOR OF HAWAII



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

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

ROBERT K. MASUDA
FIRST DEPUTY

JEFFREY T. PEARSON, P.E.
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

November 19, 2018

MEMORANDUM

TO: Gordon Heit, Hawaii Island District Land Agent
Land Division

FROM: David G. Smith, Administrator *DGS*

SUBJECT: Request for Right-of-Entry to United States Department of Agriculture – Agriculture Research Service – Pacific Basin Agricultural Research Center for Removal of Rapid Ohia Death Diseased Trees from State Lands Encumbered by General Lease No. S-5374 to Kapapala Ranch, situate.

The Division of Forestry and Wildlife works closely with the applicant, USDA ARS, which is conducting important research on the pathogens causing Rapid Ohia Death. The Division supports issuing the Right-of-Entry so that the project can be completed in a timely manner.

Should you need more information, please contact Rob Hauff at (808) 587-4174.

Exhibit D

DAVID Y. IGE
GOVERNOR OF HAWAII



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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

75 Aupuni Street, Room 204
Hilo, Hawaii 96720
PHONE: (808) 961-9590
FAX: (808) 961-9599

November 15, 2008

Ref. No.: 18HD-136

Author: LD-DG

MEMORANDUM

TO:

State Agencies:

☐ DOH
☐ DHHL
☐ DLNR-Aquatic Resources
☒ DLNR-Forestry & Wildlife
☐ DLNR-Historic Preservation
☐ DLNR-State Parks
☐ DLNR-Conservation and Coastal Lands
☐ DLNR-Water Resource Management
☐ DOT
☒ DOA

County Agencies:

☐ Planning
☐ Parks & Recreation
☐ Public Works
☐ Water Department

Federal Agencies:

☐ Corps of Engineers
☐ NRCS
☐ USDA

Other Agencies:

☐ Office of Hawaiian Affairs

FROM: Gordon Heit, Hawaii Island District Land Agent

SUBJECT: Request for Right-of-Entry Permit to United States Department of Agriculture - Agriculture Research Service - Pacific Basin Agriculture Research Center for Removal of Rapid Ohia Death Diseased Trees from State Lands Encumbered by General Lease No. S-5374 to Kapapala Ranch, situate.

LOCATION: Kapapala, Ka'u, Hawai'i, Tax Map Key: (3) 9-8-001:010por

APPLICANT: United States Department of Agriculture - Agriculture Research Service - Pacific Basin Agriculture Research Center (USDA ARS PBARC)

Transmitted for your review and comment is a copy of the draft board submittal of the above referenced request involving State lands. The submittal is tentatively set to be presented at the BLNR meeting on December 14, 2018. We would appreciate your comments on this application. Please submit any comments by _____ If no response is received by _____

Exhibit D

this date, we will assume your agency has no comments. If you have any questions about this request, please contact HDLO Land Agent, Dan Gushiken at (808) 961-9590, or email dan.k.gushiken@hawaii.gov. Thank you.

Attachments

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

Signed: 

Date: 11/20/18

cc: Central Files
District Files

Aloha,
Dan K. Gushiken, Land Agent
Hawai'i District Land Office/Land Division
Hawai'i Department of Land and Natural Resources

KAPAPALA RANCH

P. O. Box 537
Pahala, HI 96777
lanipetrie@aol.com

November 21, 2018

Mr. Dan Gushiken,
District Land Agent
Hawaii State Department of Land and Natural Resources
75 Aupuni Street; Room 204
Hilo, Hawaii 96720

Dear Mr. Gushiken

Subject: ROD Sanitation measures at Kapapala Ranch Reference #18HD-136

We support USDA's Pacific Basin Agricultural Research Center's (PBARC) effort to remove ROD diseased trees from Kapapala Ranch, specifically from the area along the Peter Lee Road on GL 5374. We have allowed various ROD experiments in this area for the past year or so and defer any removal of trees to your Department.

Sincerely,

KAPAPALA RANCH



Lani C. Petrie
Partner

Exhibit E