United States Department of Agriculture

# Coconut Rhinoceros Beetle Response Program on Oahu

## Final Supplemental Environmental Assessment

## November 2019

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# I. Purpose and Need

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) has a response program (referred to as the Program) for the coconut rhinoceros beetle (CRB), *Oryctes rhinoceros*, on Oahu in Hawai'i. This program is necessary to prevent further spread and establishment of CRB on Oahu. APHIS has the responsibility for taking actions to exclude, eradicate, and/or control plant pests under the Plant Protection Act of 2000 (7 United States Code (U.S.C.) 7701 et seq.). The program is a joint effort between APHIS, the Hawai'i Department of Agriculture (HDOA), and Joint Base Pearl Harbor-Hickam (JBPHH).

CRB is one of the most damaging insects to coconut palms (*Cocos nucifera*). Although primarily found attacking coconut and oil palm, CRB has also occasionally been recorded on bananas, sugarcane, papayas, sisal, and pineapples (CPC, 2010). In Mauritius, the royal palm (*Roystonea regia*), the latanier palm (*Livistona chinensis*), the talipot palm (*Corypha umbraculifera*), and the raphia palm (*Raphia ruffia*) are attacked. CRB may also infest the genus *Pandanus*, which is endemic to Hawai'i (Bedford 1980).

Adults are the injurious stage of the insect. CRB adults damage palm trees by boring into the center of the crown, where they injure the young, growing tissues and feed on the exuded sap. As they bore into the crown, they cut through the developing leaves. When the leaves grow out and unfold, the damage appears as V-shaped cuts in the fronds or holes through the midrib. If the growing tip is injured, severe loss of tissue may cause decreased nut set. In addition, the tree may die if the beetle directly destroys the growing tip or if secondary infection moves in. The adult can damage spadices and leaflets, resulting in loss of coconut production (Hinckley 1973).

The CRB is native to the coconut-growing regions of South and South-East Asia from Pakistan to the Philippines and was accidentally introduced into the South Pacific, including American Samoa, Fiji, Mayotte, Micronesia, Niue, Palau, Papua New Guinea, Reunion (La Réunion), Samoa, Solomon Islands, Tokelau, Tonga, and Wallis and Futuna (GISD 2015, EPPO 2018). An infestation of CRB was detected on Guam on September 12, 2007. APHIS initiated an eradication program on Guam but due to the insects spread and establishment on Guam, APHIS shifted from eradication to limiting further spread.

On December 23, 2013, one suspect CRB was caught in a trap on Oahu, Hawai'i that was part of a cooperative agricultural pest survey program between APHIS and the University of Hawai'i. The suspect specimen was confirmed on January 3, 2014. Subsequent surveys to date have captured adult beetles, the majority of which have been collected from breeding sites (Appendix A).

In March 2014, APHIS prepared an environmental assessment (EA) for the response to the CRB on the south-central side of Oahu (the EA is available at https://www.aphis.usda.gov/plant_health/ea/downloads/2014/CRB_HI_March%2020.pdf, last accessed August 8, 2019). The 2014 EA analyzed alternatives consisting of (1) no APHIS action, and (2) the proposed action alternative, where APHIS would participate in the CRB response program on Oahu. The EA described the effects of CRB on the environment and analyzed the impacts of using the insecticides cypermethrin with piperonyl butoxide (PBO) and pyriproxyfen to control CRB, and traps to monitor and control for CRB. APHIS issued a finding of no significant impact (FONSI) in June 2014, concluding that the implementation of the program would not significantly impact the quality of the human environment. This FONSI is available at https://www.aphis.usda.gov/plant_health/ea/downloads/2014/crb-hawaii-final.pdf (last accessed August 8, 2019).

Since the publication of the 2014 EA and FONSI, the Program has found CRB in areas outside of the geographic scope of the 2014 EA and new treatments have become available to treat for CRB. The Program proposes to add chemical and non-chemical treatments to the CRB response program and expand the geographic area of the Program to include the entire island of Oahu. The Program would exclude critical habitat areas from Program chemical and non-chemical treatments; however, the Program would continue to conduct surveys (Appendix B). The Program proposes the addition of chemical and non-chemical treatments to improve efficacy of the Program and minimize potential impacts to nontarget species. The Program plans to add the following treatments: 1) tree injections of the insecticides imidacloprid or acephate, 2) steaming or composting of greenwaste, which includes compost piles and mulch piles, 3) and the use of magnesium sulfate (Epsom salts) and several residential and non-residential insecticides to treat larval breeding sites, greenwaste, compost, mulch, soil, and turf.

This supplemental EA examines the environmental impacts associated with the new treatment options as well as the current program treatments with the expansion to include the entire island of Oahu; the 2014 EA covered a limited geographic area of Oahu. This supplemental EA incorporates the 2014 EA and FONSI by reference. The draft supplemental EA was made available for a 30-day public comment that ended on October 27, 2019.  One comment was received during the public comment period from a private citizen.

This supplemental EA was prepared in accordance with: (1) the National Environmental Policy Act of 1969 (NEPA) (42 United States Code (U.S.C.) § 4231 et seq.); (2) the Council of Environmental Quality NEPA regulations (40 Code of Federal Regulations (CFR) part 1500 et seq.); (3) USDA regulations implementing NEPA (7 CFR §§ 1b, 2.22(a)(8), 2.80(a)(30)); and (4) APHIS' NEPA implementing regulations (7 CFR part 372).

## Public Outreach

Public outreach efforts since 2014 occur through cooperative efforts with the HDOA, JBPHH, and APHIS. They publish information brochures and quarantine maps through their respective websites:

- HDOA CRB website, http://hdoa.hawaii.gov/pi/main/crb/
- JBPHH CRB website, https://www.cnic.navy.mil/regions/cnrh/om/environmental/coconut-rhinoceros-beetle.html
- APHIS CRB website, https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/coconut-rhinoceros-beetle

The USDA invited comment on the 2014 EA. The USDA sent the draft EA to the HDOA, the APHIS State Plant Health Director in Hawai'i, and the U.S. Fish and Wildlife Service for comment. In addition, the Program published a notice of availability in the local newspaper and invited the public to comment. The USDA made available the final EA and the FONSI on the APHIS website.

The Program plans outreach activities regularly. The Program presents at neighborhood board meetings and the Western Chapter of the International Society of Arboriculture. The Program is planning a brown-bag briefing through the Hawai'i Invasive Species Council.

The Program holds routine multiagency coordination meetings to exchange information with program partners. This includes the following agencies, if they chose to participate:

HDOA (primary partner)
USDA APHIS PPQ (primary partner)
Department of Navy (primary partner)
University of Hawai'i (primary partner)
Hawai'i Invasive Species Council
State Department of Land and Natural Resources
US Fish and Wildlife Services
US Army
Oahu Invasive Species Committee
Coordinating Group on Alien Pest Species
University of Hawai'i Leeward Community College
Kamehameha Schools

# II. Alternatives

This supplemental EA analyzes the potential environmental impacts associated with three alternatives:

Alternative A. No APHIS Participation in the CRB Response Program;
Alternative B. No Action – Current Response Program; and
Alternative C. Proposed Action (Preferred Alternative).

Table 1 summarizes the potential treatments under Alternatives B and C.

## Alternative A. No APHIS Participation in the CRB Response Program

Under this alternative, APHIS would not participate in the CRB response program on Oahu. Other Federal and non-federal entities, including the State of Hawai'i, could take control measures; however, APHIS would not assist in either the response or funding of these measures.

## Alternative B. No Action – Current Response Program

Under the No Action alternative, the CRB response program would remain unchanged. The program uses a combination of quarantine, survey, mass trapping, sanitation, and insecticide treatment to respond to the CRB outbreak in Oahu. A detailed description of the program actions is available in the 2014 EA but is summarized briefly here and in Table 1.

The delimitation survey and mass trapping strategies use the same methodology in trap design and location but trapping density differs. Delimitation survey determines whether the CRB is present in an area, while mass trapping is a method to reduce the CRB population. The trap density for survey depends on the proximity of other CRB finds and perceived risk. The following description of delimitation survey trap density is a general standard operating procedure. The Program places 64 traps (or greater) per square mile within a two mile radius of an active CRB larval breeding site, a CRB find outside of the buffer zone, or when CRB has occurred within 2 miles of another CRB find within one year. The Program places four traps per square mile outside of the 2-mile range if the Program thinks there is a high risk of additional CRB detections. High-risk parameters include a large amount of mulch or compost that could serve as breeding material, proximity of breeding sites or trap detections, and possible routes for greenwaste movement. A larval breeding site is any site with confirmed larval or pupal stages of the beetle and usually consists of piles of rotting or composting plant material from coconut palms often mixed with other organic matter. Greenwaste, mulch, and compost pose a risk of becoming a larval breeding site. Greenwaste is unprocessed plant material, mulch is semi-processed plant material, and compost is decomposed further and depending on the state of decomposition is considered finished or unfinished. The Program places one trap per square mile at airports and seaports on unaffected islands and on other islands in close proximity to Oahu.

Mass trapping density is one trap per acre (500 traps per square mile) in a two-mile radius around a CRB find. CRB traps contain the synthetic aggregation pheromone, ethyl 4-methyloctanoate that attracts male and female adult CRB. The lure also contains a mixture of wax, water, and oils. The Program uses barrel traps when there are no suitable places to hang a panel trap and the location is high priority (K. Weiser, personal communication). Barrel traps are set in addition to panel traps when saturation trapping a breeding site. There is no difference in the lure composition between panel and barrel traps. Barrel traps contain greenwaste but otherwise are not chemically different from panel traps.

The Program determines an area is free of CRB if they do not capture the pest in a trap for a year following the last trap catch. The Program continues to monitor a previously positive area for three years; however, the Program may reduce the trapping density depending on funding.

Sanitation involves removing greenwaste within two miles of CRB detections, chipping or grinding the waste (at which point it is not considered greenwaste), and disposal of raw greenwaste or chipped/ground greenwaste using incineration (burning with a device, such as filters, to remove particulates) or burning (burning without particulate-removing devices). The Program removes dead palms and other dead trees, as well as heavily infested live trees of low economic value. Processed debris is transported from the site in a way to prevent the material from escaping during transit. The HDOA holds permits for burning greenwaste in air curtain burners. This type of burner is a pollution control device for open burning. The “air curtain” traps smoke particles and reburns them, reducing particulate matter. Ash from air curtain burners is disposed at an approved solid waste disposal site. Landowners may also obtain burn permits but they do not use air curtain burners and dispose of their ash through local use.

The Program treats crowns of infested trees and stumps of felled trees with the insecticide mix of cypermethrin and piperonyl butoxide. The Program may also use the insecticide pyriproxyfen on stumps of felled trees. All the insecticides used in the program are labeled for use on larval breeding sites, which are sites with confirmed larval or pupal stages of the beetle. Prior to treatment, the Program removes coconuts from trees. The Program applies insecticides with a backpack or power sprayer according to label rates and instructions. The Program follows insecticide labels regarding application buffers but imposes a minimum buffer of 50-feet of streams, drainages, surface waters, or the intertidal high water mark where no applications will be made.

### Alternative C. Proposed Action (Preferred Alternative)

Under the proposed action alternative, The Program expands to include the entire island of Oahu, excluding critical habitat areas (Appendix B), and includes additional treatment options to control CRB (see Table 1 for the list of treatment options). The Program would continue to conduct surveys in critical habitat areas.

The Program proposes to add trunk injections of two insecticides to the current response program for CRB. The Program would inject imidacloprid (IMA-jet, Arborjet Inc.) or acephate (ACE-jet, Arborjet Inc.) at the base of the palm tree into the sapwood (vascular tissue) to enable the insecticide to translocate upward into the tree (Arborjet 2016, Arborjet 2017). The application rate for both insecticides depends on the palm tree's diameter 54 inches from the ground. The Program would inject a small number palm trees (around 1,000-2,000 trees) located on the military base, airport, golf courses, and agricultural lands. The Program may expand tree injections to other parts of the island if treatments prove effective. Treated trees are maintained with trimming and removal of flowers and fruits at a minimum of twice a year to avoid insecticide residues in these parts. The Program repeats acephate injections every 6-months and imidacloprid injections every year until the Program determines the area is free of CRB or until additional injections do not increase the level of protection.

The Program proposes to add steam treatment to kill potential CRB in greenwaste, compost and mulch. Steaming involves placing the material into a sealed, closed system. The Program is evaluating a vacuum steam system that creates a vacuum and injects steam into the material through a thermocouple for 45 minutes. A supplier of the steam vacuum system did limited testing on the sanitation of compost. It takes 45 minutes to bring the compost up to 56$^{o}$C (measured using thermocouples buried within the material) and hold for 30 minutes at that temperature. APHIS studies suggest that all CRB life stages are killed after a 1-hour exposure to about 47$^{o}$C. The temperature of the treatment is lethal to CRB and the duration adequate as the temperature of the material will remain elevated long after the treatment. The Program plans to add the steaming method if further tests confirm efficacy.

The Program proposes to add composting to kill potential CRB in greenwaste. The goal of composting is to 1) raise temperatures to a minimum of 120$^{o}$F for 24 hours to kill all life stages of the beetle and 2) accelerate the processing of greenwaste to reduce the amount of material that can be utilized by the beetle for breeding sites. Composting will be done by adding an appropriate nitrogen source with greenwaste and if necessary application of water and air to increase temperatures within the compost. The Program composts in containers covered with tarps or in rows. If composting in containers, finishing will be offsite at an approved facility. If composting in rows, finishing is done in a manner that minimizes infestation by CRB. This includes securing the material in a CRB-proof container or removing it from the buffer zone before the temperatures come back down. The Program does not always treat compost with insecticides due to expense of treatment. The Program determines if treatment is necessary based on several factors including the amount of the material, its composition, and the surrounding environment. The entire compost process takes about nine months to one year. Finished compost will be used locally. Composting is used for any material but has size limitations. As material approaches being soil, it ceases to be useful in composting as it will smother the decomposition process.

Burning (as described in Alternative B) is the preferred method for greenwaste disposal but the size of the material and its state of decomposition will determine if it can be burned.

The Program may treat larval breeding sites, greenwaste, mulch, compost, turf, and soil beneath these materials with magnesium sulfate (Epsom salts). Magnesium sulfate is a fertilizer/soil amendment used by commercial growers and homeowners. The Program would soak the material or area with 50 g/L magnesium sulfate for five minutes. After treatment, the Program separates the solids manually with hand tools and broadcasts it on a lawn or field nearby or disposes of it at a recycle center that is approved to receive this material. The Program asks for permission prior to spreading the material on privately owned lawns and fields. The remaining salt solution is poured on the ground at the original site of the pile or broadcast on the site. The Program is unable to reuse the remaining salt solution because it becomes contaminated with fine particle waste and dissolved organics that may spoil if stored (Weiser, K., personal communication).

The Program proposes to treat larval breeding sites, greenwaste, mulch, compost, turf, and soil beneath these materials with insecticides according to label instructions. The Program is considering the following residential formulations:

gamma cyhalothrin (e.g., Triazicide, Spectrum Brands, Inc.)
zeta cypermethrin with bifenthrin (e.g., Sevin, GardenTech)
lambda-cyhalothrin
imidacloprid with beta cyfluthrin (e.g., Bayer Complete Insect Killer Granules)

The Program is considering the following non-residential formulations;

beta-cyfluthrin (e.g., Tempo WP, Bayer)
zeta-cypermethrin with bifenthrin and imidacloprid (e.g., Triple Crown, FMC Corporation)
imidacloprid with beta-cyfluthrin (e.g., Temprid, Bayer)

This EA evaluates the ecological and human health risks associated with the active ingredients, not the brands or specific formulations. The Program may use other formulations with the same active ingredients in different concentrations as those listed above. The addition of any new active ingredients to the Program will require analysis under NEPA before use.

Table 1. Potential program chemical and non-chemical treatments and their use pattern

| | **Alternative B – Current CRB Response Program** | **Alternative C – Preferred Alternative** |
|---|---|---|
| **Mass trapping (ethyl 4-methyloctanoate)** | X | X |
| **Treatment of stumps of felled trees** | | |
| Cypermethrin with piperonyl butoxide | X | X |
| Pyriproxyfen | X | X |
| **Treatment of infested trees** | | |
| Cypermethrin with piperonyl butoxide | X | X |
| Imidacloprid | | X |
| Acephate | | X |
| **Treatment of uninfested trees** | | |
| Imidacloprid | | X |
| Acephate | | X |
| **Treatment of larval breeding sites** | | |
| Cypermethrin with piperonyl butoxide | X | X |
| Pyriproxyfen | X | X |
| Beta cyfluthrin | | X |
| Bifenthrin | | X |
| Gamma-cyhalothrin | | X |
| Imidacloprid | | X |
| Lambda-cyhalothrin | | X |
| Zeta cypermethrin | | X |
| Magnesium sulfate (Epsom salt) | | X |
| **Treatment of greenwaste** | | |
| Beta cyfluthrin | | X |
| Bifenthrin | | X |
| Gamma-cyhalothrin | | X |
| Imidacloprid | | X |
| Lambda-cyhalothrin | | X |
| Zeta cypermethrin | | X |
| Magnesium sulfate (Epsom salt) | | X |
| Steaming | | X |
| Composting | | X |
| Burning | X | X |
| **Treatment of mulch and compost** | | |
| Beta cyfluthrin | | X |
| Bifenthrin | | X |
| Gamma-cyhalothrin | | X |
| Imidacloprid | | X |
| Lambda-cyhalothrin | | X |
| Zeta cypermethrin | | X |
| Magnesium sulfate (Epsom salt) | | X |

| | Alternative B – Current CRB Response Program | Alternative C – Preferred Alternative |
|---|---|---|
| Steaming | | X |
| **Treatment of soil and turf** | | |
| Beta cyfluthrin | | X |
| Bifenthrin | | X |
| Gamma-cyhalothrin | | X |
| Imidacloprid | | X |
| Lambda-cyhalothrin | | X |
| Zeta cypermethrin | | X |
| Magnesium sulfate (Epsom salt) | | X |

# III. Affected Environment

The program action area described in the 2014 EA included the south-central side of Oahu with the majority of the action area comprised of lands developed for industry, urban and military use (see the 2014 EA for a detailed description). The Joint Base Pearl Harbor-Hickman is located on the south-central side of the island. CRB's distribution on Oahu has expanded since the publication of the 2014 EA, resulting in the proposed expansion of the Program to include the entire island, excluding critical habitat areas from chemical and non-chemical treatments (Appendix B).

Oahu has many historic, recreation, and nature preserves and areas, many with trees that are hosts to CRB, which grow naturally or are planted. Oahu has 19 state parks and monuments (Hawai'i State Parks 2019). Several parcels of federal lands on Oahu are in the Federal Lands to Parks Program, which transfers federal lands to States, Counties, and communities at no cost as long as they are protected for public parks and recreation. These include the Kapolei Regional Park, Makalapa Park, Manana Kai Neighborhood Park, Ted Makalena Golf Course, and Waipahu Cultural Garden Park (NPS 2019). The Foster Botanical Garden located in Honolulu has a palm collection that contains potential CRB host plants. Hawai'i State Legislature passed the Exceptional Tree Act (Act 105) to protect trees of "exceptional stature" (HDFW 2018). The list of exceptional trees on Oahu contains at least two trees that are host to CRB (City and County of Honolulu nd). Oahu has numerous State and Federally listed threatened and endangered (T&E) species. In 2014, APHIS looked at the T&E species the Program may impact and found program actions may affect, but are not likely to adversely affect the Hawaiian hoary bat (*Lasiurus cinereus semotus*), Hawaiian coot (*Fulica alai*), Hawaiian common moorhen (*Gallinula chloropus sandvicensis*), Hawaiian stilt (*Himantopus mexicanus knudseni*), or Hawaiian duck (*Anas wyvilliana*).

Oahu has just under 1 million people. Due to the significant development within the proposed action area, some of the waterbodies have degraded water quality and some are listed as impaired under 303(d) of the Clean Water Act. Air quality in the area over the past two years appears to be good based on the lack of exceedance of any priority pollutants (averaged over the year) that are assessed under the Clean Air Act (USEPA 2018).

# IV. Environmental Impacts

Each alternative results in potential environmental impacts. The ecological and human health impacts associated with 'Alternative A - No APHIS Participation in the CRB Response Program' and 'Alternative B - No Action – Current CRB Response Program' alternatives are described in the 2014 EA (USDA APHIS 2014) and incorporated by reference.

## Alternative A. No APHIS Participation in the CRB Response Program

The environmental impacts under this alternative do not change from that described in the 2014 EA. The impacts are summarized here; refer to the 2014 EA 'No Action' alternative for additional details.

Impacts that could result from this alternative relate primarily to economic and environmental effects related to the spread of CRB. Damage from CRB to host plants would be substantial if CRB spread and established on Oahu. The damage and loss of palms and other shade and ornamental plants to resort, park, and residential communities from CRB could result in reductions in private property values, loss of tourism, and increased costs associated with replacing dead palms. Economic impacts would also be anticipated if CRB becomes established in commercial palm production affecting costs as well as diminishing yields through the loss of trees. A permanent infestation could lead to additional interstate and international quarantine restrictions affecting other countries and the United States. These restrictions would result in increased costs to producers through implementation of mitigation measures. The establishment of CRB on Oahu would also put other Hawaiian Islands and mainland United States at risk from introduction of CRB.

From an environmental perspective, the loss of native palms would impact the diversity of forests on Oahu and result in increased erosion on beaches where palms and other vegetation provide protection against erosion (Mimura and Nunn 1998, Moore 2009). Individual efforts to limit plant damage would likely involve use of insecticides with increasing frequency resulting in increased pesticide loading in the environment and risk to human health and the environment.

## Alternative B. No Action – Current CRB Response Program

The environmental impacts under this alternative do not change from that described in the 2014 EA. The impacts are summarized here; refer to the 2014 EA "Preferred Alternative" for additional details.

Impacts to the human environment related to any regulatory controls, such as quarantine, as well as delimitation/mass trapping and survey are not anticipated. The specificity of the pheromone, the localized trapping effort, and low density of traps per acre are not expected to result in population level impacts to non-target invertebrate populations. Impacts to human health and other non-target organisms from ethyl 4-methyloctanoate are not expected due to its low toxicity and exposure potential (BPDB 2014).

Delimitation and mass trapping will also use an ultraviolet light to attract CRB. These types of lights will attract some non-target invertebrates and incidental collection may occur. Trapping is non-lethal so some non-target invertebrates may be released as traps are checked. The low density of traps used in the response program, and the localized area of trapping, suggests that population level impacts to non-target invertebrates would not be anticipated.

## Sanitation

Sanitation activities related to the CRB response program are expected to have minimal impacts to the environment. Plant material containing CRB either will be composted, chipped, ground, or burned on-site, or transported off-site to a facility approved for burning or incineration. On-site chipping could result in excessive noise during the operation of machinery but these events would be brief and are not expected to impact wildlife and the public. Any on-site burning would be minor and only occur in circumstances where appropriate permits have been obtained. There is the possibility of some physical soil disturbance during the removal of infested trees, debris, and stumps; however, areas will be raked to minimize the amount of disturbance and decrease the potential for erosion.

## Insecticide Treatments

### *Pyriproxyfen*

The program uses the insecticide pyriproxyfen on stumps of felled trees or larval breeding sites using the formulation NyGuard® applied with a backpack sprayer. Pyriproxyfen is part of a group of insecticides known as insect growth regulators that act as a juvenile hormone (JH) analog. Juvenile hormones are produced in insects naturally and are important in development, reproduction, and diapause. In this case, the JH analog is used as an insecticide to prevent larval insects from maturing to adults. Pyriproxyfen has several agricultural and non-agricultural uses in controlling a variety of insect pests.

*Human Health*

Acute toxicity data for the pyriproxyfen active ingredient and the proposed formulation demonstrate very low toxicity from oral, dermal, or inhalation exposures. Median lethality values ($LD/LC_{50}$) for the three exposure pathways are greater than the highest test concentrations, suggesting the formulation is practically non-toxic in acute exposures. Handling the formulated product can result in eye and skin irritation. Pyriproxyfen, and associated metabolites, are not considered to be carcinogenic or mutagenic (Bayoumi et al. 2003, USEPA 2009) and are not endocrine disruptors (USEPA 2009). The exposure risk to applicators is low; only certified personnel make applications and they follow label recommendations regarding worker safety. In addition, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides. Dietary exposure through food and water is not anticipated due to the method of application, the environmental fate of the chemical, and the use of application buffers (a minimum of 50-feet) to protect surface water.

*Ecological Resources*

Proposed pyriproxyfen applications are not expected to have adverse impacts to fish and wildlife. The risk of exposure to ecological resources is minimal because of the method of application, the low toxicity of the insecticide to most organisms, and program mitigations. Pyriproxyfen has low toxicity to wild mammals and birds, suggesting very little direct risk. Based on the mode of action of pyriproxyfen and the small areas of treatment, it would not be expected to have adverse impacts for those terrestrial organisms that depend on insects as prey items. Pyriproxyfen will have some impacts to non-target terrestrial invertebrates but the small area of treatment and the selective nature of the insecticide will minimize these impacts. The concentrations used in the program are not expected to have adverse effects to honeybees (Mommaerts et al. 2006, USEPA 2019). Pyriproxyfen toxicity to aquatic organisms is variable with acute toxicity above water solubility (0.367 milligrams per liter (mg/L)) for most fish species, suggesting low acute risk to aquatic vertebrates (USEPA 2019). Direct or indirect risk to aquatic organisms through loss of food items is expected to be low. The application method will reduce the likelihood of off-site drift and runoff, as well as the implementation application buffers required by the label, or a minimum of 50-feet from aquatic areas.

*Environmental Quality*

Impacts to soil quality from pyriproxyfen applications are not expected, based on where treatments will occur and its fate in soil. Applications are directed primarily at stumps or small areas where larval host material occurs. Any contact with soil will be localized and not expected to persist, based on field dissipation half-lives ranging from 3.5 to 16.5 days and aerobic soil metabolism half-lives of less than two weeks (CA DPR 2000). Pyriproxyfen is not anticipated to have impacts to air quality, based on the proposed method of application and environmental fate for the insecticide. Pyriproxyfen has a low vapor pressure suggesting that volatilization into the atmosphere from plants and soil will be minimal. Some material may be present in the atmosphere at the site of treatment during application but will quickly dissipate to the ground since applications are made using backpack sprayers using large, coarse droplets, reducing drift. Impacts to surface or ground water are also not anticipated due to the low solubility of pyriproxyfen in water as well as its preference to bind to soil and sediment, thus reducing the threat to surface and ground water. In addition, the Program follows label requirements regarding application buffers and imposes a minimum 50-foot buffer from water bodies, further reducing the potential of program insecticides to impact water quality. This will also reduce the potential for volatilization from water into the atmosphere, which is considered moderate for pyriproxyfen based on available fate data (CA DPR 2000).

#### ***Cypermethrin + Piperonyl Butoxide (PBO)***

The Program treats the crowns of infested trees and stumps of felled trees with the insecticide mix of cypermethrin and piperonyl butoxide. Cypermethrin is a pyrethroid insecticide that effects the axon of the nerve causing paralysis in affected organisms (USEPA 2005c). Cypermethrin has several agricultural and non-agricultural uses to control a variety of insect pests. Its proposed use in the CRB program is to treat bore holes, frond bases, stumps, and larval breeding sites using an emulsifiable concentrate or wettable powder formulation. Cypermethrin will also be mixed with the insecticide synergist, piperonyl butoxide, to increase the efficacy of treatments.

*Human Health*

The technical active ingredient, cypermethrin, and the proposed formulation is moderately toxic in oral exposures but is considered practically non-toxic in dermal and inhalation exposures. The formulated material is severely irritating to the eye and moderately irritating to the skin. It is also considered a mild skin sensitizer. Cypermethrin is not considered mutagenic or teratogenic; however, it is considered a possible carcinogen based on results from a chronic mouse study where benign lung tumors were observed at the highest dose level. These levels are well above those expected in this program. Similar effects were not observed in other test species in chronic studies (USEPA 2007b). There is data that demonstrate endocrine related impacts in vertebrates, but at residues that would not be expected to occur in this program. PBO is considered practically non-toxic to mammals via acute oral, dermal or inhalation exposures. It is minimally irritating to the eye and skin but is considered a skin sensitizer. PBO is not considered neurotoxic or mutagenic and has only been shown to cause developmental effects or demonstrate carcinogenicity at very high doses (USEPA 2006b). Synergistic effects of PBO and pyrethroids does not appear to occur in mammals at relevant doses (Cantalamessa 1993, USEPA 2006b).

Similar to pyriproxyfen, exposure and risk will be the greatest for applicators. Adherence to personal protective equipment recommendations will reduce risk to workers. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides. Exposure to the general public in areas where they may frequent will be very low for cypermethrin treatments because applications are made directly into the boreholes and the frond bases which are well above the reach of the general public. The greatest chance for exposure to cypermethrin treatments would be through the ingestion of soil or plant material in cases where breeding sites are treated. No applications are made to parts of the plant that would be consumed as food; therefore, dietary exposure would not be expected. Exposure to cypermethrin from drinking water is also not anticipated due to use of application buffers from surface water and the extremely low probability of groundwater contamination based on the environmental fate for this insecticide. Risk to cypermethrin through soil ingestion is very low based on the known toxicity and conservative assumptions regarding the amount of soil that would need to be consumed to reach an adverse effect.

*Ecological Resources*

Cypermethrin has low acute and chronic avian toxicity with reported acute median lethal doses and chronic no observable effect concentrations greater than the highest test concentration (USEPA 2005c). Toxicity is high to most terrestrial invertebrates, including honeybees; however, the applications to boreholes and stumps as well as the small areas of treatment for larval sites will reduce exposure because flowers are not treated. In addition, label language designed to protect foraging honeybees will provide additional protection from risk to cypermethrin exposure. PBO has low avian and wild mammal toxicity and has been shown to be practically non-toxic to honeybees (USEPA 2019). Treatments using cypermethrin and PBO could impact some soil borne terrestrial invertebrates; however, this will be minimized by the small treatment areas for the larval breeding sites and the affinity for the insecticide to bind to soil, reducing bioavailability (Hartnik and Styrishave 2008). The localized impacts that could occur to some terrestrial invertebrates from treatment of larval breeding sites are not expected to pose an indirect risk to terrestrial vertebrates that depend on invertebrates for prey because they would forage over areas greater than the area of treatment. Direct risk to wild mammals and birds from the use of PBO with cypermethrin is also not expected to result in an increased risk compared to cypermethrin alone. As previously mentioned the synergistic effects of PBO and pyrethroids are not expected in mammals at relevant doses.

Cypermethrin is considered highly toxic to aquatic invertebrates and vertebrates with reported median lethality values in the low parts per trillion to low parts per billion range, depending on the test species, although fish were slightly less sensitive when compared to aquatic invertebrates (Solomon et al. 2001, USEPA 2005c). PBO is considered moderately to highly toxic to freshwater and marine aquatic invertebrates (USEPA 2019). Acute fish toxicity is also considered moderate. PBO can act as a synergist with pyrethroids in its effects to aquatic invertebrates. Data regarding synergistic effects of PBO and pyrethroids in fish are less conclusive (USEPA 2006b). Acute and chronic risk to aquatic habitats is not anticipated because of the proposed use pattern, environmental fate of cypermethrin and PBO, and the implementation of application buffers per label requirements but at least a minimum of 50-feet from aquatic habitats.

*Environmental Quality*

Cypermethrin is not expected to cause adverse impacts to soil, water, or air quality due to the method of application, the environmental fate of the insecticide, and additional mitigation measures beyond those stated on the label. Cypermethrin breaks down in soil under aerobic and anaerobic conditions with half-lives of less than 65 days (USEPA 2005c). Cypermethrin has very low water solubility and a high binding affinity to soil and sediment that would result in a very low probability of ground or surface water contamination. Surface water is further protected by adherence to label restrictions and the implementation of application buffers according to the label but at least a minimum of 50-feet from surface water. Physical and chemical characteristics for cypermethrin preclude significant volatilization into the atmosphere. Cypermethrin may be present in the air as drift following an application to stumps or larval breeding sites; however, the ground-based application using large, coarse droplets will minimize the probability of any off-site drift during these types of applications. PBO is also not expected to result in measurable impacts to soil, water or air quality. PBO is degraded by soil microorganisms and is sensitive to light with a photolysis half-life of less than 8.4 hours in water (USEPA 2006b). PBO is moderately mobile in water and could be susceptible to runoff; however, application restrictions near surface water will reduce the potential for impacts to water quality. The method of application for PBO plus its short half-life in air (< 3.4 hours) suggests impacts to air quality will not occur. There may be some material in the air immediately after application as drift; however, this will be very localized and short duration.

## Alternative C. Proposed Action (Preferred Alternative)

Under the proposed action, the Program would add trunk injections using the insecticides imidacloprid and acephate. The Program also proposes to use magnesium sulfate (Epsom salts) and commercially available grub insecticides (labeled for residential or non-residential use) to treat larval breeding sites, greenwaste, turf, compost, mulch, and soil beneath these materials. The Program would also add steaming and composting of greenwaste to destroy CRB.

The action area covers the entire island of Oahu, excluding critical habitats for T&E species (Appendix B) from Program chemical and non-chemical treatments. The Program may still conduct surveys in critical habitat areas. Because the 2014 EA covered a smaller geographic area than the entire island, the current program treatments are reviewed for additional impacts given the geographic expansion of the program.

Impacts to the human environment related to any regulatory controls, such as a quarantine, as well as delimitation/mass trapping and survey are not anticipated. The expansion of the Program to the entire island of Oahu could increase the number of CRB traps set for survey and mass trapping. The Program already sets traps for early detection throughout the island. The location of CRB will dictate the number of traps used in delimiting surveys and mass trapping. An increase in the number of CRB traps set for survey and mass trapping is unlikely to increase impacts to human health because the pheromone is applied by hand as a lure suspended below the vanes that are attached to the trap. This method of pheromone application results in low exposure potential for the general public. In addition, traps are labeled advising the public not to disturb the traps, which will further reduce the potential for exposure. Acute effects data for mammals, birds, fish, and terrestrial and aquatic invertebrates suggests that ethyl 4-methyloctanoate is practically non-toxic with median lethality values exceeding the highest test concentrations (BPDB 2014).

The CRB traps can attract nontarget organisms, but the traps are not lethal. The Program monitored panel and barrel CRB traps to identify the type of non-target insects captured in the traps (K. Weiser, personal communication). For three weeks, traps in 17 locations on Oahu were monitored for a total of 669 trap checks. Sixteen percent of the trap checks had bycatch of some kind. The bycatch was mainly the scarab beetle, *Protaetia orientalis* (27%), various roach species (25%), Black witch moth, (*Ascalapha odorata*) (15%), and a variety of other species comprising the other 33% of nontarget terrestrial invertebrate collected. The other species included houseflies, ladybird beetles, wasps, click beetles, longhorn beetles, a hemipteran, small moths, and a grasshopper.

The low toxicity and low potential for exposure to humans and nontarget organisms suggests the use of ethyl 4-methyloctanoate will result in negligible risk.

### Sanitation

The impacts from sanitation activities such as composting, chipping, onsite burning, or transport to an offsite facility for incineration are not expected to change significantly from that described in the 2014 EA with the expansion of the Program to the entire island. Expansion of the Program to the entire island does not mean that CRB is present throughout the island. The volume of material routed for sanitation depends on the infestation of hosts. Spread of CRB infestation could increase the amount of material entering the sanitation stream, and if Program activities occur within a narrow timeframe, this could be a large volume at one time. The Program's goal is to eradicate CRB, and intermediately reduce the spread and infestation of CRB. The Program anticipates a reduction in CRB populations over time, which will reduce the amount of host material entering the sanitation stream.

#### *Magnesium sulfate (Epsom salts)*

Under this alternative, the Program may use magnesium sulfate (Epsom salts, CAS 10034-99-8) to control CRB in larval breeding sites, greenwaste piles, turf, compost, mulch, and soil beneath these materials. The Program creates piles of plant material for treatment in several designated areas and does not confine treatment to one spot. The Program would soak the material in 50 g/L Epsom salt for five minutes. The volume of solution used depends on the volume of material for treatment. In two test plots, the Program applied 50 to 100 gallons magnesium sulfate per plot (Weiser, K., personal communication). The Program then separates the solids manually with hand tools and broadcasts it on a publically or privately owned lawn or field nearby. The Program receives approval from landowners prior to broadcasting the material. The Program spreads the solids to a maximum depth of 1 inch. The remaining salt solution is poured on the ground at the original site of the pile or broadcast on the site. The volume of remaining solution from Program test plots was low, usually less than 5 gallons (Weiser, K., personal communication). The Program is unable to reuse the salt solution because the presence of fine particle waste and dissolved organics could spoil the solution in storage (Weiser, K., personal communication). The Program would impose a 50-foot buffer from water resources and would not apply magnesium sulfate in waterbodies.

Magnesium sulfate is a white crystalline powder with a low vapor pressure of <0.1 mm Hg (20 C) and high water solubility (NIH 2019). Magnesium sulfate naturally occurs in the environment and both magnesium and sulfur are essential elements in plant and animal life (McLaughlin 2013, Kaiser 2016). In humans, magnesium sulfate is used to treat a range of medical conditions. Homeowners and growers use magnesium sulfate as a fertilizer.

Information on the use of magnesium sulfate in the control of plant pests is limited. One study showed that magnesium sulfate had residual action on eggs and neonate larvae of the gooseberry sawfly, *Nematus ribesii* (Wenneker and Helsen 2008). In the laboratory, researchers applied a high concentration (20 g/L) of magnesium sulfate to foliage of currant leaves and evaluated the mortality of eggs and young larvae after treatment. A common concentration of magnesium sulfate for foliar fertilization is 7 g/L. Mortality of treated eggs was 60% compared to 27% in the control. The mortality of larvae that hatched from treated eggs was 32%. In contrast, the mortality rate of hatched larvae in the control was 36%. Combined, the mortality of treated eggs and larvae that hatched from treated eggs was about 92% six days after treatment. Recently hatched larvae placed on foliage two days after foliar treatment had a mortality rate of 73%. The researchers did not notice an effect on older larvae from residues of magnesium sulfate. The extension of efficacy in the field was not tested. In laboratory trials, the Program found applications of Epsom salt at the recommended rate of ½ cup Epsom salt/gallon water (1X rate) for palms would kill off some CRB larvae and inhibit the development of the survivors. As application rates increase, mortality and inhibition of larval development increases. In laboratory studies, female CRB may avoid ovipositing in mulch treated at 5X the recommended rate, but not at 1X or 2X the recommended rate (W. Wesela, personal communication). For field applications, the Program proposes to apply a 2X rate (50 g/L equivalent to 1 cup Epsom salt/gallon water) based off laboratory studies (K. Weiser, personal communication).

Magnesium sulfate may impact other invertebrates and mollusks located in treated material or in the immediate vicinity but will have negligible risk to humans, mammals, birds, and aquatic species due to the Program's use pattern as well its environmental fate and toxicity, which are reviewed below.

*Human Health*

There are several medicinal uses for magnesium sulfate including oral ingestion as a laxative and topical saturated solution for anti-inflammation and analgesic effects (NIH 2019). The Food and Drug Administration lists magnesium sulfate as 'Generally recognized as safe (GRAS)' (21 CFR §582.5443). In humans, magnesium sulfate can be an irritant to skin, eyes, and the respiratory system (NIH 2019). The subcutaneous $LD_{50}$ in the rat and mouse is 1,200 mg/kilogram (kg) and 645 mg/kg, respectively (NIH 2019). In a small study, men given 13.9 g (average 183 mg/kg) magnesium sulfate at four equal hourly intervals developed diarrhea (Morris and Levy 1983). Dietary exposure is unlikely because the Program's use pattern does not affect food crops or drinking water resources. The Program requires applicators to wear label-required PPE, reducing potential exposure. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides.

*Ecological Resources*

Magnesium sulfate naturally occurs in the environment and is practically nontoxic to terrestrial and aquatic species. The Program uses a high concentration of magnesium sulfate (50 g/L), which can be harmful to terrestrial and aquatic species (see toxicity summary below). The Program expects adverse effects to occur to other organisms that are in materials during treatment. After treatment, the Program spreads the treated solid matter on nearby lawns and fields to a maximum depth of 1-inch, which reduces the concentration of magnesium sulfate in a given area, minimizing the risk of magnesium sulfate toxicity. The Program may dispose of treated solid matter at a recycle facility, but would need prior approval from the facility. Magnesium sulfate is highly soluble and the Program expects some runoff into nearby untreated areas and water sources. To reduce the exposure risk of water resources, the Program does not treat or spread material treated with magnesium sulfate within 50-feet of a water resource.

In rabbit, an oral LDLo (lowest dose at which lethality occurred) of 3,000 mg/kg was reported suggesting low toxicity (NIH 2019). Magnesium sulfate toxicity to birds also appears to be low based on available data. Under laboratory conditions, mallard ducklings given magnesium sulfate in drinking water for 28 days exhibited sublethal effects, including reduced quill length at 1,500 parts per million (ppm) and reduced weight, weak bones, enlarged adrenals and reduced thymus at 3,000 ppm, although some of these symptoms may be interrelated (Mitcham and Wobeser 1988). In a laboratory study on hens, mortality data indicate that lethal levels of magnesium sulfate are between 16,000 and 23,680-ppm total salt (Adams et al. 1975). Hens given 4,000-ppm total sulfate (magnesium sulfate) had reduced hen-day production and water and feed consumption (Adams et al. 1975).

Acute toxicity testing using the freshwater Northern trout gudgeon, *Mogurnda mogurnda*, reported an $LC_{50}$ of 198 mg/L using magnesium sulfate, indicating it is practically nontoxic (Van Dam et al. 2010). The $LC_{50}$ value for the freshwater cladoceran, *Ceriodaphnia dubia* for 24-h and 48-h exposure was 1,770 mg/L (Mount et al. 1997). In *Daphnia magna*, the magnesium sulfate $LC_{50}$ value at 24-h and 48-h exposure was 2,360 mg/L and 1,820 mg/L, respectively (Mount et al. 1997). In another study, the $EC_{50}$ value (effective concentration which results in a 50% reduction in immobilization) at 24-h and 48-h exposure was 405.98 mg/L and 343.56 mg/L, respectively, for *D. magna* (Khangarot and Ray 1989). The $LC_{50}$ values at 24-h, 48-h, and 96-h exposure was 4,630 mg/L, 3,510 mg/L and 2,820 mg/L for the fathead minnow, *Pimephales promelas*, respectively (Mount et al. 1997). In a study testing magnesium sulfate exposure to tropical freshwater species (*Chlorella* sp., unicellular green algae; *Lemna aequinoctialis*, tropical duckweed; *Amerianna cumingi*, pulmonate snail; *Moinodaphnia macleayi*, cladoceran; and *Hydra viridissima*, green hydra), inhibition concentrations ($IC_{50}$) ranged from 22 to 6,014 mg/L (Van Dam et al. 2010). IC is the concentration at which activity is inhibited by 50%.

*Environmental Quality*

Magnesium sulfate is highly soluble in water. Magnesium binds to clay particles and organic matter and does not readily leach from soils (Kaiser 2016). Sulfate easily leaches from soil, particularly from sandy soils that receive high rainfall (McLaughlin 2013). An increase of sulfates in freshwater wetlands can change the vegetative composition through eutrophication (Lamers et al. 1998). The Program imposes a 50-ft application buffer to protect nearby water resources from runoff or leaching of magnesium sulfate from treated material. Impacts to air quality are negligible as magnesium sulfate is not volatile.

## Insecticides to treat crowns of infested trees and stumps of felled trees

### *Pyriproxyfen and Cypermethrin with Piperonyl Butoxide*

The 2014 EA evaluated the human health and ecological risks associated with pyriproxyfen and cypermethrin with piperonyl butoxide. Alternative B summarizes the 2014 EA evaluation.

Under this alternative, the Program's use pattern and application method for pyriproxyfen and cypermethrin with piperonyl butoxide remains unchanged except for the approval granted in 2019 from the Federal Aviation Administration (FAA) for the Program to use unmanned aircraft systems (UAS)/drones to dispense pesticides to palm crowns. Using a lift or ladder, program personnel would ascend to the tree crown and remove all adults and immature beetles from any boreholes, frond bases, or other visible areas. The Program treats the crowns of infested trees and stumps of felled trees with the insecticide mix of cypermethrin and piperonyl butoxide. The program uses pyriproxyfen on stumps of felled trees and larval breeding sites. If CRB spreads on Oahu and causes further damage, the number of stumps, larval breeding sites, and other plant parts with CRB damage will increase which may increase the number of insecticide treatments as well the number of locations treatments occur. Despite these increases, the risk to humans and nontarget organisms remains the same because the Program's use pattern and the insecticide's toxicity and environmental fate are unchanged.

## Insecticides to treat larval breeding sites, soil, turf, compost, mulch and greenwaste

The Program proposes to use residential and non-residential lawn and grub insecticides to treat CRB larval breeding sites, soil, turf, compost, mulch, and greenwaste piles for CRB. The location of this material is or has been present on all property types, including residential, public, and military lands. In this EA, the risk evaluation is on the active ingredients, not the specific brands or formulations as the Program may select a brand/formulation not mentioned in this document but has the same active ingredient(s).

These insecticides are broad-spectrum and are labeled for use in a range of residential and commercial applications. The Program follows federal and state pesticide regulations and makes applications according to label requirements.

The Program conducted laboratory trials testing the efficacy of lawn/grub insecticide formulations on greenwaste piles. The insecticides labeled for residential use were effective at the 2X rate, with the imidacloprid + beta cyfluthrin and zeta cypermethrin + bifenthrin appearing the most effective (100% $1^{st}$ instar mortality after 1 week). Gamma cyhalothrin and lambda cyhalothrin +

propiconazole had >95% mortality after two weeks (1 of 25 1st instars survived). Control mortality was higher than usual at 44% after two weeks; in control treatments, 20% mortality is common with 1st instars.

The Program may make applications on residential properties, depending on the situation. The Program mulches or composts greenwaste treated with insecticides (other than magnesium sulfate), but would not use burning or incineration to dispose of insecticide-treated greenwaste. The mulch and compost is available for local use. In the Program, the potential for impacts to human health are going to be greatest for workers and applicators.

Dermal, inhalation and dietary exposure to the public is unlikely. The public is unlikely to touch treated material. In addition, weathering and degradation of insecticides and the binding of insecticides to soil particles reduce the risk of exposure. Dietary exposure is unlikely since the treated material is not food for consumption. The potential for dietary risk from exposure to program insecticides through drinking water are discussed for each pesticide. A review of the labels for each insecticide offers a range of requirements for personal protective equipment, based on the potential risk of each insecticide. All applications made in the Program will be done by qualified individuals and in compliance with all label recommendations to ensure applicator and worker exposure and subsequent risk is minimized. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides.

From an environmental perspective, all treatments are focused on making applications to larval breeding sites, soil, turf, compost, mulch, and greenwaste piles. Exposure to nontarget terrestrial animals is expected to be lower because ground-based applications are made to specific treatment areas as opposed to broadcast applications over large areas. The disturbance from human activity during application would cause many terrestrial animals to move away from the treatment area, reducing exposure during application. The majority of the insecticides used in the Program are nonsystemic[1]; therefore, no insecticide plant residues would be anticipated for most of the treatments, with the exception of treatments using imidacloprid, which is a systemic insecticide. The potential for risks to nontarget organisms consuming residues from plants and insects are discussed in the following summaries.

### *Gamma-Cyhalothrin*

The Program proposes to use 0.05% gamma-cyhalothrin as granules (example formulation, Triazide®, Spectracide®, Spectrum Brands, Inc.). After spreading the granules, the label instructs applying water but not to the point of runoff.

[1] Nonsystemic means that the pesticide remains on the outside of the plant that is treated. By comparison, a systemic pesticide is incorporated into the plant that is treated.

The Program follows the label for application instructions and PPE requirements. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes and wear gloves when applying insecticides. The Program adheres to the label's application buffer requirements and at a minimum imposes 50-foot buffer from water resources.

Gamma-cyhalothrin is a non-systemic, broad-spectrum pyrethroid insecticide. Cyhalothrins (lambda- and gamma-cyhalothrin) cause neurotoxicity from interaction with sodium channels (USEPA 2017a). Toxicity data for gamma-cyhalothrin is completed by bridging data for lambda-cyhalothrin and cyhalothrin (USEPA 2017a). Gamma-cyhalothrin has similar environmental fate properties as lambda-cyhalothrin. Gamma-cyhalothrin has a greater insecticide activity than lambda-cyhalothrin and usually is applied at half the rate of lambda-cyhalothrin (USEPA 2017a).

*Human Health*

Both lambda- and gamma-cyhalothrin are toxicity category II for acute oral and dermal routes of exposure to mammals, indicating it is moderately toxic and moderately irritating (USEPA 2017a). Acute inhalation studies show gamma-cyhalothrin is a toxicity category I while lambda-cyhalothrin is a toxicity category II showing high acute inhalation to mammals (USEPA 2017a).

*Ecological Resources*

As with lambda-cyhalothrin, gamma-cyhalothrin is highly toxic to honey bees and aquatic species (PPDB 2018). In honey bees, gamma-cyhalothrin has a contact acute 48-hour $LD_{50}$ of 0.005 μg/bee (high toxicity) and an oral acute 48-hour $LD_{50}$ of 4.2 μg/bee (moderate toxicity). Gamma-cyhalothrin has high acute toxicity to the bluegill sunfish, *Lepomis macrochirus* (96-h $LC_{50}$ of 0.035 µg/l) and freshwater cladoceran, *Daphnia magna* (48-h $EC_{50}$ of 0.045 µg/l), and high chronic toxicity to the rainbow trout, *Oncorhynchus mykiss* (21-d No Observed Effect Concentration (NOEC) of 0.13 µg/l) and *D. magna* (21-d NOEC of 0.0022 µg/l) (PPDB 2018). Both lambda- and gamma-cyhalothrin have low toxicity in birds; gamma-cyhalothrin has an acute $LD_{50}$ of >2,000 mg/kg in exposures using the mallard, *Anas platyrhynchos* (PPDB 2018).

Although the risk of gamma-cyhalothrin is higher than lambda-cyhalothrin for some species, the hazard is similar to lambda-cyhalothrin because generally it is applied at half the rate of lambda-cyhalothrin (USEPA 2017a). As such, refer to the lambda-cyhalothrin summary for gamma-cyhalothrin impacts to human health, ecological resources, and environmental quality covered elsewhere in this document.

### *Zeta Cypermethrin + Bifenthrin*

The Program proposes to use zeta cypermethrin (0.029%) mixed with bifenthrin (0.115%) as a granular formulation (example formulation, Sevin®, GardenTech Inc.).

The human health and ecological risks for zeta cypermethrin are the same as discussed for cypermethrin under Alternative B. Cypermethrin and zeta cypermethrin toxicological endpoints are the same (USEPA 2006c). Below is a summary of the human health and ecological impacts for bifenthrin.

**Bifenthrin**

*Human Health*

Bifenthrin is a synthetic pyrethroid insecticide that acts on the peripheral and central nervous system impacting axons, and is effective as a contact or ingested compound. The Program would apply bifenthrin according to label instructions. The Program follows the labels instructions for PPE but at a minimum requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides.

Bifenthrin has moderate acute oral toxicity but low dermal toxicity. The reported median lethality value ($LD_{50}$) in mammals ranges from 53.8 to 70.1 mg/kg. Bifenthrin is not considered to be a dermal sensitizer or an eye or skin irritant (Wassell et al. 2008). Acute effects of the formulation appear to be similar or less than the technical active ingredient, based on available data on the safety data sheet. Bifenthrin is not considered a reproductive or developmental toxicant; however, it is considered a potential carcinogen, based on the formation of urinary bladder tumors when administered at high doses to mice. Risk to ground and surface drinking water resources are not expected to be significant for the proposed use pattern, based on label restrictions regarding the protection of surface water and the environmental fate properties for bifenthrin that demonstrate low solubility and a high affinity for binding to soil. The Program follows the label’s application buffer requirements and imposes a minimum 50-foot application buffer from water resources.

*Ecological Resources*

Bifenthrin has low to slight toxicity to birds, and moderate acute toxicity to wild mammals. Significant exposure and risk to nontarget terrestrial vertebrates are expected to be minimal due to its toxicity profile and the fact that applications are restricted to larval breeding sites, greenwaste piles, mulch, compost, soil and turf suspected to have CRB larvae where sensitive nontarget organisms may occur but are not solely found in the treatment area. Impacts to terrestrial invertebrate populations in the environment surrounding the treatment area from bifenthrin treatments are not anticipated as treatments are confined to areas where CRB larvae are suspected. Any incidental contact by terrestrial invertebrates could result in toxicity because pyrethroid insecticides are toxic to most terrestrial invertebrates. Bifenthrin is considered highly toxic to honey bees by oral and contact exposure. Honey bees may not be attracted to CRB breeding sites, greenwaste, mulch, compost and soil, but may be attracted to flowering weeds growing in turf.

Similar to other pyrethroid insecticides, bifenthrin is considered highly toxic to fish and aquatic invertebrates. Toxicity values for both groups of organisms range from the low parts per trillion (ppt) to the low parts per billion (ppb), depending on the test species and conditions (Solomon et al. 2001, Meléndez and Federoff 2010). Offsite transport of bifenthrin to aquatic habitats is not expected to occur because treatments are restricted to areas where CRB is known or expected and the Program follows the label's application buffer requirements and does not apply the product within a minimum of 50-feet of water resources. Any bifenthrin that could move offsite would not be at concentrations that could result in adverse impacts to aquatic resources. Bifenthrin binds tightly to soil and has very low solubility, reducing the potential for transport and exposure to aquatic organisms.

*Environmental Quality*

Bifenthrin impacts to soil will be localized under the current use pattern because it is applied only to larval breeding sites, greenwaste, mulch, compost, soil, and turf with suspected CRB larvae. Due to the method of application, bifenthrin is also not expected to runoff or drift from the point of application in quantities that could impact aquatic resources because treatments occur to materials in a localized area. Any bifenthrin that could move offsite would not be expected to impact surface or groundwater. Bifenthrin has extremely low solubility and mobility in soil, suggesting that it would not be a threat to ground water (Meléndez and Federoff 2010). Bifenthrin does degrade slowly in soil and sediment, based on field terrestrial and aquatic dissipation data (Gan et al. 2008, Meléndez and Federoff 2010). Dissipation half-lives range from approximately 80 days to greater than 1 year under different soil and sediment conditions. Impacts to air quality from volatilization are not expected due to the low vapor pressure for bifenthrin. The Program proposes to use a granular formulation, but may select a liquid formulation. Some bifenthrin could occur in the atmosphere during liquid application, but will be restricted to the area of treatment because applications would be made using ground sprayers with a large coarse droplet size that will minimize drift.

### Lambda Cyhalothrin

The Program proposes to use lambda-cyhalothrin as a treatment to larval breeding sites, uninfested trees and greenwaste, where applicable and registered for use.

**Lambda-cyhalothrin**

Lambda-cyhalothrin is a broad-spectrum, pyrethroid insecticide registered for use in a variety of agricultural crops as well as non-agricultural areas. It targets a susceptible insect's nervous system by disrupting sodium channels in nerve cells leading to the stoppage of feeding, loss of muscular control, paralysis, and death.

The Program proposes to use lambda-cyhalothrin through granule or liquid applications using ground-based equipment or hand casting (granular) in accordance with the label conditions.

*Human Health*

Based on acute oral, dermal, and inhalation toxicity, U.S. Environmental Protection Agency's (USEPA) Office of Pesticide Programs (OPP) classifies lambda-cyhalothrin as moderately toxic (Category II). The eye irritation data shows that it is a moderate eye irritant (Category II). Technical grade lambda-cyhalothrin is not a skin irritant (Category IV) or a skin sensitizer. Dermal exposure to lambda-cyhalothrin may cause numbness or tingling of the skin (commonly referred as paresthesia).

Symptoms of human exposure to lambda-cyhalothrin reported in USEPA's incident data system (2007–April 2010) include headache, dizziness, confusion, numbness, muscle weakness, muscle spasms, vomiting, diarrhea, abdominal pain, difficulty breathing, and burning sensations of the skin, throat, and eyes (USEPA 2010b). USEPA's recent review on human incidents and epidemiology (2017) identified numerous lambda-cyhalothrin incidents reported to the Incident Data System (2011–2016) and Sentinel Event Notification System for Occupational Risk-Pesticides (SENSOR)-Pesticides (1998–2013). Less than 1 percent of the cases were classified as having major severity, and there were no deaths reported. The majority of the incidents (96 percent in the Incident Data System and 89 percent in SENSOR-Pesticides) were of minor severity. This means that the symptoms are minimally traumatic, resolved rapidly, and usually involves skin, eye, or respiratory irritation (USEPA 2017b).

The result of a 3-generation reproduction study in rats that examined lambda-cyhalothrin toxicity showed a decrease in adult and fetal body weight at 5 mg/kg bodyweight/day (bw/day) (USEPA 2002a). There were no effects in reproductive parameters (i.e., gross signs of toxicity, the length of the estrous cycle, assays on sperm and other reproductive tissue, and the number, viability, and growth of offspring). Developmental studies evaluate the potential to cause birth defects (teratogenic effects) and other effects during development or immediately after birth. The results of the developmental studies for lambda-cyhalothrin in both rats and rabbits did not show developmental toxicity (USEPA 2002a). At doses of 10 mg/kg bw/day, there were no signs of toxicity.

USEPA classifies lambda-cyhalothrin as “not likely to be carcinogenic to humans” based on the lack of evidence of carcinogenicity in mice and rats (USEPA 2002a, USEPA 2007a). Among eight mutagenicity studies (four studies for technical lambda-cyhalothrin and four studies for technical cyhalothrin) reviewed by USEPA (USEPA 2002a), five of the studies did not indicate mutagenic activity, and three other studies for cyhalothrin were inconclusive because of issues associated with the experimental designs of the studies.

USEPA (USEPA 2002a) concludes that “There is no evidence that lambda-cyhalothrin induces any endocrine disruption.” Three studies indicate lambda-cyhalothrin may affect endocrine function. A 21-day gavage study in rats showed significant suppression of serum thyroid hormones and their ratios and significant increases in serum thyroid stimulating hormone levels (Akhtar et al. 1996). In an *in vivo* study, pregnant rats exposed to ICON® (a formulation of lambda-cyhalothrin used in Sri Lanka) resulted in increased pre-implantation losses at the two highest test concentrations, which was blocked by co-administration of progesterone (Ratnasooriya et al. 2003). A study in a breast carcinoma cell line (Zhao et al. 2008) indicated that lambda-cyhalothrin may have estrogenic activity.

Applicators make treatments with ground-based equipment or by hand if granular. Watering the granules after spreading may temporarily release aerosol droplets of lambda-cyhalothrin in the immediate treatment area, but these droplets would settle on the treatment surface. The Program would apply liquid formulations using large, course droplets to minimize aerosol dispersal. Impacts to air quality are unlikely as lambda-cyhalothrin is considered nonvolatile based on its low Henry’s Law constant and vapor pressure (He et al. 2008). Volatilization of lambda-cyhalothrin from soil occurs slowly. The amount of lambda-cyhalothrin settling on nearby foliage will be minor as application occurs via ground-based equipment directly to the treatment area.

Some formulations of lambda-cyhalothrin are restricted use due to its toxicity to fish and aquatic organisms. The Program adheres to label requirements for application buffers and imposes a minimum buffer of 50-feet from water sources. Certified applicators or people working under their supervision make the Program applications and are trained in the proper use of insecticides and PPE. As such, certified applicators are the most likely human population segment subject to exposure. The potential exposure pathway for applicators is through direct contact (i.e., incidental ingestion, inhalation, and dermal contact) during application. However, the use of label required PPE would minimize exposure to workers and applicators. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The

Program also requires their personnel to wear gloves when handling pesticides.

Exposure of the public to insecticide applications containing lambda-cyhalothrin will be minimal. The Program makes applications to CRB larval breeding sites and greenwaste as well as mulch, compost, soil and turf with suspect CRB larvae. The label instructs to keep children and pets off treated area until the area is dry. The likelihood of drift into residential areas from the ground-based application is minimal because applications are in close proximity to the targeted area. Exposure through the consumption of food is unlikely because applications are not to food crops. Label restrictions and the environmental fate properties of the chemical minimize the potential for exposure through drinking water resources. In addition, the Program imposes a minimum 50-foot buffer from water resources.

*Ecological Resources*

Available oral and dietary dosing studies suggest lambda-cyhalothrin is practically non-toxic to birds (USEPA 2015). USEPA/OPP assumes that avian toxicity is similar to reptile toxicity in their risk assessment process, even though reptile toxicity data for lambda-cyhalothrin is not available in the scientific literature.

Under this alternative, ground-based applications of lambda-cyhalothrin are made to CRB larval breeding sites, greenwaste piles, soil, compost, mulch, and turf. Based on this proposed use pattern for lambda-cyhalothrin, soil invertebrates would be the most likely non-target terrestrial invertebrates at risk of exposure.

Other non-target terrestrial species, including wild mammals, birds, and reptiles have a low probability of exposure. There is the potential for terrestrial vertebrates to forage for soil-inhabiting invertebrates leading to consumption of treated soil and soil invertebrates containing lambda-cyhalothrin residues. However, based on the typical food consumption rates for various sized mammals, birds, and reptiles, combined with the toxicity profile for lambda-cyhalothrin, there is not a plausible exposure scenario where terrestrial vertebrates would consume enough lambda-cyhalothrin residues from soil or soil-inhabiting invertebrates to result in adverse effects (USDA APHIS 2017).

Studies indicate lambda-cyhalothrin is highly toxic to pollinators, and in particular, honeybees (USDA APHIS 2017). However, the application of lambda-cyhalothrin is not to flowering parts of host plants, making direct exposure negligible to pollinators. Turf may have flowering weeds, which pollinators may visit but the Program would adhere to the label's instructions not to make applications during bee activity. However, after the Program spreads treated material on lawns and fields, pollinators may return to forage on flowering weeds. Lambda-cyhalothrin is not systemic in terrestrial plants.

Applications would not result in detectable levels of lambda-cyhalothrin in pollen and nectar (USDA APHIS 2017). Program personnel are unlikely to disturb ground nesting or solitary miner bees when applying the insecticide because they can see the entrances and active bees in an area.

Terrestrial phytotoxicity data does not appear to be available for lambda-cyhalothrin. The mode of action for lambda-cyhalothrin suggests that phytotoxicity would be low. Lambda-cyhalothrin has a variety of agriculture and non-agricultural uses and there is no information from those uses that would demonstrate impacts to plants.

Toxicity studies indicate lambda-cyhalothrin is very highly toxic to aquatic vertebrates and invertebrates. Representative toxicity data for warm water and cold-water fish species show typical median lethality values ranging from the low part per billion to less than a part per billion (USDA FS 2010, Kumar et al. 2011, USEPA 2015). Aquatic invertebrates show greater comparative sensitivity with median lethality values in the low part per trillion range for most test species. Chronic toxicity to fish was also reported to be high in an early life stage study using the sheepshead minnow (*Cyprinodon variegatus variegatus*), and in a fish full life cycle study using the fathead minnow (USDA FS 2010). During a 21-day reproductive study, chronic toxicity was also high with a reported NOEC of 0.002 microgram (µg)/L for the freshwater cladoceran, *Daphnia magna* (Maund et al. 1998).

Lambda-cyhalothrin strongly adsorbs to soil and becomes unavailable for uptake by the roots of vascular plants (ATSDR 2003). However, the roots of aquatic macrophytes can take up lambda-cyhalothrin in water and translocate the chemical throughout their plant biomass. The uptake rates of various macrophytes are species specific.

The Program's use pattern and label restrictions reduce the likelihood of lambda-cyhalothrin entering waterbodies. In addition, the Program imposes a minimum 50-foot application buffer to reduce exposure risk of water resources. The low probability of exposure of aquatic vertebrates, invertebrates, and plants to lambda-cyhalothrin results in low risk to aquatic species.

*Environmental Quality*

Impacts to water quality are unlikely from treatments using lambda-cyhalothrin based on the proposed use pattern under this alternative and label restrictions designed to protect water quality. The application of granules through ground-based spreader reduces the chance of any significant drift from these applications, and the environmental fate and label restrictions will reduce the likelihood of runoff. Lambda-cyhalothrin has low water solubility and a high binding affinity for soil and sediment (not mobile in soil), and these properties reduce the potential for significant runoff (Laabs et al. 2000). Material that is not bound to soil or organic matter will preferentially bind to sediment once it enters water, reducing the bioavailability and risk to most non-target aquatic species. The Program follows the label's application buffer requirements and imposes a minimum 50-foot application buffer from water resources. Application buffers have been shown to be beneficial for reducing runoff of pesticides, including lambda-cyhalothrin (Moore et al. 2001, He et al. 2008).

Applications will affect soil in the immediate treatment area. Lambda-cyhalothrin has a high binding affinity for soil and is not mobile (Laabs et al. 2000), indicating it will remain in the treated area and not move offsite. Lambda-cyhalothrin is moderately persistent in soil. A representative soil half-life for lambda-cyhalothrin is 30 days with values ranging from 28-84 days (NPIC 2001). A 28-day leaching study showed that a majority of the lambda-cyhalothrin residues were recovered within the top 15 cm of the soil where the top 10-cm soil layer contained 50 percent clay and 26.3 grams (g)/kg organic carbon (Laabs et al. 2000).

Lambda-cyhalothrin degrades in the environment through a combination of biotic and abiotic mechanisms (photolysis, hydrolysis, and microbial biodegradation) (USEPA 2007a, He et al. 2008).

### *Imidacloprid + Beta Cyfluthrin*

The Program is considering the use of imidacloprid with beta cyfluthrin. An example formulation is the Bayer Complete Insect Killer Granules that contains pre-mixed beta cyfluthrin (0.05%) and imidacloprid (0.15%). This formulation is not considered a skin sensitizer, and has a low risk as a skin and eye irritant. Another example formulation is one of the Bayer Temprid formulations that contain 10.5% beta-cyfluthrin and 21% imidacloprid.

#### Beta-cyfluthrin

Cyfluthrin is a synthetic pyrethroid insecticide with broad-spectrum activity. The mode of toxic action occurs by causing the sodium channels to stimulate nerves to produce repetitive discharges. Muscle contractions are sustained until a block of the contractions occurs. Nerve paralysis can occur at high levels of exposure (Walker and Keith 1992).

*Human Health*

The acute oral median lethal toxicity of cyfluthrin is considered low to moderate in mammals. Inhalation and acute dermal toxicity are considered low. The formulation of cyfluthrin to be used in the program is of comparable or lower acute toxicity than the active ingredient. The program applications pose no evident dermal irritation or sensitization, but may result in mild eye irritation.

An acute neurotoxicity study using the rat resulted in a decrease in motor activity at 10 mg/kg/day with a resulting NOEL of 2 mg/kg/day. Based on this study, the acute reference dose (RfD) was set at 0.02 mg/kg/day (USEPA 2005a). Cyfluthrin is rapidly absorbed and largely excreted as conjugated (joined) metabolites within 48 hours. RfD is "an estimate of daily oral exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA Risk Assessment Glossary, http://www.epa.gov/risk_assessment/glossary.htm).

Chronic studies of oral exposures were found to have a NOEL of 2.5 mg/kg/day and a lowest observed effect level (LOEL) of 6.2 mg/kg/day based upon decreased body weights and other effects. Uncertainty factors were applied to the NOEL to determine a chronic RfD for cyfluthrin of 0.025 mg/kg/day (USEPA 1997). An acute RfD of 0.02 mg/kg/day was determined based upon a rat neurotoxicity study (USEPA 2005a). Reproductive and developmental toxicity studies in rats found a maternal NOEL of 3 mg/kg/day, and a developmental NOEL of 10 mg/kg/day. Cyfluthrin is not considered to be a mutagenic or carcinogenic risk (USEPA 1997).

Cyfluthrin will be applied as a topical granular treatment to CRB larval sites, greenwaste piles, soil, compost, mulch and turf. The potential exposure to applicators was determined to be two to four orders of magnitude lower than the RfD, so there is minimal risk for workers (USDA APHIS 2008). Ingestion of plant material is not an exposure scenario. Ingestion of contaminated drinking water was an exposure scenario analyzed for the use of cyfluthrin. All calculated risks for children and adults indicate minimal risk to the public (USDA APHIS 2008).

*Ecological Resources*

The acute oral median lethal toxicity of cyfluthrin is considered low to moderate for mammals. Inhalation and acute dermal toxicity are considered low. The formulation of cyfluthrin to be used in the program is of comparable or lower toxicity than the active ingredient.

Cyfluthrin is considered practically nontoxic to birds with acute oral median lethal toxicity values greater than 2,000 mg/kg (USEPA 2015).

Mammals, birds, and other wildlife that may forage for invertebrate prey will have other available food items from areas that have not been treated. Terrestrial invertebrates are expected to recolonize areas after treatment. Direct risk to wild mammals and birds that may feed on contaminated prey is expected to be low based on the use pattern, the available toxicity data, and conservative estimates of residues that can occur on prey items. There is the potential for indirect risk to terrestrial vertebrates that depend on insects as a food source. Cyfluthrin is expected to impact some nontarget terrestrial invertebrates, resulting in a temporary depression in invertebrate populations in the treated area. The potential for indirect impacts will be greater in larger treatment areas due to the larger area of application relative to the foraging range for small mammals and birds; however, their ability to forage outside the treatment range and the recovery of invertebrate populations will help to minimize the potential for these types of impacts. In addition, the Program treatment areas typically are not large.

The broad-spectrum activity of cyfluthrin results in high toxicity to most insects, including pollinators. Pollinators would be attracted to plants flowering in turf but the other treatment areas, e.g., larval breeding sites, greenwaste piles, mulch, compost and soil, are unlikely to attract pollinators. The 48-hour contact median lethal dose for honey bees is 0.037 μg/bee (USEPA 2015). Adherence to cyfluthrin label requirements regarding the protection of honey bees will reduce exposure and risk to honey bees and other pollinators.

Cyfluthrin is highly toxic to fish and very highly toxic to most aquatic invertebrates (USEPA 2015). The greatest risk to aquatic resources is through drift from cyfluthrin applications. Cyfluthrin runoff is not expected to be significant to aquatic resources because this type of insecticide binds tightly to soil and has very low solubility, thereby reducing the potential for transport and exposure to most aquatic organisms. Off-site transport from drift to aquatic resources is minimized with ground-based equipment and adherence to application buffers. The Program follows label instructions for application buffers and follows a minimum buffer of 50-ft from water resources.

*Environmental Quality*

Cyfluthrin impacts to soil, water, and air quality are expected to be minimal based on the environmental fate, label requirements for application and the Program’s minimum 50-foot application buffer. Cyfluthrin half-lives in soil are variable depending on pH and organic matter. Laboratory and field dissipation half-lives range from approximately 30 to 94 days. Once cyfluthrin reaches the soil, it binds very tightly to soil particles and is not considered to be water-soluble. The high affinity for soil and low solubility suggest that any cyfluthrin that reaches an aquatic resource will be soil bound or partition very rapidly to the sediment. The lack of mobility suggests that ground water contamination will not be a concern. Surface water quality could be impacted from drift during applications; however, several mitigation measures are stated on the label to protect surface water quality. Cyfluthrin will only occur in the atmosphere during application; however, it will dissipate rapidly and is not expected to volatilize back into the atmosphere, based on its chemical properties.

## Imidacloprid

The Program proposes to use imidacloprid in three formulations and two use patterns: as a premix with beta-cyfluthrin or premix with zeta-cypermethrin and bifenthrin for a ground-based granular or liquid application and as a single active ingredient in a liquid formulation in trunk injections (discussed later in this assessment). Imidacloprid is registered for use on a wide variety of agricultural commodities as well as in horticultural and turf applications and for animal health. Imidacloprid controls a variety of insects including sucking insects such as psyllids, aphids, thrips, whiteflies, rice hoppers, turf and soil insects, and some beetles.

Its mode of action involves disruption of an insect's central nervous system by binding agonistically to the post-synaptic nicotinic acetylcholine receptors, thereby competing with the natural neurotransmitter acetylcholine (Simon-Delso et al. 2015). This long-lasting receptor binding has delayed lethal effects such that repeated or chronic exposure can lead to cumulative effects over time (Simon-Delso et al. 2015).

*Human Health*

Imidacloprid belongs to a class of insecticides called neonicotinoids that act by binding directly to the acetylcholine binding receptor. Multiple acute toxicity studies have been conducted using imidacloprid on several mammalian species. These studies along with other available data have been summarized in several reports (USDA FS 2005, USEPA 2005b, CA DPR 2006, USEPA 2010a). Acute oral median lethal toxicity values range from 131 mg/kg for the mouse to 475 mg/kg for the rat, suggesting moderate acute toxicity to mammals. Inhalation and dermal toxicity is considered low for imidacloprid with $LC_{50}$ and $LD_{50}$ values greater than 5.33 mg/L and 2,000 mg/kg, respectively. Acute oral and inhalation sublethal effects have been measured in the rat and mouse with oral no observable effect levels (NOEL) ranging from 10 to 50 mg/kg/day and inhalation NOELs ranging from 3.4 to 192 mg/kg/day (CA DPR 2006). Sublethal impacts noted in these studies were apathy, labored breathing, trembling and staggering gait. The NOEL reported in the two-year rat study was used by USEPA/OPP to set the chronic RfD of 0.057 mg/kd/day (USEPA 2010a).

There is no evidence of carcinogenic potential in the rat and mouse carcinogenicity studies, and there is no concern for mutagenicity. Based on studies with rats and mice, the USEPA has classified imidacloprid into Group E, no evidence of carcinogenicity (USEPA 2005b, USEPA 2013). Imidacloprid is not considered mutagenic or genotoxic based on the weight of evidence from several in vitro and in vivo studies. A literature search did not identify any study indicating the potential of imidacloprid to affect the endocrine system. A literature review of earlier studies indicates that imidacloprid does not have a direct effect on the immune system in mammals (USDA FS 2005). Recent studies suggest that exposure to imidacloprid may induce immunotoxicity (Mohany et al. 2011, Badgujar et al. 2013, Gawade et al. 2013).

Potential risks to human health are restricted, primarily, to applicators. As proposed in this Program, the use of granular formulations will minimize oral, dermal, and inhalation exposure during application. Adherence to label language regarding personal protective equipment and the low oral, dermal, and inhalation toxicity of this formulation will minimize risk to workers who would be making applications. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides. Imidacloprid does have chemical properties that suggest it could be a threat to groundwater. Avoiding applications in areas where a high water table is present and soils that are highly permeable will reduce the potential for groundwater contamination.

*Ecological Resources*

The acute toxicity of neonicotinoids to mammals, fish, and birds generally is lower than other insecticides, but extremely low water concentrations (below 1μg/L) can induce short-term lethal effects to some sensitive crustaceans (Branchiopoda) and insects, such as mayflies (Ephemeroptera), caddisflies (Trichoptera), and midges (Diptera) (Morrissey et al. 2015).

Imidacloprid has moderate acute oral toxicity to wild mammals based on the available toxicity data used to evaluate human health effects. Imidacloprid is considered toxic to birds with acute oral median toxicity values ranging from 41 to 152 mg/kg (USDA FS 2005, USEPA 2015).

No acute or chronic toxicity data appears to be available for reptiles or terrestrial phase amphibians based on a review of the literature and databases containing toxicity data for imidacloprid. Available data for the aquatic phase of amphibians demonstrates low toxicity and is comparable to the data for surrogate fish species. In cases where effects data are lacking for reptiles USEPA assumes that the sensitivity is comparable to birds which would suggest that imidacloprid is toxic to reptiles. There is uncertainty in that assumption due to physiological and life history differences between birds and reptiles.

Imidacloprid acute toxicity to fish and amphibians is low based on the available acute median lethal concentrations (Feng et al. 2004, USDA FS 2005, Jemec et al. 2007, USEPA 2015). Sublethal toxicity based on available NOEC data ranges from 25 to 58 mg/L for fish with effects such as erratic swimming behavior, discoloration, quiescence and labored respiration noted at higher concentrations (USDA FS 2005).

Sublethal effects have also been observed for various aquatic invertebrates under acute and chronic exposures. Agatz et al. (2014) reported feeding inhibition for *Gammarus pulex* in four-day exposures to imidacloprid residues as low as 30 µg/L. Agatz et al. (2013) reported similar effects to the cladoceran, *D. magna*, where 50% reductions in feeding occurred at an exposure concentration of 1.83 mg/L.

Exposure to wild mammals and birds from granular applications of imidacloprid and associated residues is not expected to occur at levels that could result in significant risk. The terrestrial insects that inhabit areas that have been treated with these applications are likely to be impacted, but the effects would be restricted to the areas of treatment. The toxicity of imidacloprid to pollinators is covered below under tree injection treatments with imidacloprid. Indirect impacts to vertebrate populations that depend on insect prey are not anticipated. Areas treated would be expected to have some impacts to nontarget terrestrial invertebrates; however, the impacts would be restricted primarily to areas of treatment. Vertebrates that might forage in these areas would also forage outside of the treatment area since their foraging range would not be restricted to the treatment areas.

Drift is not considered a significant route of exposure because the formulation proposed for use is granules. Runoff could occur and would be greatest for the proposed use on soil and turf. Conservative estimates of potential residues that could runoff from the proposed applications are not expected to have any direct impacts to aquatic vertebrate populations. In addition, the Program adheres to label requirements to avoid water resources and follows a 50-ft minimum no application buffer zone. Indirect risk through the loss of aquatic prey items is also not anticipated based on the potential range of concentrations and toxicity data for aquatic invertebrates.

*Environmental Quality*

Neonicotinoid insecticides exhibit high water solubility and low soil adsorption, leading to movement of these chemicals in runoff and long half-lives in soil and water, even though individual metabolites may be shorter-lived and the presence of decreased pH and low turbidity can reduce chemical persistence (Morrissey et al. 2015). In addition to agricultural factors such as the application rate, non-agricultural factors that affect soil persistence – and therefore the likelihood of movement into waters – include temperature, presence of plant cover, soil type, and organic content at the site. There are reports of measurable and ecotoxicologically relevant concentrations of imidacloprid stable in water for more than one year (Morrissey et al. 2015).

Based on the chemical properties of imidacloprid, there is the potential for leaching into groundwater resources. Adherence to label requirements, as well as the avoidance of applications to permeable soils and/or areas where the water table is high will ensure the protection of groundwater. Imidacloprid is not expected to impact air quality because the method of application (granule formulation) will not result in significant drift. Volatilization to the atmosphere is also not anticipated, based on the chemical properties of imidacloprid.

## Insecticides used in trunk injections

### *Imidacloprid*

The Program proposes to use imidacloprid in trunk injections, using the IMA-jet formulation containing 5.0% imidacloprid (Arborjet, Inc.). The application and dose rate is based on the diameter of the tree at 54 inches from the ground (Arborjet 2017). Imidacloprid is a systemic neonicotinoid insecticide and is translocated upward throughout the plant. Insects must feed on the treated host plant or tree to be exposed to a dose, which kills them, but the presence of the chemical only within the plant simultaneously minimizes exposure of non-target organisms. Imidacloprid treatments do not ensure complete control of CRB on a tree due to variability in treatments, weather conditions, and tree health, all of which can result in uneven distribution of imidacloprid within a tree.

*Human Health*

Information on imidacloprid's human health impacts and toxicity was covered above for the use of imidacloprid to treat CRB larval breeding sites, greenwaste, soil, compost, mulch, and turf.

Based on the expected use pattern for imidacloprid application (trunk injection), applicators and workers in the program who are mixing and applying the insecticide in the field are the most likely subgroup of the human population to be exposed to imidacloprid. Exposure during transportation is not anticipated because the container of the concentrated material is sealed. Following label directions including the use of proper personal protective equipment (PPE) will minimize exposure to workers. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides. Accidental exposure may occur during application. Under an accidental spill scenario, workers may be exposed to imidacloprid through dermal contact. However, the potential dermal contact exposure is anticipated to be limited because these accidental events would be of low frequency and short duration.

In addition to worker exposure there is the possibility of exposure to the general public in areas during and after treatment. Generally, exposure to the general public during treatment is not expected based on the method of application (trunk injection). Exposure can be minimized through proper notification prior to treatment. Therefore, a significant exposure pathway is not identified for direct contact to imidacloprid for the general public. A significant exposure pathway is not identified for dietary plant consumption because treated trees will not have products harvested for human consumption. There is the potential for children and adults to be exposed to residual imidacloprid in leaf litter. Environmental monitoring data indicates that imidacloprid can persist in treated trees for at least 12 months after treatment. Chemical uptake occurs throughout the tree with higher residues detected in leaf samples than twig samples for most species of trees sampled (USDA APHIS 2002).

A significant exposure pathway is not identified for groundwater or surface water media under the trunk injection use pattern. Imidacloprid is soluble and has the potential to leach from soil to groundwater. Groundwater sampling between 2003 and 2006 in Suffolk County, New York, where trunk and soil applications were made to trees to eradicate the Asian longhorned beetle (ALB), demonstrated that approximately half of the water samples had no detectable levels of imidacloprid. Of those where detections occurred, the average concentration was 3.2 parts per billion (ppb) which is below the level of concern for human health (USDA APHIS 2007). Samples with detectable levels of imidacloprid do not suggest a contribution from the ALB eradication program because other uses of imidacloprid occurred in these areas, and there did not appear to be a significant correlation between ALB-related treatment activities and increased residues (USDA APHIS 2013). The CRB response program would not use soil applications. Significant surface runoff into aquatic resources is not expected based on the trunk injection use pattern (USDA FS 2005). In addition, the Program follows a minimum 50-ft application buffer from water resources.

*Ecological Resources*

The ecological toxicity and risk information was covered above for the use of imidacloprid to treat CRB larval breeding sites, greenwaste, soil, mulch, compost, and turf.

Drift of imidacloprid into sensitive aquatic habitats and impacts to air quality are not expected based on the direct application to tree trunks, which minimizes the potential for off-site transport. Imidacloprid residues in trees depend on a range of environmental factors and type of tree. Residues of imidacloprid in hemlock trees treated for hemlock wooly adelgid were detectible in foliage over 3 years post treatment (Cowles et al. 2006). There may be an environmentally important concentration of imidacloprid remaining in the leaves that drop in the autumn, are carried to water resources, and serve as a source of chemical leachate from the leaves (exposure) or are consumed (dietary) by aquatic organisms such as detritivorous macroinvertebrates (shredders) (Englert et al. 2017). Sublethal impacts to some aquatic invertebrates that feed on leaf litter containing imidacloprid have been observed, as well as effects on decomposition rates (Kreutzweiser et al. 2007, Kreutzweiser et al. 2008, Kreutzweiser et al. 2009). Mortality to leaf-shredding insects occurred at higher rates that were intentionally overdosed; however, significant mortality did not occur to shredding insects such as *Pternarcys dorsata* and *Tipula* sp. at typical field applications. Feeding inhibition was observed at imidacloprid leaf concentrations of 18-30 µg/g, which have been observed in the field under normal applications (Kreutzweiser et al. 2009). The program's treatment of only palm trees with high economic value effectively reduces the number of insecticide-bearing leaves that could follow this pathway. In addition, the Program follows a minimum 50-foot application buffer from water resources.

Aquatic plant studies testing technical and formulated material on blue green algae, freshwater diatoms, and green algae have demonstrated low toxicity (USDA FS 2005, USEPA 2015). No impacts to treated terrestrial plants have been noted in forestry or agricultural settings (Westwood et al. 1998, USDA FS 2005).

Exposure and risk to aquatic organisms will be minimized by adherence to label requirements regarding applications near water and the Program's minimum 50-ft application buffer. Risk is expected to be minimal to fish, with an increased risk to some sensitive aquatic invertebrates in very shallow water bodies immediately adjacent to treated trees. Ecological risks for terrestrial and aquatic non-target organisms also are expected to be low based on the method of application, toxicity, and environmental fate of imidacloprid.

There is some risk to sensitive terrestrial invertebrates that consume vegetation from treated trees. Terrestrial invertebrate populations may consume a wide range of host plants, which would limit the percentage of exposure through their diet. Neonicotinoid insecticide toxicity is high for honeybees yet there is uncertainty regarding the impacts of residues from this class of systemic insecticides in pollen and nectar. The main imidacloprid metabolite in plants is also toxic to honeybees and mice, while another metabolite (6-chloronicotinic acid) may induce plant defenses against plant disease or drought (Simon-Delso et al. 2015). Studies measuring pollen and nectar residues in crops with imidacloprid show sublethal effects occurring above residues measured in the field. Sublethal effects from low-level chronic exposures to neonicotinoid pesticides in bee species vary with the species' sensitivity, life cycle, foraging behaviors, and colony development (Li et al. 2016, Arce et al. 2017); however, there are significant knowledge gaps concerning the impacts of neonicotinoids on bees (Lundin et al. 2015). Chronic exposure to imidacloprid at the higher range of field doses in pollen of certain treated crops could cause negative impacts on honeybee colony health and reduced overwintering success (Dively et al. 2015). Recent data suggests bees reduce total food consumption even though they cannot taste neonicotinoids in nectar, and chronic neonicotinoid exposures may impair olfactory learning and memory in honeybees leading to reductions in foraging efficiency (Kessler et al. 2015). In general, declines in bees are due to chronic multiple interacting stressors that may act synergistically (Lundin et al. 2015, David et al. 2016, Goulson et al. 2017). Impacts to susceptible insects that feed on treated trees are expected, but due to the method of application and the treatment of specific host palm trees, the effects are expected to be localized and not widespread. In addition, the program requires flower and fruit removal from treated trees, reducing the available food source from these trees to pollinators.

Tree injections do cause wounds to the tree. However, trees regularly are wounded by biological (e.g., insect feeding, woodpeckers, etc.) and natural factors (e.g., storm damage). The wound response varies between trees based on their genetic response and health status. The Program follows the label rates and instructions on the number of injection sites. The Program only uses trunk injections on trees that are high risk and that are in healthy condition to receive treatments. The Program does not treat trees with advanced CRB damage or serious damage from other causes.

*Environmental Quality*

Neonicotinoid insecticides exhibit high water solubility and low soil adsorption, leading to movement of these chemicals in runoff and long half-lives in soil and water, even though individual metabolites may be shorter-lived and the presence of decreased pH and low turbidity can reduce chemical persistence (Morrissey et al. 2015). In addition to agricultural factors such as the application rate, non-agricultural factors that affect soil persistence – and therefore the likelihood of movement into waters – include temperature, presence of plant cover, soil type, and organic content at the site. There are reports of measurable and ecotoxicologically relevant concentrations of imidacloprid stable in water for more than one year (Morrissey et al. 2015).

Environmental fate information for imidacloprid is covered earlier in this assessment. Exposure of soil to imidacloprid is reduced with trunk injections. Soil exposure could occur if roots release the insecticide or if plant material with imidacloprid residue falls to the ground and decays, releasing the chemical.

In air, imidacloprid is expected to exist solely in the particulate phase and not expected to volatilize into the ambient atmosphere based on the low reported volatility ($3 \times 10^{-12}$ mm Hg) and Henry's Law Constant ($2 \times 10^{-15}$ atm m3/mole) (HSDB 2014). The Program uses trunk injections and air exposure is negligible for this type of application.

### *Acephate*

Acephate is an organophosphate pesticide used to control a range of pests in commercial crops, golf courses, residential landscapes, and in and around residential and commercial buildings (USEPA 2001). Acephate degrades to methamidophos, another registered organophosphate for the control of a variety of insect pests on numerous commercial crops. Acephate and methamidophos inhibits cholinesterase. The Program proposes to use acephate in trunk injections for select palm trees. The formulation is 97.4% acephate and 2.6% other ingredients packaged in 15 gram packets (Arborjet 2016). Applicators mix 100 milliliters of water per packet in the injection canister, following the dosage tables on the label, which are based on the tree's diameter (Arborjet 2016). According to the label, the maximum rates potentially applied to a tree, calculated for trees in the widest DBH group, are 324 ml/tree (ca. 48.6 g formulation) to 800 ml/tree (ca. 120 g formulation) (Arborjet 2016). Acephate has a short residual time and the effective application time is when the pest is active (Doccola and Wild 2012).

*Human Health*

Acephate is listed as Category III for acute oral toxicity, indicating it is slightly toxic. Acephate has low acute dermal and inhalation toxicity. It is non-irritating to skin and is not a skin sensitizer. It causes minimal irritation to the eyes (USEPA 2001). Methamidophos is acutely toxic at low oral, dermal, and inhalation doses (Toxicity Category 1) (USEPA 2002b). It causes moderate irritation to eyes and mild irritation to the skin (USEPA 2002b).

Acephate is unlikely to leach into ground water despite being very soluble and mobile, because it does not persist under aerobic conditions (USEPA 2001). Methamidophos does not persist in aerobic conditions but may persist in anaerobic aquatic environments (USEPA 2002b). Acephate dietary exposure through water is negligible because the Program uses trunk injections, not ground or aerial spraying or soil injection. In addition, the Program imposes a minimum application buffer of 50-ft from water resources.

The risk of acephate exposure to the public is low to negligible. The Program uses trunk injections. The Program removes flowers and fruit from trees during treatment, which removes dietary exposure. The Program continues to trim trees every six months when there is a potential for residual impact. The label instructs not to apply the product to food bearing trees or shrubs or on trees and shrubs that will bear food within one year of application (Arborjet 2016). Acephate has a short residue time, reducing dietary exposure in subsequent flowers and fruit (Doccola and Wild 2012). Applicators are at risk of exposure during mixing and application; however, label requirements specifying personal protective equipment minimizes exposure. At a minimum, the Program requires Program personnel to wear long pants and closed-toe shoes in the field. The Program also requires their personnel to wear gloves when handling pesticides.

*Ecological Resources*

Acephate has moderate acute toxicity to small mammals while methamidophos has high acute oral and dermal toxicity (USEPA 2001). The Program's use pattern reduces exposure risk to small mammals because acephate is injected directly into trees, not broadcast as a granular or topically sprayed in liquid form. Studies indicate bioaccumulation of acephate residues is not a concern (USEPA 2001).

Acephate has moderate acute toxicity to birds (oral $LD_{50}$ ranges from 51-500 mg/kg) (USEPA 2001). Subacute acephate toxicity to birds ranges from practically non-toxic to moderately toxic ($LC_{50}$ ranges from 501-1,000 ppm) (USEPA 2001). Methamidophos has high to very high acute toxicity to birds (oral $LD_{50}$ ranges from <10 to 50 mg/kg) and has subacute toxicity that is slightly toxic to very highly toxic ($LC_{50}$s ranges from <50 to 500 ppm). Chronic toxicity studies indicate adverse reproductive effects between 5 and 80 ppm using technical grade acephate (USEPA 2001). Technical grade methamidophos at 5 ppm caused a reduction in eggshell thickness in northern bobwhite quail. However, no effect occurred in mallard ducks at greater than 15 ppm. Exposure data indicate acephate has little acute risk to birds; however, methamidophos may be responsible for the high acute risk reported in studies and field observations (USEPA 2001). These exposure data are from granular broadcast and liquid applications, not from trunk injections. Acephate exposure to birds from tree injections would be reduced significantly when compared to broadcast applications. Direct exposure during application would not occur since applications are made as injections. Exposure from the consumption of contaminated insect prey would also be low since injections are specific to certain trees and other invertebrates from soil and other vegetation that haven't been treated would be available as food items.

Acephate and methamidophos has high acute contact toxicity to honey bees and beneficial insects (USEPA 2001). The Program removes fruit and flowers on trees prior to treatment, which may reduce exposure to terrestrial organisms foraging on those plant parts. The label instructs not to apply the product or allow it to drift to blooming crops or weeds while bees are actively visiting the treated area (Arborjet 2016). Drift is not expected since the Program uses trunk injection instead of topical or soil application of acephate.

Acute toxicity risks to aquatic environments from acephate and methamidophos use in the Program is minimal. Based on available toxicity data, risks to freshwater and estuarine fish is minimal. Acephate is practically nontoxic to slightly acutely toxic to fish ($LC_{50}$ ranges from 10 to 100 ppm) (USEPA 2001). Methamidophos has slight acute toxicity to freshwater fish ($LC_{50}$ ranges from 10 to 100 ppm) and moderately toxic to estuarine/marine fish ($LC_{50}$ ranges from 1 ppm to 10 ppm) (USEPA 2001). Data on chronic toxicity to freshwater fish is lacking (USEPA 2001). Acephate is practically nontoxic to freshwater amphibians (USEPA 2001). Acephate is practically non-toxic to moderately acutely toxic to freshwater and estuarine/marine invertebrates ($LC_{50}$/$EC_{50}$ ranges from 1 ppm to greater than 100 ppm) (USEPA 2001). Methamidophos is moderately acutely toxic to estuarine/marine invertebrates ($LC_{50}$/$EC_{50}$ ranges from 1 ppm to greater than 100 ppm) and very highly toxic to freshwater invertebrates ($EC_{50}$ values are less than 0.1 ppm) (USEPA 2001). Mysid shrimp have a NOAEC of 0.58 ppm acephate for mortality and a LOAEC of 1.4 ppm (USEPA 2001). The label does not permit application to water sources and the Program would not use acephate within 50 feet of a water source, both of which minimizes exposure risk to aquatic environments. Direct injection of acephate into the tree trunk also reduces environmental exposure to acephate and methamidophos through runoff and drift. Chronic risk is not expected because acephate and methamidophos degrade rapidly in the environment.

In plants, the half-life of acephate is about five to ten days (Doccola and Wild 2012). Acephate has a short residual activity in plants indicating the exposure window of organisms that feed or come in contact with treated material is short (Doccola and Wild 2012).

Tree injections do cause wounds to the tree. However, trees regularly are wounded by biological (e.g., insect feeding, woodpeckers, etc.) and natural factors (e.g., storm damage). The wound response varies between trees based on their genetic response and health status. The Program follows the label rates and instructions on the number of injection sites. The Program only uses trunk injections on trees that are high risk and that are in healthy condition to receive treatments. The Program does not treat trees with advanced CRB damage or serious damage from other causes.

*Environmental Quality*

Acephate does not persist in the soil under aerobic or anaerobic conditions (USEPA 2001). Similarly, methamidophos does not persist under aerobic conditions, but may persist in anaerobic environments (USEPA 2002b). Acephate and methamidophos are very soluble and mobile in water and soil, but because they do not persist under aerobic conditions, they are not likely to leach to groundwater (USEPA 2001). Should acephate reach groundwater, it is not expected to persist due to its short anaerobic half-life (USEPA 2001). Methamidophos photodegrades rapidly in soil but very slowly in aqueous solutions (USEPA 2002b). Translocation of acephate in a tree or plant is from the direction of the roots to the foliage, not from the foliage to the roots, which reduces potential release into the soil (IPCS 1976). Acephate's half-life in plants is about 5 to 10-days (Doccola and Wild 2012). Acephate residues peaked in foliage two weeks following injection into avocado while imidacloprid residues were not detected until 7-9 weeks following application (Morse et al. 2008). Treated plant material may fall to the ground and decompose, potentially releasing acephate and methamidophos into the soil and water. The exposure risk to non-target organisms from the release of fallen plant material is low because both chemicals generally do not persist in soil and water. Acephate is not expected to volatize from soil or water due to its vapor pressure (USEPA 2001).

# V. Other Issues

## A. Cumulative Impacts

Under NEPA, Federal agencies are required to analyze the potential cumulative impacts of a proposed action. The Council on Environmental Quality defines cumulative impacts as impacts on the environment that result from incremental impact(s) of an action when added to other past, present, and reasonably foreseeable future actions. Actions resulting in a cumulative impact may or may not be generated by the same agency. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period.

The selection of the preferred alternative described in this EA for the CRB response program is not anticipated to have a significant cumulative impact on human health or the environment. There will be an increase in insecticide loading in certain areas; however, it is anticipated that insecticide use would be less compared to permanent establishment of CRB on Oahu that could occur should APHIS and its partners not implement a response program.

Synergism of the toxicity of organophosphates and synthetic pyrethroids, such as cyfluthrin, has been shown in laboratory and field tests (Horowitz et al. 1987, Keil and Parrella 1990). Although this is possible in the program area, it is unlikely that the timing of applications of organophosphates will occur at intervals close enough to program applications of cyfluthrin to result in this effect.

Insecticide use would not be expected to have cumulative impacts to soil, air, or water quality beyond baseline conditions. The Program adheres to all restrictions on the pesticide labels. The Program's proposed use pattern, the environmental fate of the insecticides and magnesium sulfate, and the implementation of a minimum 50-foot application buffer from water resources for all insecticides and magnesium sulfate reduces exposure to nontarget species. These conclusions are based on assumptions of labeled maximum use rates for each insecticide and would hold true if efficacy work results in higher applications rates due to the wide margins of safety with current rates. The Program's insecticides and magnesium sulfate may be used on Oahu for other purposes; however, their use in areas where CRB detections would be likely to occur are expected to be minimal.

## B. Threatened and Endangered Species

Section 7 of the Endangered Species Act (ESA) and ESA's implementing regulations require Federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat. APHIS has considered the impacts of the proposed program regarding listed species on Oahu. In 2014, APHIS received concurrence from the U.S. Fish and Wildlife Service (FWS) that with the implementation of protection measures for some species, the proposed Program may affect, but is not likely to adversely affect the Hawaiian hoary bat (*Lasiurus cinereus semotus*), Hawaiian coot (*Fulica alai*), Hawaiian common moorhen (*Gallinula chloropus sandvicensis*), Hawaiian stilt (*Himantopus mexicanus knudseni*), or Hawaiian duck (*Anas wyvilliana*). APHIS received technical assistance from the FWS regarding the program actions described in this supplemental EA and determined that there would be no impacts to listed species and their designated critical habitat.

## C. Historical Preservation

Section 106 of the National Historical Preservation Act (NHPA) and 36 CFR part 800: Protection of Historic Properties requires consultation with the State Historic Preservation Office regarding the proposed activities. Consistent with the NHPA, APHIS has examined the proposed action in light of its impacts to national historical properties. APHIS has submitted a letter to the State Historic Preservation Office (SHPO) at the Historic Preservation Division in the Department of Land and Natural Resources. HDOA will continue to coordinate with the SHPO to ensure that if any historic properties occur in the proposed treatment area there will be no impacts to these properties. APHIS has also contacted all native Hawai'I organizations located on Oahu regarding the proposed Program.

## D. Executive Orders

Consistent with Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," APHIS considered the potential for disproportionately high and adverse human health or environmental effects on any minority or low-income populations. The proposed treatment block is based on CRB finds in the area. The proposed treatment itself will have minimal effects to those that live in this area, and will not have disproportionate effects to any minority or low-income population.

Consistent with EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks," APHIS considered the potential for disproportionately high or adverse environmental health and safety risks to children. The children in the proposed treatment areas are not expected to be adversely affected disproportionately more than adults from the proposed program actions. The Program follows label language to reduce human exposure and imposes application buffers to protect water resources. Notification to the public prior to the proposed insecticide treatments and the low risk of adverse impacts and exposure from insecticides used in trunk injections will ensure protection of this group of the human population. The Program would provide a 30-day notification and consult with stakeholders prior to applying insecticides in an area frequented by children.

# VI. Listing of Agencies and Persons Consulted

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

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Plant Health Programs
4700 River Road, Unit 134
Riverdale, MD 20737

USDA, APHIS, PPQ
300 Ala Moana Blvd, Rm 8-120
P.O. Box 50002
Honolulu, HI, 96850

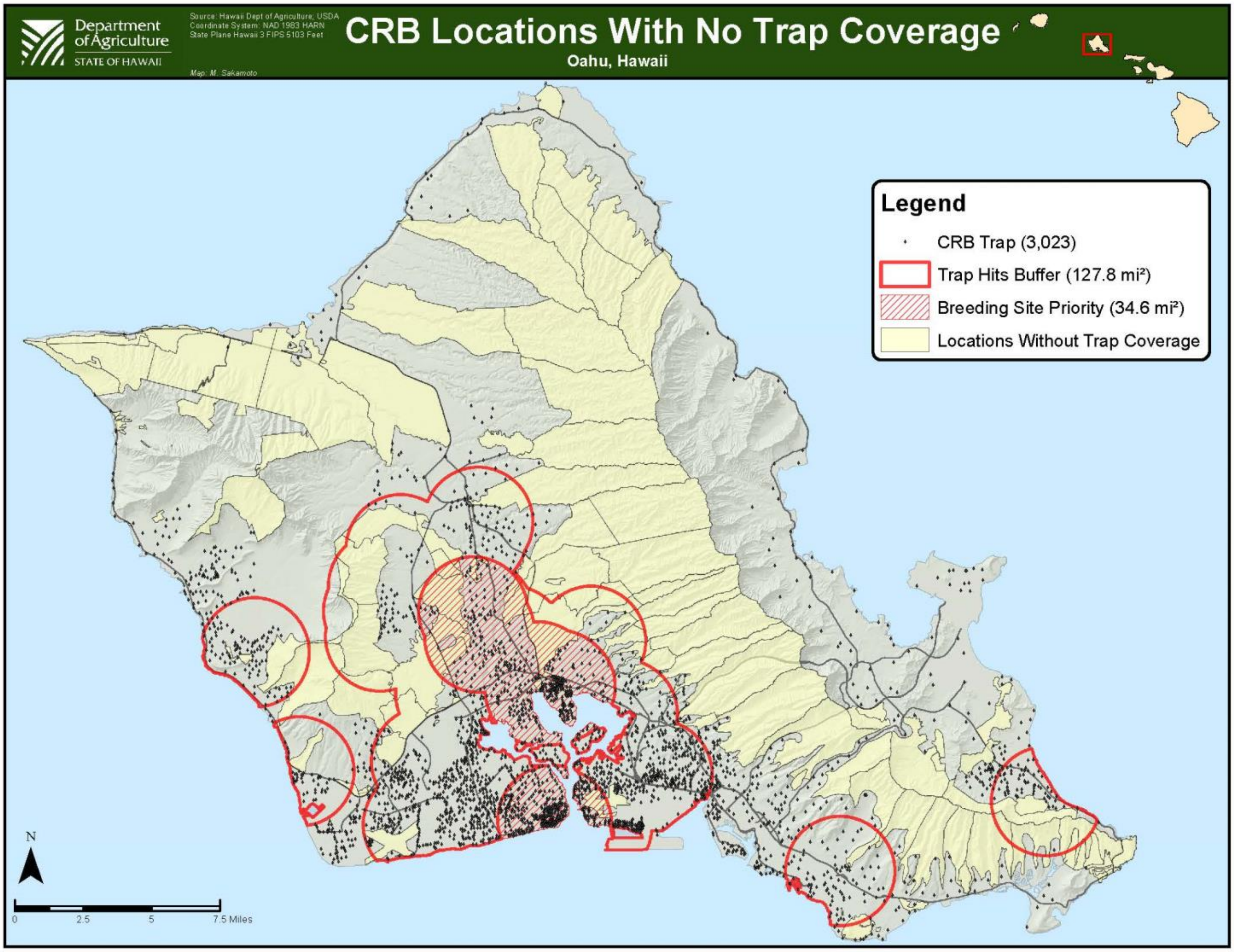
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Policy and Program Development
Environmental and Risk Analysis Services
4700 River Road, Unit 149
Riverdale, MD 20737

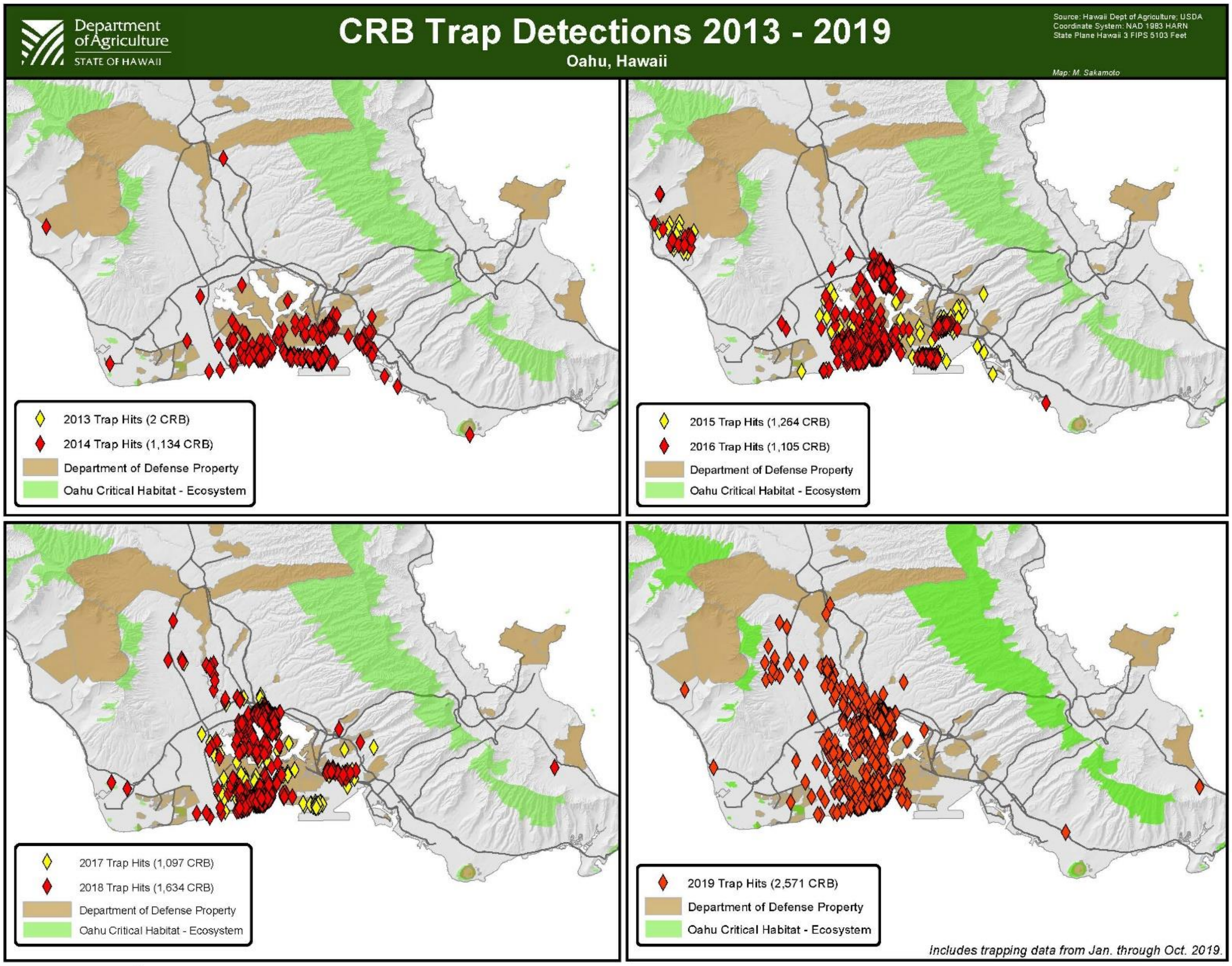
U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard
Room 3-122, Box 50088
Honolulu, HI 96850

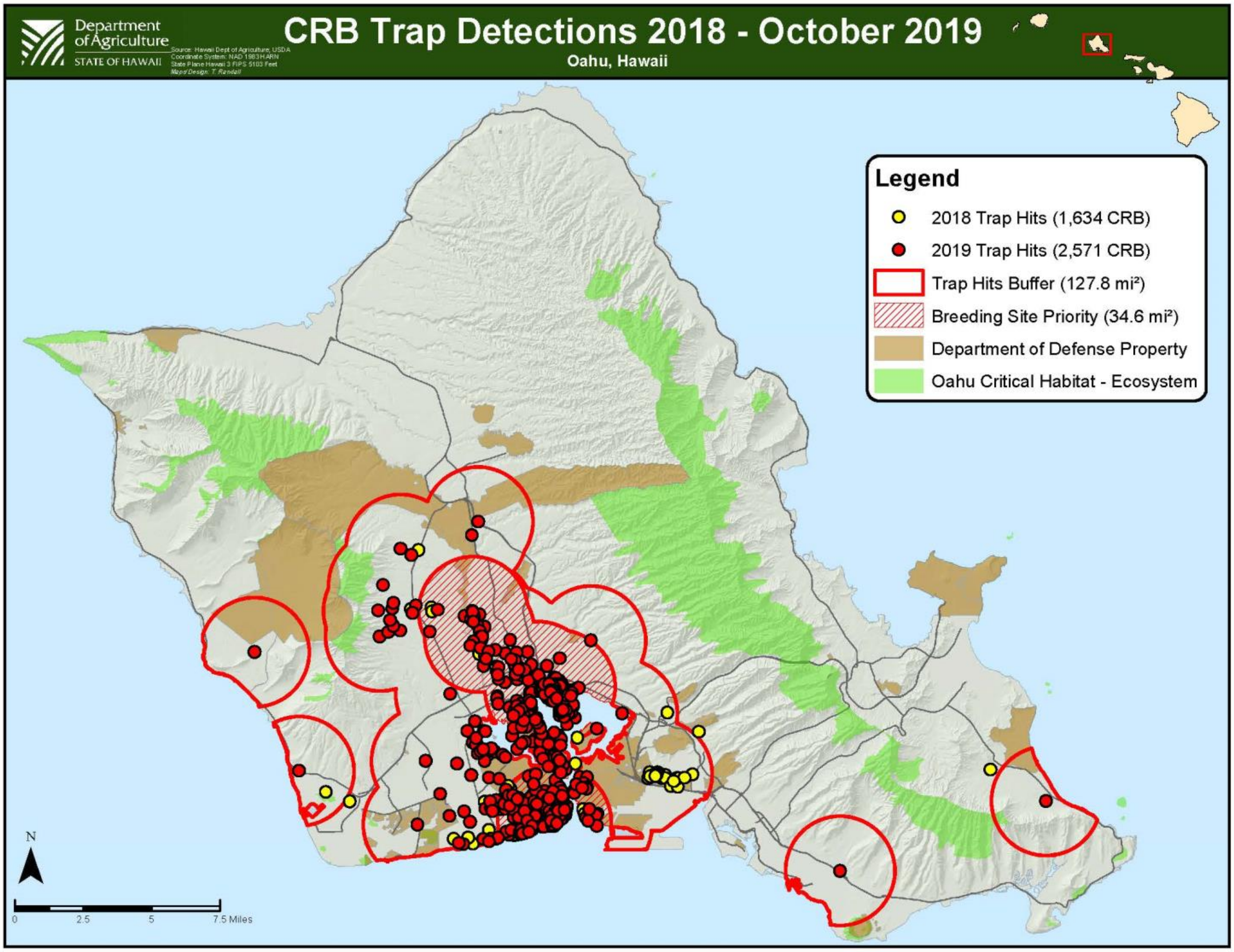
State Historic Preservation Division
Kakuhihewa Building
601 Kamokila Blvd., Suite 555
Kapolei, HI 96707

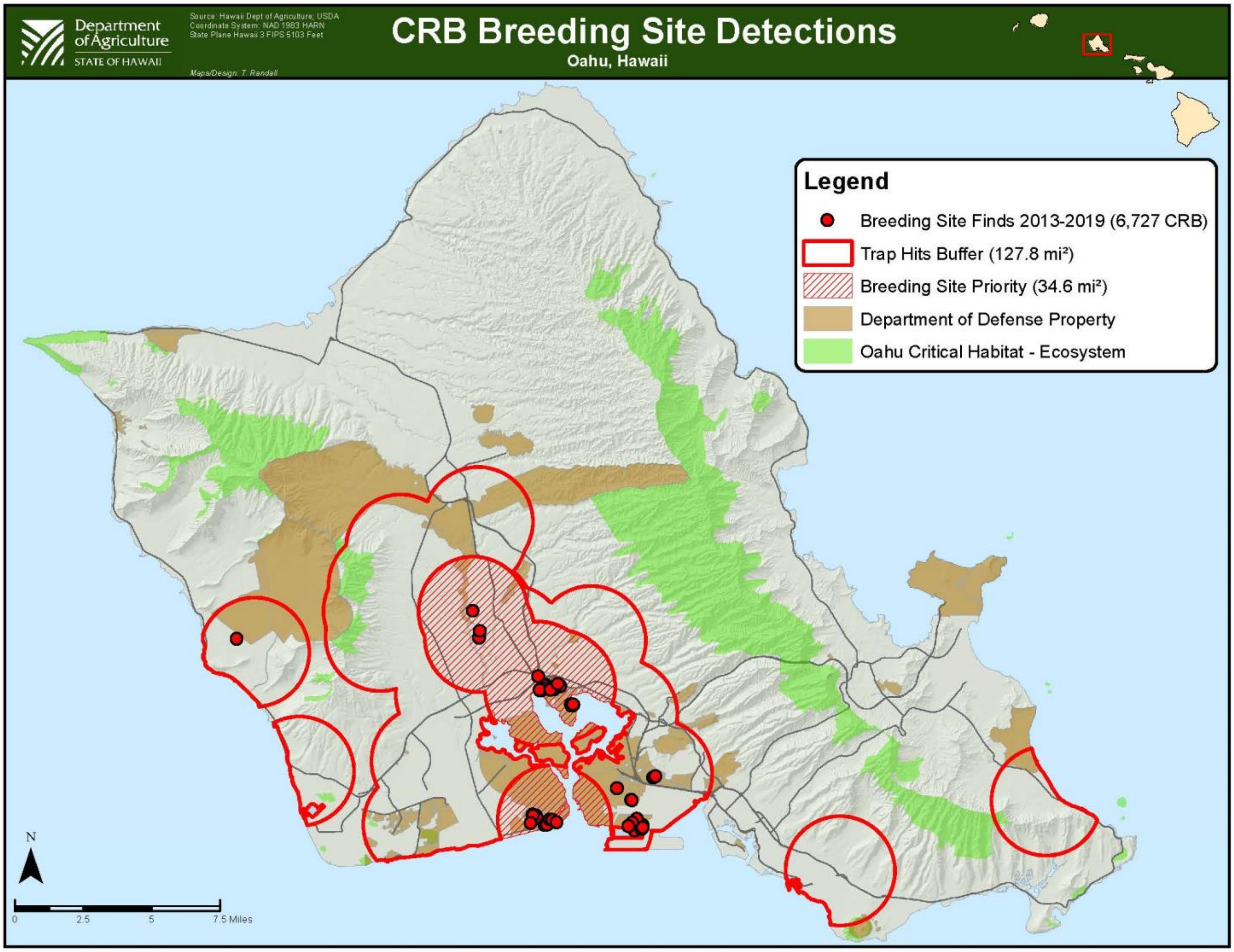
# Appendix A.  Maps of CRB Trapping and CRB Detections

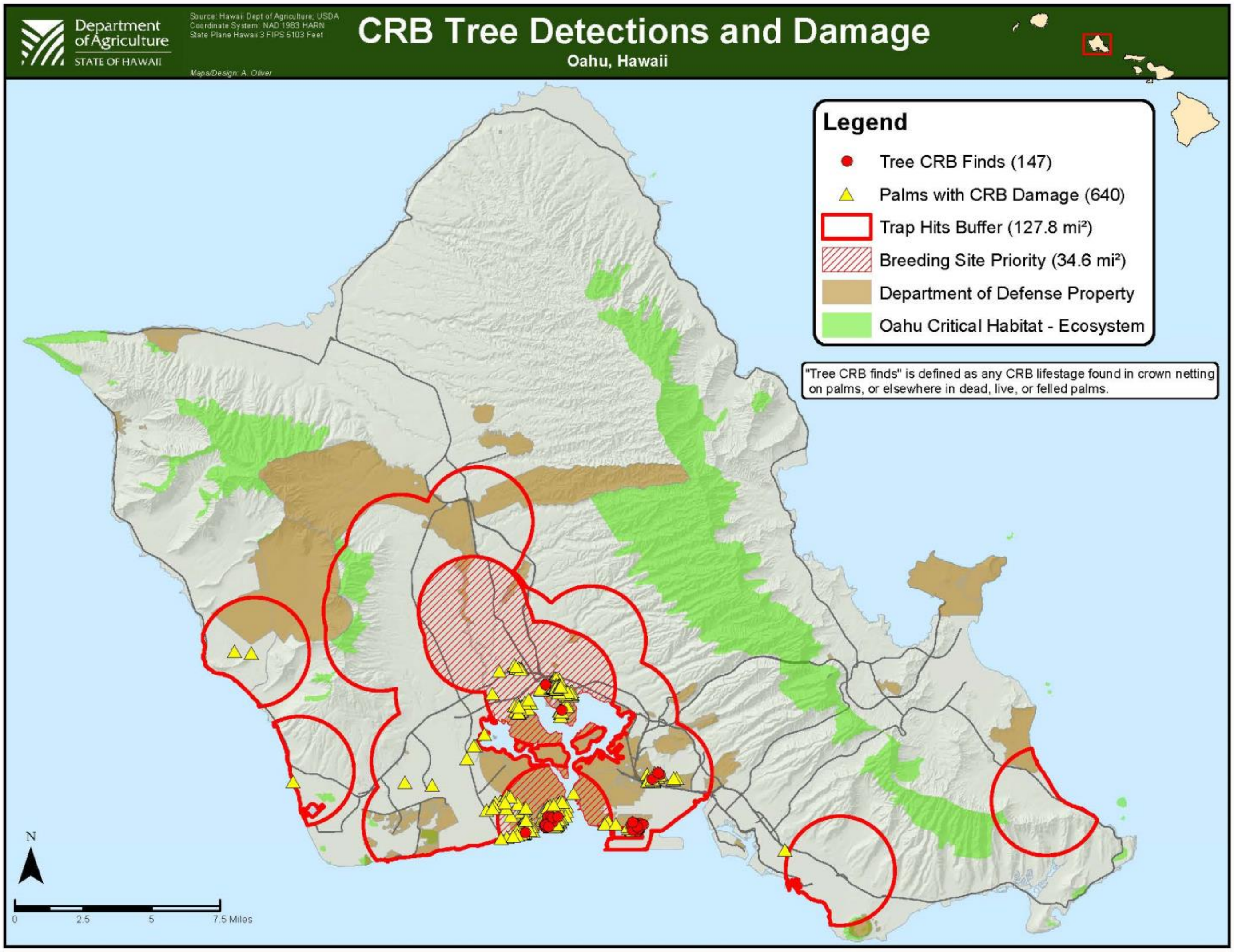
Maps prepared by HDOA (2019)

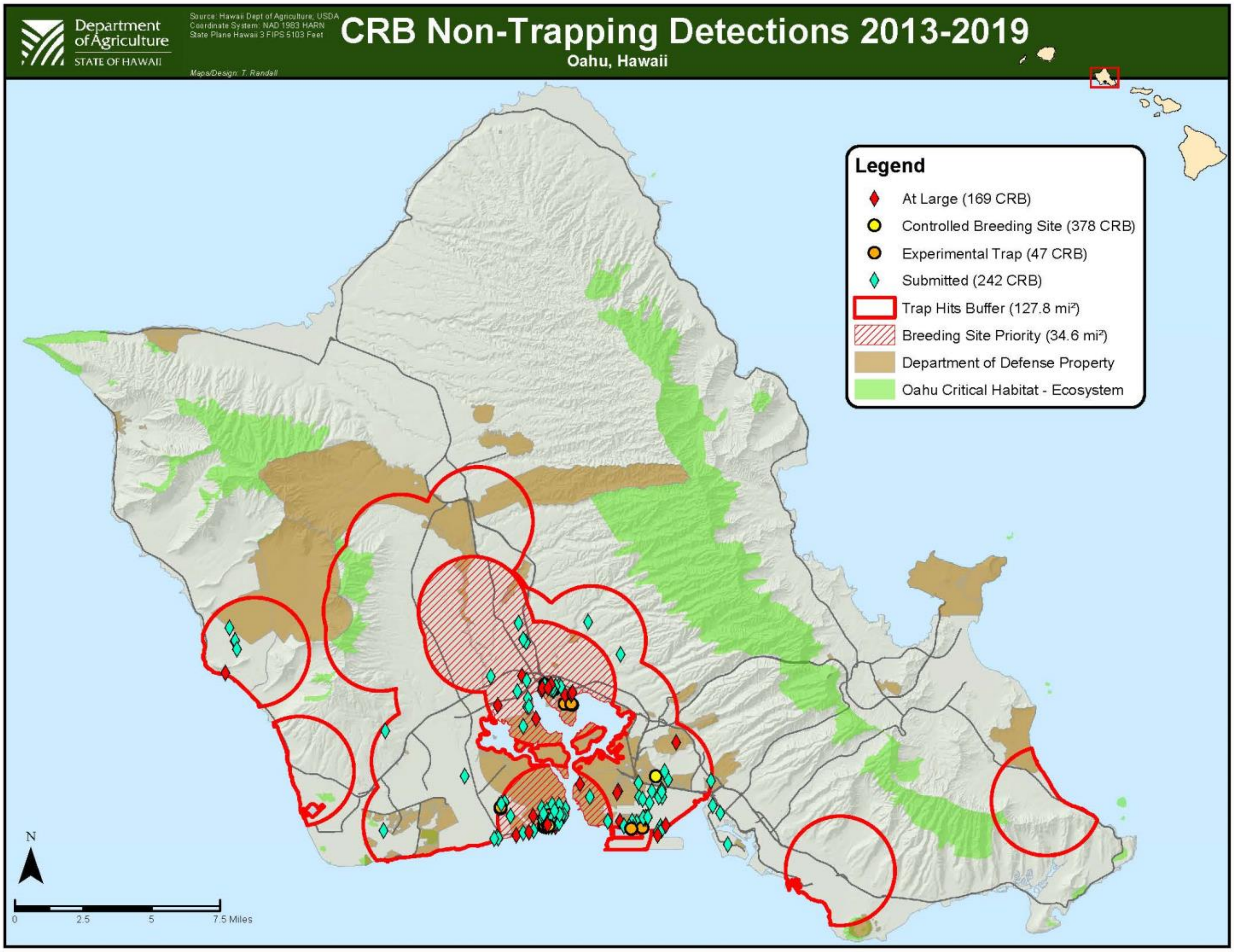



Department of Agriculture
STATE OF HAWAII
CRB Trap Detections 2013 - 2019
Oahu, Hawaii
Source: Hawaii Dept of Agriculture; USDA
Coordinate System: NAD 1983 HARN
State Plane Hawaii 3 FIPS 5103 Feet
Map: M. Sakamoto
2013 Trap Hits (2 CRB)
2014 Trap Hits (1,134 CRB)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
2015 Trap Hits (1,264 CRB)
2016 Trap Hits (1,105 CRB)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
2017 Trap Hits (1,097 CRB)
2018 Trap Hits (1,634 CRB)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
2019 Trap Hits (2,571 CRB)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
Includes trapping data from Jan. through Oct. 2019.


Department of Agriculture
STATE OF HAWAII
Source: Hawaii Dept of Agriculture; USDA
Coordinate System: NAD 1983 HARN
State Plane Hawaii 3 FIPS 5103 Feet
Map Design: T. Randall
CRB Trap Detections 2018 - October 2019
Oahu, Hawaii
Legend
2018 Trap Hits (1,634 CRB)
2019 Trap Hits (2,571 CRB)
Trap Hits Buffer (127.8 mi²)
Breeding Site Priority (34.6 mi²)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
N
0
2.5
5
7.5 Miles

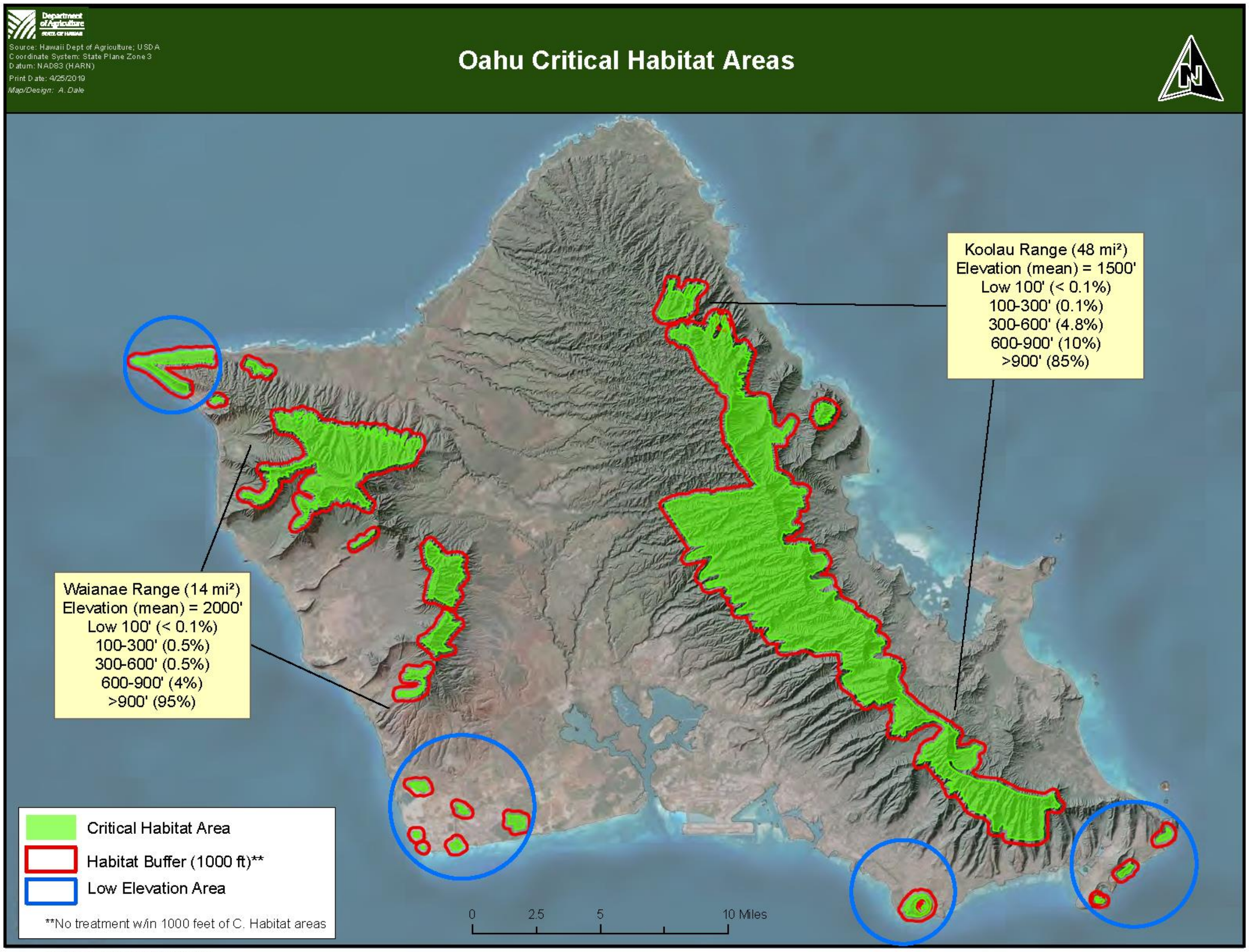

Department of Agriculture
STATE OF HAWAII
Source: Hawaii Dept of Agriculture; USDA
Coordinate System: NAD 1983 HARN
State Plane Hawaii 3 FIPS 5103 Feet
Maps/Design: T. Randall
CRB Breeding Site Detections
Oahu, Hawaii
Legend
Breeding Site Finds 2013-2019 (6,727 CRB)
Trap Hits Buffer (127.8 mi²)
Breeding Site Priority (34.6 mi²)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
N
0
2.5
5
7.5 Miles


Department of Agriculture
STATE OF HAWAII
Source: Hawaii Dept of Agriculture; USDA
Coordinate System: NAD 1983 HARN
State Plane Hawaii 3 FIPS 5103 Feet
Maps/Design: A. Oliver
CRB Tree Detections and Damage
Oahu, Hawaii
Legend
Tree CRB Finds (147)
Palms with CRB Damage (640)
Trap Hits Buffer (127.8 mi²)
Breeding Site Priority (34.6 mi²)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
"Tree CRB finds" is defined as any CRB lifestage found in crown netting on palms, or elsewhere in dead, live, or felled palms.
N
0
2.5
5
7.5 Miles


Department of Agriculture
STATE OF HAWAII
Source: Hawaii Dept of Agriculture; USDA
Coordinate System: NAD 1983 HARN
State Plane Hawaii 3 FIPS 5103 Feet
Maps/Design: T. Randall
CRB Non-Trapping Detections 2013-2019
Oahu, Hawaii
Legend
At Large (169 CRB)
Controlled Breeding Site (378 CRB)
Experimental Trap (47 CRB)
Submitted (242 CRB)
Trap Hits Buffer (127.8 mi²)
Breeding Site Priority (34.6 mi²)
Department of Defense Property
Oahu Critical Habitat - Ecosystem
N
0
2.5
5
7.5 Miles

# Appendix B. Oahu Critical Habitat Areas

Map prepared by the State of Hawaii, Department of Agriculture, 4/25/2019



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