EXHIBIT "P"

Survey of Native Invertebrate Resources in proposed HoKua Place project area

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Submitted to:
Agor Jehn Architects, LLC

For:

HG Kaua‘i Joint Venture LLC

Table of Contents

Figures

SUMMARY

This report summarizes the findings of an invertebrate[1] survey conducted within approximately 97-acre parcel, TMK (4) 4-3-003: 001 (portion) in Kapa‘a of the Kawaihau District on the island of Kaua‘i. (Figure 1, 2)

INTRODUCTION

The primary purpose of this survey was to determine the presence or absence on the property of any endemic or indigenous terrestrial invertebrates, especially any species with legal status under federal or state threatened and endangered species statutes (DLNR 1998, USFWS, 2017). Invertebrates are often the dominant fauna in natural Hawaiian environments. Native Hawaiian plant, vertebrate, and invertebrate populations are interdependent. Invertebrates are the food of some birds and the pollinators of plants. Certain insects are obligatorily attached to specific host plants and are able to use only that plant as their food. Those insect - host relationships are ancient and intertwined. Native invertebrates have proven inventive in adapting to opportunities in changed ecosystems. A surprising number of native arthropod species survive even in degraded habitats. Nevertheless, the overall health of native Hawaiian invertebrate populations depends upon habitat quality and absence or low levels of predators introduced from the continents. Sufficient food sources, host plant availability, and the absence or low levels of introduced, continental predators and parasites comprise a classic native, healthy ecosystem. Consequently, where appropriate in the survey discussion, host plants, and some introduced arthropods are also noted.

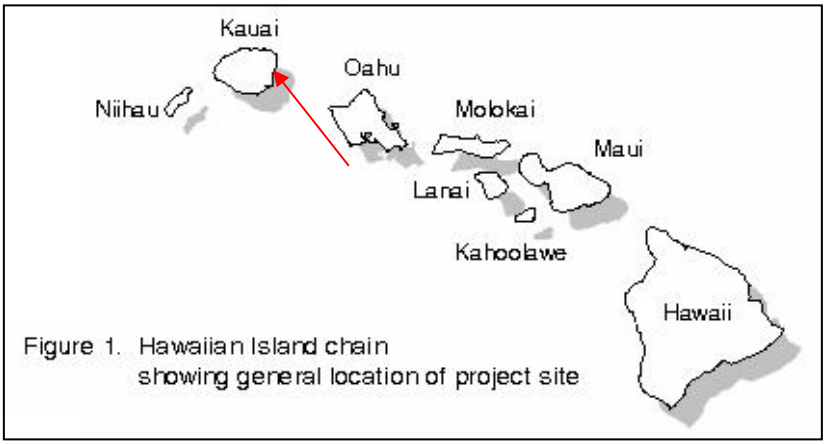

Figure 1. Hawaiian Island chain showing general location of project site

[1] Animals without backbones: insects, spiders, snails, shrimp, etc.

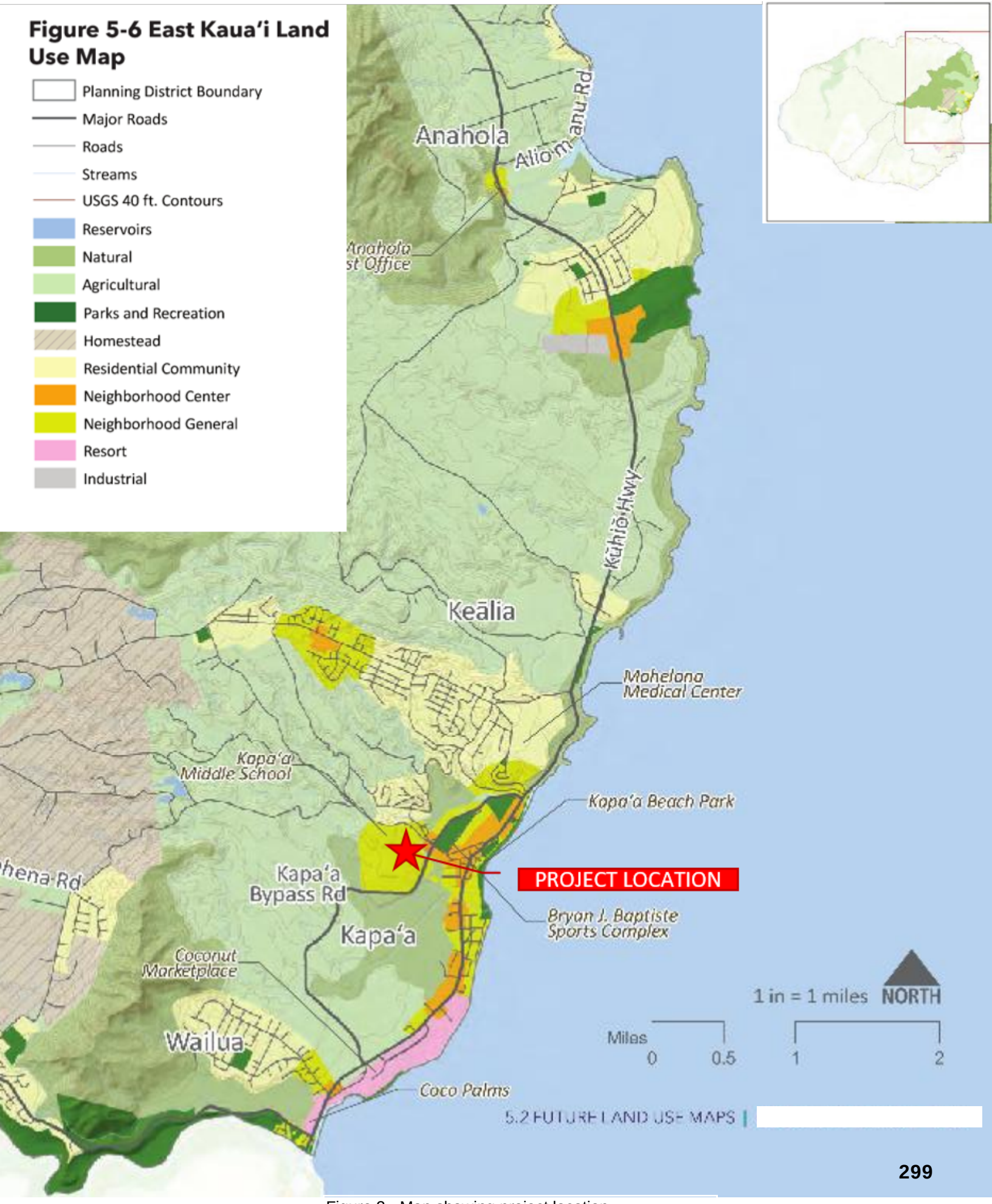

Figure 2 - Map showing project location

GENERAL SITE DESCRIPTION

The botanical survey describes the site (Figure 2) as "a lowland non-native mesic plant community dominated by secondary vegetation of trees, shrubs, and grasses, many of which are considered invasive. The land . . . has a past history of grazing and sugarcane cultivation. . . . No Hawaiian endemic species . . .were observed. One Polynesian introduction was observed, namely *Aleurites moluccana* (kukui tree) . . . The three indigenous species found at the site are quite common and include: *Hibiscus tiliaceus* (hau) which is also often an invasive tree species, the fern species *Psilotum nudum* (moa), and *Waltheria indica (*ʻuhaloa)." (Wood 2012) As many invertebrates are dependent on plant hosts, the botany report findings are predictive of the invertebrate survey results.

INVERTEBRATE SURVEY METHODS

Previous Surveys

Prior to the field survey, a search was made for publications relating to invertebrates associated with this particular site or with nearby sites, and for other projects in the general area that generated an Environmental Assessment or Environmental Impact Statement filed at the web site of the State's Office of Environmental Quality Control (2017). This review did not show any previous large scale invertebrate surveys in the area.

Searches were made in the University of Hawai'i and Bishop Museum library catalogs and in the University of Hawai'i, Hamilton Library's Hawai'i-Pacific Journal Index (2017). Searches were made for publicly available articles mounted on the web through Google Scholar. Surveys for avian and mammalian (David 2012) and botanical resources (Wood 2012) at the project area were very helpful in preparing for this study, but had no reference to other invertebrate surveys or sightings. A review of the online collection databases of the Bishop Museum entomological collections (2017 a,b) and University of Hawaii Insect Museum (UH 2017)and a search of the index of the *Proceedings of the Hawaiian Entomological Society* using place names did not reveal any prior studies. Available field reports of early Kaua'i studies by Bishop Museum entomologists were also reviewed as available.

Fieldwork

Since 1968, I have taken part in field projects in environments similar to the project site, at other locations on the island of Kaua'i, and throughout the island chain. Those experiences and the results of those surveys provided the basis for my study design and my analysis of results.

Field surveys in January 2018 were conducted at the project site over a period of three days. I conducted a general assessment of terrain and habitats after reviewing maps and prior reports (above). Survey efforts were conducted by day and night, a technique which is vital for a thorough survey. The property was traversed across all habitat types, alternately following pathways to search for any water sources or native botanical resources and substitute host plant options for native invertebrates. The areas designated "greenbelt" were a special focus as most likely to attract invertebrates (Figure 3).

FIELD SCHEDULE:

January 7	recon; day field survey, night light survey; sunset 6:10 p.m. moonset 11:56 a.m.
January 8	day field survey; night light survey; moonrise 12:19 a.m. [midnight] [2]
January 9	day field survey

COLLECTING METHODS

The following collecting methods for terrestrial invertebrates were used as appropriate to the terrain, botanical resources, and target species.

Host plant searches: Host plants, both native and introduced, were sampled for arthropods that feed or rest on plants. Searches included visual inspection of resting sites and searching known feeding or breeding sites such as under dead bark or rocks.

Sweep nets: This is a general method of censusing most flying and perching insects. A fine mesh net was swept across plants, leaf litter, etc. to sample any flying or perching insects. Transfer from the net was either by aspiration, or by placing the net contents into a holding container.

Visual observation: At all times, I was vigilant for any visual evidence of arthropod presence or activity. Visual observations provide valuable evidence and are a cross check that extends the reach of sampling techniques. Visual observation also included turning over rocks, dead wood, and other debris.

Light sampling: A survey of insects active at night is vital to a complete record of the fauna. Many insects are active only at night to evade birds, avoid desiccation and high temperatures, or to use night food sources, such as night opening flowers. Light sampling uses a bright light in front of a white cloth sheet. Night active insects seem to mistake the collecting light for the light of the moon, which they use to orient themselves. In attempting to navigate by the entomologist's light, confused insects are drawn to circle the light and land on the cloth in confusion. This type of collecting is most successful during the dark phase of the moon, or under clouds blocking starlight. On level sites vegetation usually blocks the light from being seen over long distances, and moths and other night fliers are not drawn from distant locations outside the survey area.

The locations for my light were chosen based on experience, potential native host plant proximity, and to obtain a variety of terrain types (Figure 3). Screening vegetation meant that the nearby housing areas contributed little competing light. The primary light source was a mantel propane lantern bulb. Light wave lengths from the bulb are known to be attractive to night active insects. The sheet was monitored and visiting species observed and recorded.

[2] all moon data from U.S. Naval Observatory [USNO]

Survey Limitations / Conditions

My ability to form advisory opinions is limited or influenced in the following ways:

Collecting conditions

Weather was favorable for surveying during the fieldwork. Day one had some light passing showers. Day two and three had patchy clouds and light breezes on the second night. Night monitoring was not influenced by the partial moon as the rise and set times caused the moo n to be visible only after light surveying had ceased (USNO). Nights were dark making stars quiet visible. Street and school lights presented no competition to the collecting light as I was able to position my site to mask their light.

Seasons: Monitoring at a different time of the year might produce a different arthropod list. Weather and seasonal vegetation changes play an especially important role in any survey of invertebrates. Many arthropods time their emergence and breeding to overlap or follow seasonal weather or to coincide with growth spurts of an important plant food. Host plant presence/absence, and seasonal changes, especially plant growth after heavy rains, affect the species collected. Winter 2017 rains put vegetation into a normal seasonal condition optimal for invertebrate growth. However, the low level of native plants found at the site is the strongest factor in determining the invertebrates encountered. Given the very short inventory of native plants at this site, even with positive seasonal factors, native insects traveling across HoKua simply do not find the flora to support them or their eggs are soon eaten by ants.

Limited duration: Surveying for a longer period of time might change the list of species; however, given the size of the property, I believe the survey provides an adequate review of the property's resident native invertebrates. (See below: INVERTEBRATES NOT PRESENT, for exceptions)

Physical limitations: The size of the property allowed the survey to cover the area adequately. The overall study strategy and light survey site selections were designed to achieve this aim. The resulting survey was representative and targeted in favor of locating and examining the few native host plants.

Selectivity: My survey was focused on finding endemic and indigenous Hawaiian species. No attempt was made to collect or completely document the many common alien arthropod species present in the area. Several invertebrates of human health concern are noted later in this report. See MEDICALLY IMPORTANT SPECIES.

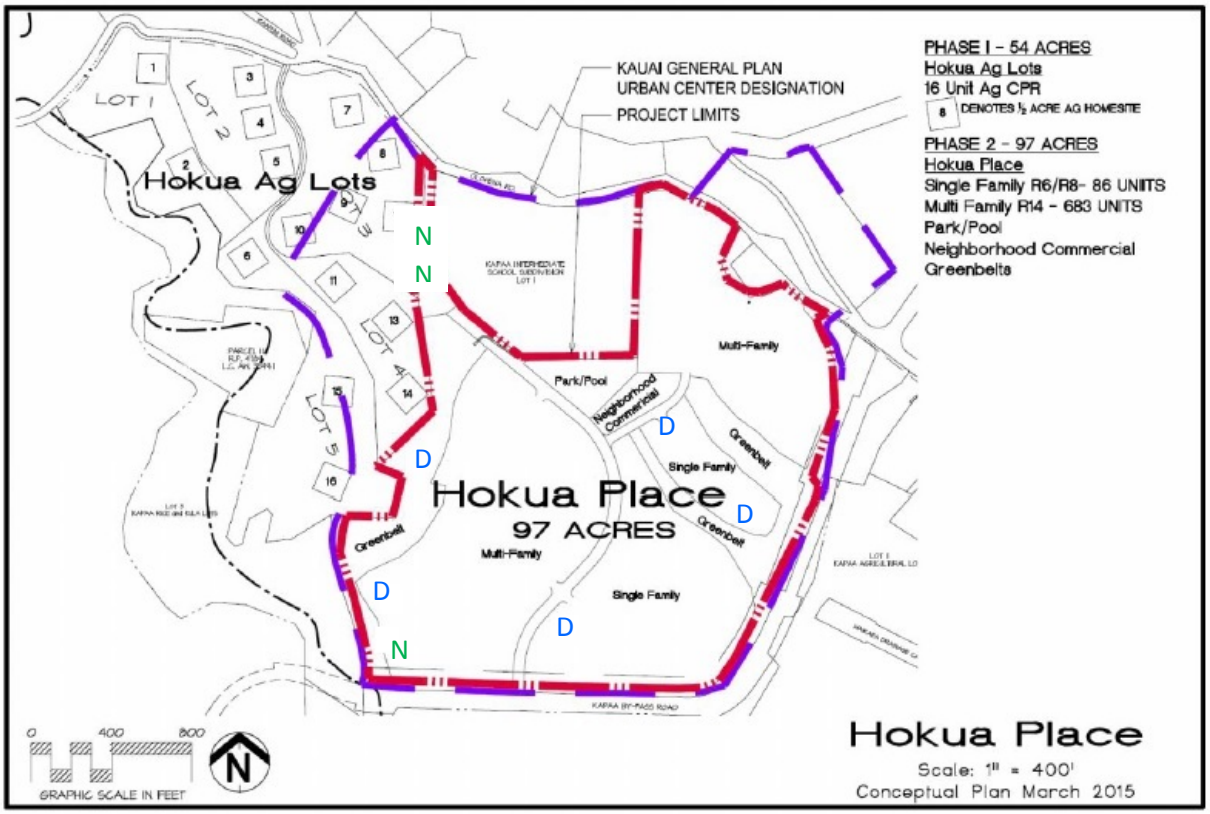

Figure 3: Map of project site showing light survey locations
[from "HoKua Place ...Final EIS Vol. 1"]

N = night light survey sites

D = areas of day survey concentration

INVERTEBRATE SURVEY RESULTS:

This discussion focuses on native species encountered, on species that affect native invertebrate survival, and on adventive species of concern in human health or commonly feared.

MOLLUSCA: PULMONATA

Giant African Snail
Lissachatina fulica (Bowdich)
The Giant African Snail (Figure 4) is an introduced pest common throughout the island chain lowlands. The Rosy Wolf snail, introduced as a control species, was not seen, but may be present. Rosy Wolf snail has done great damage to populations of native land snails, but there are no longer native snails here.

Figure 4: Rosy Wolf snail (R) approaching Giant African Snail (L)

ARTHROPODA: ARANEAE (spiders)

Araneidae
Orb Weaver Spiders
Argiope appensa (Walckenaer 1841)
Orb Weaver spiders (Figure 5) were found in bushes especially well placed to host the spiders as breezes deliver flying insects to their webs. They are easily spotted by the distinctive white X where they rest ready to rush out and wrap up the next item snagged by their web. These spiders pose no threat to people or pets and are a good control on pest alien species. They should be allowed to scramble off to find a new home during clearing operations.

Figure 5: Orb Weaver spiders are common in home gardens throughout the island chain.

Heteropodidae
Heteropoda venatoria
Large Brown Spider or Cane Spider

Although the fast running Cane spider (Figure 6) is often startling to people, they are not known to bite or harm humans. Conversely, they are helpful in controlling pests such as cockroaches. They hunt mostly at night and do not pose a risk to people or pets. They may be encountered by work crews in clearing the site. They should be allowed to run away.

NOTE [3]

Figure 6: Adult cane spider with egg case

ARTHROPODA: INSECTA
DIPTERA (Flies and Mosquitoes)

Lauxaniidae

Homoneura hawaiiensis (Grimshaw 1902) is the Gray-thorax pomace fly look-alike species that, despite the species name "hawaiiensis", is now known to be adventive and widespread in Oceania to Solomon Islands.

HYMENOPTERA (wasps, bees, ants)
Formicidae (ants):
Big-headed ant
Pheidole megacephala, especially fierce predators on other insects, are present. They are a known threat to native species of invertebrates. Alien ants are known to prey on other insects (Zimmerman 1948-80) and are well documented as a cause of low levels of native arthropods, especially in elevations up to 2000 ft. (Perkins 1913). They are not a common threat to humans.

[3] For anyone skeptical of the safety of either spider: we have used Cane spiders in close 'encounters' filming on numerous occasions; we used orb weavers in filming scenes for the TV series LOST where the actors had to have the spider ON them; we use orb weavers with children's wildlife classes.

LEPIDOPTERA (butterflies and moths)

Cosmopterygidae (Case-bearer micro-moths)

Hyposmocoma sp. 1 nocturnal

Hyposmocoma sp. 2 larvae on slender cases on stones

Figure 7: *Hyposmocoma* sp.
Photo# starr-030724-0089
credit: "Forest & Kim Starr" (HEAR)

Adult *Hyposmocoma* or Case-bearer moths responded to the light. *Hyposmocoma* (Figure 7) are called "case-bearers" because after an early beginning inside a leaf curl or similar hiding place, caterpillars create protection in intricately constructed portable shells of silk. For camouflage, they add bits of their surroundings to the case: snips of dry grass / leaves, flakes of bark, maybe a little dirt. The case is then easily mistaken by a predator as another part of the inedible landscape. These bunkers are fitted with a hinged lid (operculum), pulled shut by mandibles to defend them from enemies, especially ants now. They are dependent on their case, and die if removed – even if protected from predators and given food. They don't move far, feed while partly emerged from the case, dragging along the protective armor by six true legs. Cases are sometimes attached to rocks or tree trunks and foliage. (Manning/Montgomery in Liittschwager & Middleton 2001) With over 500 kinds, these micromoths are the greatest assemblage of Hawaiian Island moths, with astonishing diversity. After writing 630 pages on them, Dr. Zimmerman lamented the inadequacy of his study. He noted an enormous cluster of species with explosive speciation and diverging radiation (Zimmerman 1978). Much remains to be learned about them by University of Hawaii's Daniel Rubinoff and his graduate students (Rubinoff & Haines 2006).

Crambidae (micro-moths)

Mestolobes minuscula (Butler 1881)

The commonest of the small moths or micro-moths, *Mestolobes* (Figure 8), responded to the light survey. It is known from every major island. Although a large genus of over 30 species, 9 known from Kaua'i, it has not been studied in depth despite a 1906 plea to study its habits by R. C. L. Perkins (1907). It has been collected while visiting flowers for nectar diurnally and when responding to light. *Mestolobes* was reported to "often fly actively in cane fields" (Williams 1931). In the 1800s it was reported to fly in small groups and was seen at lower elevations (Perkins 1913). The host plant of this endemic is not certain. There is one record of one larvae reared from a host - the roots of sugar cane on O'ahu in 1930, yet it was never considered even a minor pest (Swezey 1931.) (HBS 2002a, HOSTS, Zimmerman 1958)

Figure 8: *Mestolobes* sp.
Photo# starr-030825-0008
credit: "Forest & Kim Starr" (HEAR)

Lepidoptera: continued

Orthomecyna phaeophanes Meyrick 1899
This is a little known ½ inch long moth known from 3 other islands that may feed on grass roots.

ODONATA (Dragonflies, Damselflies)

Coenagrionidae

Ischnura posita (Hagen, 1862) Fragile Forktail Damselfly

This damselfly was introduced to Hawaiian Islands in 1936 and is now found on all the main islands up to 1000 ft. It originated in Canada and is considered an indicator of disturbed aquatic habitat (Polhemus & Asquith 1996).

Libellulidae

Pantala flavescens (Fabricius) (Globe Skimmer)

An indigenous dragonfly (*Pantala flavescens)* (Figure 9) was observed on the property. Among the most readily observed native insects, Globe Skimmers are large, easily approached by people, and graceful in flight. Any small amount of fresh water will attract them and they often colonize human maintained water sources such as golf-course water hazards and stock tanks. Globe skimmers are widely distributed throughout the Hawaiian Islands, from Kure to Hawai'i Island (HBS 2002a, Nishida 2002) and have even been found flying at sea (Howarth & Mull 1992). They will adapt or move to a nearby water source.

Figure 9: Globe skimmers are found through the Pacific.

ORTHOPTERA

Tettigoniidae

Euconocephalus nasutus (Thunberg) (Aggravating Grasshopper)

This noisy cone-headed grasshopper might be heard on site at night. It makes a variety of sounds by rubbing the base of its wings against its body. Variously described as "loud, shrill, and continuous", "wind whistling through telephone wires," "long, steady buzzing," and the buzz of high voltage wires, it is always irritating. It also can 'throw' it's voice or project the sound to another part of the underbrush, diverting you from their hiding place if you are trying to hunt them. (Tenorio and Nishida 1995)

Table 1: List of Invertebrates: HoKua Place, Kaua'i

PHYLUM ARTHROPODA		
CLASS ARACHNIDA		**MITES, SPIDERS, AND RELATIVES**
ORDER ARANEAE		**spiders**
		Araneidae
	adv	*Argiope appensa* (Walckenaer 1841) (Orb weaver spiders)
		Heteropodidae
	adv	*Heteropoda venatoria* (Linnaeus), 1767 (Cane spiders)

CLASS CHILOPODA		
ORDER SCOLOPENDROMORPHA		**centipedes**
		Scolopendridae
	adv	*Scolopendra subspinipes* Leach 1815

CLASS INSECTA		**INSECTS**
ORDER COLEOPTERA		**beetles**
		Scolytidae
	adv	*Xylosandrus compactus* (Eichhoff)
ORDER DIPTERA		**flies**
		Asteiidae
	end	*Asteiia sabroskyi* Hardy & Delfinado, 1980
		Lauxaniidae
	adv	*Homoneura hawaiiensis* (Grimshaw, 1902)
ORDER HETEROPTERA		**true bugs**
		Lygaeidae
	adv	*Pseudopachybrachius pacificus (Stal, 1874)*
ORDER HYMENOPTERA		**wasps, bees, ants**
		Anthophoridae
	adv	*Xylocopa sonorina* F. Smith, 1874 (Sonoran Carpenter Bee)
		Apidae
	pur	*Apis mellifera* (Honey bee)
		Formicidae
	adv	*Pheidole megacephala* (Fabricius 1793)

ORDER LEPIDOPTERA		**butterflies, moths**
		Cosmopterygidae (Case-bearer micro-moths)
	end	*Hyposmocoma* sp. 1 2 adults at light
	end	*Hyposmocoma* sp. 2 9 larvae in slender cases
		Crambidae (micro-moths)
	end	*Mestolobes minuscula* (Butler 1881)
	end	*Orthomecyna phaeophanes* Meyrick 1899
		Limacodidae
	adv	*Darna pallivitta* Moore, 1877
ORDER ODONATA		**dragonflies, damselflies**
		Coenagrionidae
	adv	*Ischnura posita* (Hagen, 1862) (Fragile Forktail Damselfly)
		Libellulidae
	ind	*Pantala flavescens* (Fabricius) (Globe Skimmer)
ORDER ORTHOPTERA		**grasshoppers, crickets**
		Tettigoniidae
	adv	*Euconocephalus nasutus* (Thunberg) (Aggravating Grasshopper)

Status:
End endemic (only in the Hawaiian Islands)
Ind indigenous (naturally in the Hawaiian Islands but also elsewhere)
Adv adventive (inadvertently introduced)
Pur purposeful (deliberately introduced)

Names authority: Hawaii Biological Survey 2002a,b; Nishida 2002; Zimmerman 1948-80; Zimmerman 2001

INVERTEBRATES NOT PRESENT:

Plant and invertebrate populations are interdependent; consequently, host plant availability is one way to review invertebrate health. As discussed in the botanical survey (Wood 2012) and archaeology report (McMahon Tolleson 2013), the area has a long history of human use, Hawaiian agriculture, sugar production, and current sheep, goat and cattle grazing, all activities that removed native plants. The resulting extremely low level of native flora serving as arthropod hosts leads to the low level of Hawaiian arthropods at this site. Wood did find some Hawaiian plants: *Hibiscus tiliaceus* (hau) is the sole host of a tiny moth with a leaf mining larva, *Philodoria hauicola*, reared from Kaua'i and 3 other islands, often scarce, but at this site, none were present. *Psilotum* has no insect specialists in Hawaii.

SPECIES NOT FOUND

Any survey for federally protected species should include consideration of all native invertebrates (snails, spiders, and insects).

Cave-adapted Species

A review of the archaeological survey of the area (McMahon Tolleson 2013) indicated no lava tubes at the project site which could support cave-adapted native invertebrate species, nor did this survey show any evidence of lava tubes.

MOLLUSCA:

No native mollusks were observed during this survey.

Of the family Lymnaeidae, *Erinna newcombi* Adams & Adams, 1855 *or* Newcomb's Snail, this threatened species was not found by my survey. The habitat (stream flow and moisture levels) makes the survey area unsuitable for this snail (USFWS 2006).

DIPTERA

Drosophilidae: *Drosophila*

No native *Drosophila* were observed. The property is now unsuitable habitat for any of the endemic Kauai *Drosophila*, two in the uplands being listed as endangered or threatened. These native Hawaiian picture wing flies require a much cooler native environment, with host flora not offered at this property (*Federal Register* 2006a, b).

Invertebrates not present: continued

HETEROPTERA

Based on other Kaua'i lowland surveys, I expected, but did not find, native *Nysius* seed bugs.

HYMENOPTERA

No native bees were observed on the property.

LEPIDOPTERA

Based on other Kaua'i lowland surveys, I expected to encounter the native micro- moths *Tamsica*, *Thyrocopa*, and *Philodoria*, but at this site ants and cane plows appear to have extirpated them.

Sphingidae: *Manduca blackburni*

The Blackburn's sphinx moth[4] (*Manduca blackburni*), an endangered species (Fed Reg 1999-2000) was not found in this survey. Historically, the moth is known from the Island but only in the Nāwiliwili area and has not been seen for a century. There is no critical habitat established for the moth on Kaua'i. (USFWS 2002) Neither the moth's solanaceous native host plant, 'aiea (*Nothocestrum* sp.), nor the best alien host, tree tobacco (*Nicotiana glauca*), were observed on the property or found by the botanical survey (Wood 2012).

ODONATA (Dragonflies, Damselflies)

No native Damselflies were observed on the property.

MEDICALLY IMPORTANT SPECIES

Centipedes, scorpions, black or brown widow spiders:

Centipedes were observed but scorpions, black or brown widow spiders are also likely. They typically hide in dry leaves, under dead wood or rocks. Surveyors, crews clearing debris, etc. should be alert for all these species which may pose a serious risk to some individuals. When moving stones or piled brush, wearing gloves, covered shoes, long sleeves, and long pants will greatly reduce the risk of accidental contact and bites [for example: pull socks up over pant cuffs to deter disturbed critters from crawling up pants; use cut off socks to slide over connect between gloves and long sleeve shirt cuff]. Supervisors should be aware of any allergy by employees. Some individuals can experience anaphylactic reactions to venom of any of the mentioned arthropods, not just bees. Please see *What Bit Me?* (Nishida and Tenorio 1993) for additional information.

[4] Blackburn hawk moth is the official common name recognized by the HES Committee on Common Names of Insects (1990). Blackburn's sphinx moth has come into popular usage.

Medically Important Species-continued

HYMENOPTERA:

Anthophoridae

Carpenter bees (*Xylocopa sonorina*) were observed on the property. They favor dry, dead wood on site. The black carpenter bee females and golden males are easily seen. Carpenter bees carve out a short tube tunnel in soft wood (fence post, dry branches) as their home (Figure 10). They do not form colonies, but live individually. Carpenter bees are not a danger to people under normal circumstances, but if cornered can sting.

© Figure 10: Black female, golden male Carpenter bees; tunnel housing.

Apidae

Honey bees were noted on the property although the hive was not located. As in many wild locations in the islands, there are likely hidden, wild honey bee (*Apis mellifera)* colonies on the property. Dead trees with hollows are a favored location for a hive. If in clearing areas bees are encountered, a beekeeper should be contacted to remove the colony safely. Employees with an allergy to stings should inform their supervisor and carry their response kit at all times.

Vespidae

Common Paper Wasps (*Polistes* sp.) are on the property. This wasp favors dry, sheltered sites. These wasps are common throughout the lowlands and especially like to build their 'paper' nests under natural overhangs, including tree branches. (Figure 11). They are a danger to humans. They sting repeatedly as unlike honey bees they do not die when they sting. Nests are best destroyed at night when all wasps are on the paper nest. Destroying the nest during daylight hours will result in rebuilding when the wasps return later in the day. Protection should be worn and the task should not be attempted alone for safety backup.

Figure 11: Typical paper wasp nest

Medically Important Species-continued

LEPIDOPTERA

Stinging Nettle caterpillar (*Darna pallivitta*)

This introduced pest has spreading across the islands and reached Kaua'i in 2011. The adult responded to my light survey. DOA personnel inform me the level of infestation on Kaua'i has not been high (Conant 2018). Nevertheless, survey and crews clearing the area should be alert for the caterpillar which has numerous spines. The stinging spines may cause burning and itching sensations on the skin. Swelling and welts can last for several days, then a persistent rash may last for weeks. For any severe symptoms, especially breathing difficulty, seek medical help immediately. (DOA 2005, 2011)

Figure 12. Avoid contact with the spines of the Stinging Nettle caterpillar (HDA photo)

POTENTIAL IMPACTS

Potential Impacts on Native, Rare, Federally or State Listed Species

No federally or state listed endangered species was found in this survey. No anticipated actions related to the proposed project activity in the surveyed locations are expected to threaten an entire species.

General Recommendations for promotion and protection of native invertebrates

Landscape with native plants:

The 2012 botanical survey recommended landscaping with native plants as the project develops (Wood / David 2012). In addition to their beauty and the positive cultural and social values communicated by the use of native plants, these plants would provide habitat for native arthropods while creating a more interesting botanical area. Native plants will remain green and thus more fire resistant throughout the summer. Native plantings often have lower maintenance costs and water needs when chosen to match area needs. As native plants tend to reach a predictable height and foliage spread, well-chosen plantings usually mean less hedge trimming and weed whacking. In the areas to be left undeveloped or used to screen some areas or along roadways, native plants in a mixture of ground cover, shrub, and tree heights will slow run off, retain moisture and recharge aquifers while holding soil at low cost. The plantings can provide educational, visual, and aesthetic benefits to residents. Native insects and other creatures may use this refuge over time.

Native plants can be as convenient for mass plantings as the introduced plants commonly used to re-vegetate after new construction. A list of suppliers of native plants is available at http://nativeplants.hawaii.edu/nursery/

ACKNOWLEDGMENTS

Steven Lee Montgomery conducted all surveying and is responsible for all conclusions. Anita Manning assisted with database searches and contributed to preparation of this report.

Photos are by Anita Manning or Steven Montgomery unless otherwise attributed.

STANDARD NOMENCLATURE

Invertebrate names follow
Freshwater & Terrestrial Mollusk Checklist (HBS 2002b)
Common Names of Insects & Related Organisms (HES 1990)
Hawaiian Terrestrial Arthropod Checklist (HBS2002a; Nishida 2002)

Plant names follow
Manual of the Flowering Plants of Hawai'i (Wagner et al. 1999)
A Tropical Garden Flora (Staples and Herbst 2005)

Mammal names follow *Mammals in Hawai'i* (Tomich 1986).

Place name spelling follows *Place Names of Hawaii* (Pukui et al. 1976).

ABBREVIATIONS

asl	above sea level
DLNR	Department of Land and Natural Resources, State of Hawai'i
DOA	Department of Agriculture, State of Hawai'i
DOFAW	Division of Forestry and Wildlife
ESA	Endangered Species Act of 1973, as amended.
HBS	Hawai'i Biological Survey
n.	new
sp.	species
spp.	more than one species
TMK	Tax Map Key
USFWS	United States Fish and Wildlife Service

GLOSSARY[5]

Adventive: organisms introduced to an area but not purposefully.

Alien: occurring in the locality it occupies ONLY with human assistance, accidental or purposeful; not native. Both Polynesian introductions (e.g., coconut) and post-1778 introductions (e.g., guava, goats, and sheep) are aliens.

Arthropod: insects and related invertebrates (e.g., spiders) having an external skeleton and jointed legs.

Diurnal: active in the daylight hours

Endangered: A species listed and protected under the Endangered Species Act of 1973, as amended.

Endemic: naturally occurring, without human transport, ONLY in the locality occupied. Hawaii has a high percentage of endemic plants and animals, some in very small microenvironments.

Indigenous: naturally occurring without human assistance in the locality it occupies; may also occur elsewhere, including outside the Hawaiian Islands. (e.g., Naupaka kahakai (*Scaevola sericea*) is the same plant in Hawai'i and throughout the Pacific).

Insects: arthropods with six legs, and bodies in 3 sections

Invertebrates: animals without backbones (insects, spiders, snails / slugs, shrimp)

Larva/larval: an immature stage of development in offspring of many types of animals.

Mollusk: invertebrates in the phylum Mollusca. Common representatives are snails, slugs, mussels, clams, oysters, squids, and octopuses.

Native: organism that originated in area where it lives without human assistance. May be indigenous or endemic.

Naturalized: an alien organism that, with time, yet without further human assisted releases or plantings, has become established in an area to which it is not native.

Nocturnal: active or most apparent at night.

Pupa: the stage between larva and adult in insects with complete metamorphosis, a non-feeding and inactive stage often inside a case

Purposefully introduced: an organism brought into an area for a specific purpose, for example, as a biological control agent.

5 Glossary based largely on definitions in *Biological Science: An Ecological Approach*, 7th ed., Kendall/Hunt Publishing Co., Dubuque, a high school text; on the glossary in *Manual of Flowering Plants of Hawai'i*, Vol.2, Wagner, et al., 1999, Bishop Museum Press, and other sources.

Polyphagous: eating many different types of food

Rare: threatened by extinction and low numbers.

Species: all individuals and populations of a particular type of organism, maintained by biological mechanisms that result in their breeding mostly with their kind.

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