

Ambrosia Beetle Trap Collections at Hakalau Forest National Wildlife Refuge

South Kona Unit: Round 1 May 16 – June 29, 2017

Round 2 August xx – October 4, 2017

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ROUND ONE:

COMPARING COFFEE BERRY BORER TRAPS AND LINDGREN FUNNEL TRAPS WITH EtOH:MeOH LURES (50:50)

Trapping for ambrosia beetles (Coleoptera: Curculionidae: Scolytinae) was carried out over a six week period from May to June 2017 within the South Kona unit of the Hakalau Forest National Wildlife Sanctuary. Eight trap pairs were set at five sites spanning the full elevational range of the refuge (map 1 & table 2). Two trap designs were compared, standard coffee berry borer (CBB) vs. Lindgren funnel traps, which were baited with 50:50 methanol:ethanol lures during a two week period at the end of May and 50:50 MeOH:EtOH + terpentine for 4 weeks in June . Collections were made after 1 day (May 17), two weeks (June 1) and one month (June 29) totals for all three collections combined in table 1 and raw data for each collection in table 3. Ambrosia beetle diversity and populations were highest at the low elevation site (site 1) with only a single specimen collected between the two highest elevation sites (sites 4&5). The ambrosia beetles collected represented species that attack 'ōhi'ā (3 species) and some that never (3 species) or very rarely do (1 species). The species, *Xylosandrus crassiusculus*, classified as very rarely attacking 'ōhi'ā has only been found on two trees among hundreds examined across the Big Island, one on Saddle Rd. and one in Laupāhoehoe, and has never been reared from 'ōhi'ā wood, suggesting that it is not able to breed in 'ōhi'ā. A similar comparison was carried out near sea-level adjacent to the Hilo Airport. In both cases the Lindgren funnel trap outperformed the CBB traps. Lindgren funnel traps are extremely bulky, heavy, and expensive. In round two below we evaluated a third, less bulky trap design, with 8 lures including the 50:50 MeOH:EtOH lure used in this round.

No ambrosia beetle specimens were collected after one day, 99 specimens were collected after two weeks using the 50:50 MeOH:EtOH lure, and 44 after one month using a ~33:33:33 MeOH:EtOH:terpentine lure. Terpentine is apparently repellent to the ambrosia beetle species at these sites and no additional use is anticipated.

SITE 1

The percentage of invasive woody tree and shrub species, i.e. potential ambrosia beetle hosts including feral coffee, is highest at the low elevation site. Two of the species collected at this site are associated with coffee, *Hypothenemus hampei* & *Xylosandrus compactus*, the coffee berry & black twig borers respectively. Three 'ōhi'ā associated species were collected, though none were collected in large numbers. Fourteen *Xyleborinus saxesenii*, and one each of *Xyleborus affinis* and *Xyleborus simillimus* were collected over the course of round one. *Xyleborus affinis* and *Xyleborinus saxesenii* attack 100's of woody species worldwide and the specimens collected could have come from any number plant hosts. *Xyleborus simillimus* is an endemic species found only in association with 'ōhi'ā.

SITE 2

There were no 'ōhi'ā associated specimens trapped at site 2. The only common species was *Xylosandrus crassiusculus* (32 specimens). This species attacks many species including koa, strawberry guava, and christmas berry. One native species was collected, *Xyleborus hawaiiensis*, which breeds in Araliaceae, especially *Cheirodendron*.

SITE 3

Four pairs of traps were set at this site amongst the dead ROD positive trees below camp. Three species of ambrosia beetles were collected, *X. saxesenii* was relatively abundant. The two most commonly collected native species were also collected, though just a single specimen of each was collected: *X. simillimus* ('ōhi'a associated) and *X. hawaiiensis* (Araliaceae associated).

SITE 4

No ambrosia beetles were collected at this site

SITE 5

Only a single specimen of *X. saxesenii* was collected.

Sites 4 & 5 were the highest elevation sites surveyed for ambrosia beetles by this researcher on the Big Island. The highest elevations surveyed in other districts were ~5,000 feet and similar species were collected as found at site 3 in the S. Kona Hakalau Unit (site 3 = ~5,000 ft. el.).

Map 1: Sites of trapping and trap pairs. Four pairs of traps were set at site 3 due to the high concentration of dead trees and ROD positive trees.

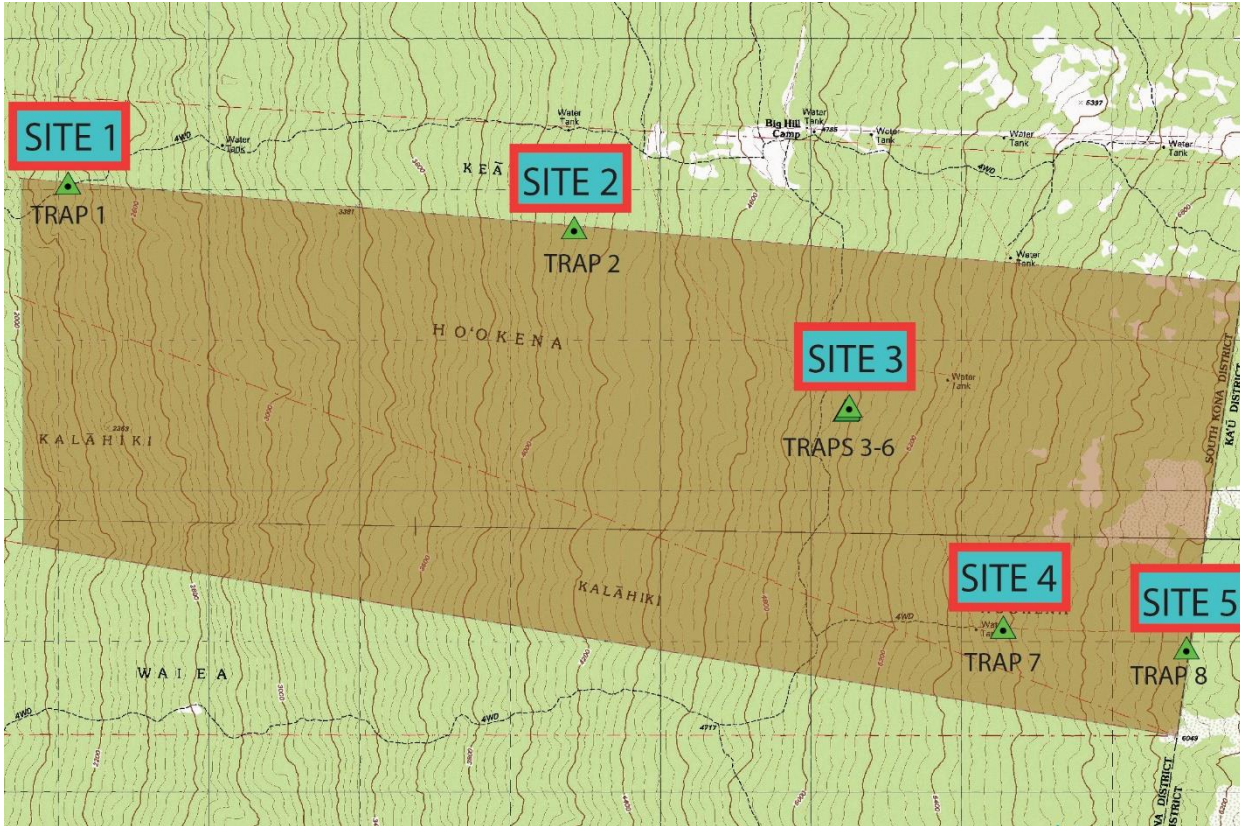


Table 1: Summary of collections for round 1 with site number, genus, species, and number of specimens collected. Green highlight species attack and breed in 'ōhi'ā and yellow do not.

SITE 1		
<i>Xylosandrus</i>	<i>compactus</i>	2
<i>Xylosandrus</i>	<i>crassiusculus</i>	15
<i>Hypothenemus</i>	<i>hampei</i>	1
<i>Xyleborinus</i>	<i>saxesenii</i>	14
<i>Xyleborus</i>	<i>affinis</i>	1
<i>Xyleborus</i>	<i>simillimus</i>	1
SITE 2		
<i>Xylosandrus</i>	<i>crassiusculus</i>	32
<i>Xyleborus</i>	<i>hawaiiensis</i>	1
SITE 3		
<i>Xyleborinus</i>	<i>saxesenii</i>	83
<i>Xyleborus</i>	<i>simillimus</i>	1
<i>Xyleborus</i>	<i>hawaiiensis</i>	1
SITE 4		
NONE		
SITE 5		
<i>Xyleborinus</i>	<i>saxesenii</i>	1

Table 2: Site Data

SITE	TRAP	LAT	LONG	Westing	Northing	ELEV ft.
1	1	19.39521	-155.85565	0200062	2147041	2320
2	2	19.39304	-155.82359	0203428	2146746	3900
3	3	19.38234	-155.80627	0205229	2145531	5270
4	7	19.36955	-155.79607	0206280	2144097	5580
5	8	19.36847	-155.78448	0207494	2143957	6065

Table 3: Raw data for round 1

Coll Number	Trap	Site	Genus	species	# of Spec.	Breeds in ohia
SITE 1						
20170601.CBB.01	1	1	Xyleborinus	saxesenii	5	Yes
20170601.CBB.01	1	1	Xylosandrus	crassiusculus	7	No
20170601.CBB.01	1	1	Xylosandrus	compactus	2	No
20170601.Lind.01	1	1	Xylosandrus	crassiusculus	6	No
20170601.Lind.01	1	1	Xyleborinus	saxesenii	5	Yes
20170601.Lind.01	1	1	Hypothenemus	hampei	1	No
20170601.Lind.01	1	1	Xyleborus	affinis	1	Yes
20170601.Lind.01	1	1	Xyleborus	simillimus	1	Yes
20170629.Lind.01	1	1	Xyleborinus	saxesenii	2	Yes
20170629.CBB.01	1	1	Xyleborinus	saxesenii	2	Yes
20170629.CBB.01	1	1	Xylosandrus	crassiusculus	2	No
			Xylosandrus	compactus	2	No
2 weeks: 28 spec		1	Xylosandrus	crassiusculus	15	No
1 month: 6 spec		1	Xyleborinus	saxesenii	14	Yes
			Hypothenemus	hampei	1	No
			Xyleborus	affinis	1	Yes
			Xyleborus	simillimus	1	Yes
SITE 2						
$\bar{1}$	2	2	Xylosandrus	crassiusculus	27	No
20170629.Lind.02	2	2	Xylosandrus	crassiusculus	5	No
20170629.CBB.02	2	2	Xyleborus	hawaiiensis	1	No
2 weeks: 27 spec		2	Xylosandrus	crassiusculus	32	No
1 month: 6 spec		2	Xyleborus	hawaiiensis	1	No
SITE 3						
20170601.CBB.03	3	3	Xyleborinus	saxesenii	2	Yes
20170601.Lind.03	3	3	Xyleborinus	saxesenii	12	Yes
20170601.CBB.04	4	3	Xyleborinus	saxesenii	1	Yes
20170601.Lind.04	4	3	Xyleborinus	saxesenii	33	Yes
20170601.CBB.05	5	3	Xyleborinus	saxesenii	1	Yes
20170601.Lind.05	5	3	Xyleborinus	saxesenii	4	Yes
20170601.Lind.06	6	3	Xyleborinus	saxesenii	1	Yes
20170629.Lind.03	3	3	Xyleborinus	saxesenii	8	Yes
20170629.Lind.03	3	3	Xyleborus	hawaiiensis	1	No

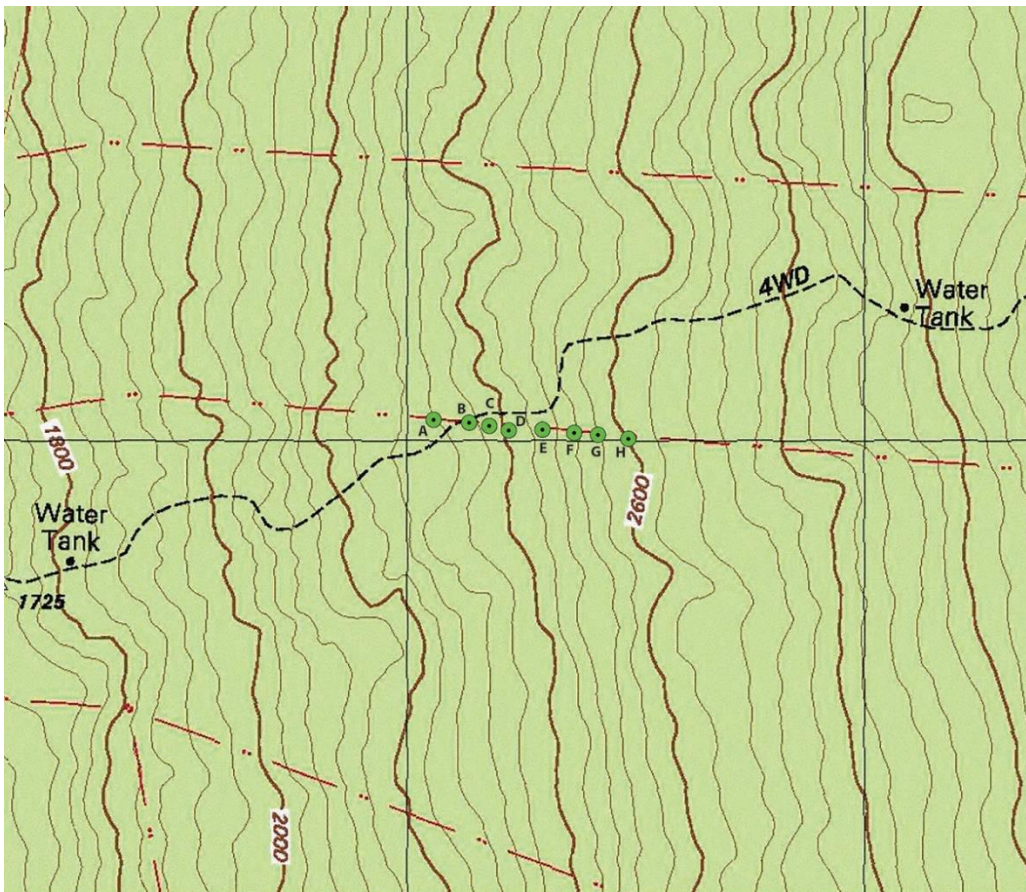
20170629.Lind.03	3	3	Xyleborus	simillimus	1	Yes
20170629.CBB.03	3	3	Xyleborinus	saxesenii	1	Yes
20170629.Lind.04	4	3	Xyleborinus	saxesenii	15	Yes
20170629.CBB.04	4	3	Xyleborinus	saxesenii	1	Yes
20170629.Lind.05	5	3	Xyleborinus	saxesenii	2	Yes
20170629.CBB.05	5	3	Xyleborinus	saxesenii	1	Yes
20170629.Lind.06	6	3	Xyleborinus	saxesenii	1	Yes
2 weeks: 54 spec		3	Xyleborinus	saxesenii	83	Yes
1 month: 31 spec		3	Xyleborus	hawaiiensis	1	No
		3	Xyleborus	simillimus	1	Yes
SITE 5						
20160629.Lind.08	8	5	Xyleborinus	saxesenii	1	Yes
1 month: 1 spec		5	Xyleborinus	saxesenii	1	Yes

ROUND TWO:

EVALUATION OF 8 LURES AT SITES 1 AND 3

Sites one and three had the most specimens collected in round one and round three has the highest concentration of ROD positive trees in the S. Kona parcel. Cross-Vane Panel Traps (CVPTs) were deployed to evaluate if they were as effective as Lingren funnels (they are much less expensive, bulky, and heavy). Eight traps with eight different lures were set at each site. The traps at site 1 were set along the north fence road (map 2) and the traps at site 3 were set around the patch of ROD trees (map 3). The lowest elevation trap at site one was in much more disturbed forest than the remaining seven. Traps at site 1 were emptied twice providing 18 samples. After the first sample was collected the lowest elevation trap (in the most disturbed forest) was rotated to the highest position (farthest from the disturbed forest) and all the remaining seven traps were shifted down slope one position. At site 3 the traps were emptied three times. After the first collection the traps were moved across the ROD tree patch to the opposite side and after the second collection rotated one position clockwise. No position effects were observed and the CVPTs (baited with 50:50 MeOH:EtOH, same as round 1 lure) performed as well or better than the Lindgren traps from round 1 sampling (table 4). The species collected that attack 'ōhi'a (in addition to other species) was similar to round 1 except a small number of *Xyleborus perforans* (5 specimens) were collected at site 1. Many more of each species was collected and additional non-'ōhi'a feeding ambrosia beetle species were collected. 50:50 MeOH:EtOH was the most effective lure followed by 95% EtOH. Future trials could compare 50:50 MeOH:EtOH with blends containing a higher percentage of MeOH, i.e. 67:33 and 75:25 with 50:50. We are currently collecting specimens alive to screen for the presence of *Ceratocystis* DNA through qPCR screening and viable inoculum through agar plating. We would be interested in collecting specimens from site 3 but logistics might prove to be prohibitive.

Map 2: Trap placement at low elevation site, traps set 50 – 70 meters apart depending on availability of suitable trees to hang them



Map 3: Trap placement around ROD positive tree patch just below camp. Traps set 20-35 meters from edge of patch.

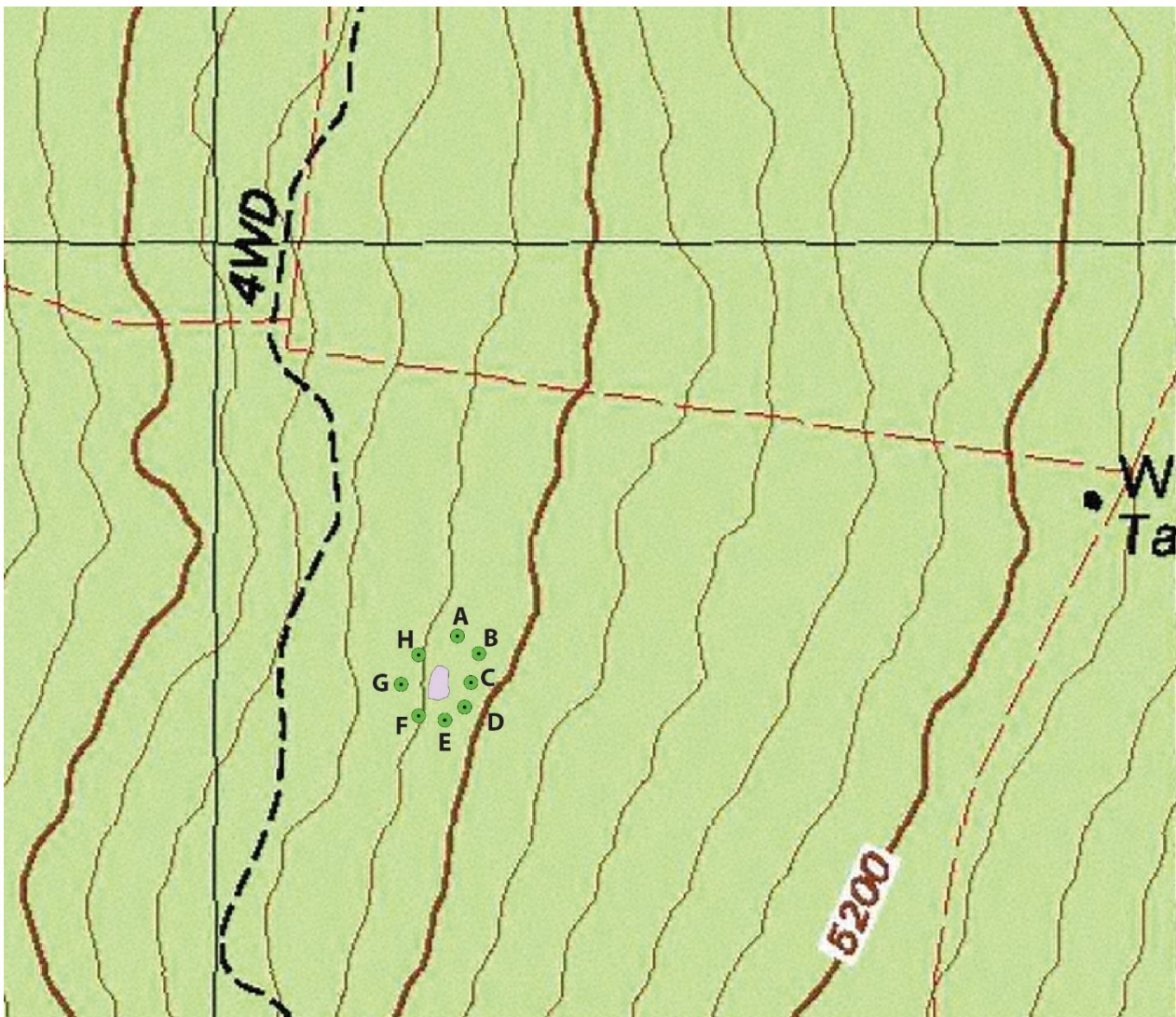


Table 4: Summary of collections for round 2 with site number, trap location letter (A-H), Genus and species of specimens collected, and number of specimens of each species for each of 2 (site 1) and 3 (site 3) collections. Green highlight species attack and breed in 'ōhi'ā and yellow do not.

Trap WP	lure	SITE	Genus	species	total
F	50:50 EtOH:MeOH 100ml sleeve	Site 3	<i>Xylosandrus</i>	<i>crassiusculus</i>	4
F	50:50 EtOH:MeOH 100ml sleeve	Site 3	<i>Xyloborinus</i>	<i>saxesenii</i>	28
				TOTAL	32
B	50:50 EtOH:MeOH 100ml sleeve	Site 3	<i>Xylosandrus</i>	<i>crassiusculus</i>	1
				TOTAL	1
C	50:50 EtOH:MeOH 100ml sleeve	Site 3	<i>Xylosandrus</i>	<i>crassiusculus</i>	1
C	50:50 EtOH:MeOH 100ml sleeve	Site 3	<i>Xyloborinus</i>	<i>saxesenii</i>	7
				TOTAL	8
D	'ōhi'a wood	Site 3	<i>Xyloborinus</i>	<i>saxesenii</i>	6
				TOTAL	6
F	95% EtOH 100ml sleeve	Site 3	<i>Xylosandrus</i>	<i>crassiusculus</i>	15

				TOTAL	15
B	95% EtOH 100ml sleeve	Site 3	<i>Xylosandrus</i>	<i>crassiusculus</i>	4
B	95% EtOH 100ml sleeve	Site 3	<i>Xyloborinus</i>	<i>saxesenii</i>	5
				TOTAL	9
G	95% EtOH 100ml sleeve	Site 3	<i>Xylosandrus</i>	<i>crassiusculus</i>	18
G	95% EtOH 100ml sleeve	Site 3	<i>Xyloborinus</i>	<i>saxesenii</i>	6
				TOTAL	24
C	3-methyl-2-buten-1-ol	Site 3	<i>Xyleborus</i>	<i>simillimus</i>	1
				TOTAL	1
A	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	171
A	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>andrewsi</i>	15
A	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Hypothenemus</i>	<i>birmanus</i>	7
A	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	936
A	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>affinis</i>	9
A	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>simillimus</i>	1
				TOTAL	1139
H	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Hypothenemus</i>	<i>hampei</i>	1
H	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>andrewsi</i>	43
H	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	202
H	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>affinis</i>	16
H	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>perforans</i>	2
H	50:50 EtOH:MeOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	1306
		Site 1		TOTAL	1570
B	'ōhi'a wood	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	7
B	'ōhi'a wood	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	1
B	'ōhi'a wood	Site 1	<i>Xyleborus</i>	fragments	2
				TOTAL	10
	'ōhi'a wood	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	11
				TOTAL	11
B	alpha copaene 50 2x bubble	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	3
B	alpha copaene 50 2x bubble	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	6
				TOTAL	9
C	3-methyl-2-buten-1-ol	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	2
				TOTAL	2
E	95% EtOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>compactus</i>	1
E	95% EtOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>germanus</i>	1
E	95% EtOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	224
E	95% EtOH 100ml sleeve	Site 1	<i>Hypothenemus</i>	<i>hampei</i>	1
E	95% EtOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>affinis</i>	14
E	95% EtOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>simillimus</i>	1
E	95% EtOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	45
				TOTAL	287
D	95% EtOH 100ml sleeve	Site 1	<i>Hypothenemus</i>	<i>hampei</i>	2
D	95% EtOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>compactus</i>	1
D	95% EtOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	164

D	95% EtOH 100ml sleeve	Site 1	<i>Xylosandrus</i>	<i>germanus</i>	4
D	95% EtOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>andrewsi</i>	3
D	95% EtOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>affinis</i>	17
D	95% EtOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>perforans</i>	1
D	95% EtOH 100ml sleeve	Site 1	<i>Xyleborus</i>	<i>simillimus</i>	2
D	95% EtOH 100ml sleeve	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	166
				TOTAL	360
F	conophthorin centrifuge tube	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	1
F	conophthorin centrifuge tube	Site 1	<i>Xyleborus</i>	<i>perforans</i>	1
F	conophthorin centrifuge tube	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	7
				TOTAL	9
E	conophthorin centrifuge tube	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	8
E	conophthorin centrifuge tube	Site 1	<i>Xylosandrus</i>	<i>germanus</i>	3
E	conophthorin centrifuge tube	Site 1	<i>Xyleborus</i>	<i>perforans</i>	1
E	conophthorin centrifuge tube	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	4
				TOTAL	16
G	cubeb oil 2x bubble	Site 1	<i>Xyleborus</i>	<i>simillimus</i>	2
				TOTAL	2
F	cubeb oil 2x bubble	Site 1	<i>Xyleborus</i>	<i>affinis</i>	1
F	cubeb oil 2x bubble	Site 1	<i>Xyleborus</i>	<i>simillimus</i>	1
F	cubeb oil 2x bubble	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	7
				TOTAL	9
H	para menthenol mini bubble	Site 1	<i>Xylosandrus</i>	<i>germanus</i>	35
				TOTAL	35
G	para menthenol mini bubble	Site 1	<i>Xylosandrus</i>	<i>crassiusculus</i>	3
G	para menthenol mini bubble	Site 1	<i>Xylosandrus</i>	<i>germanus</i>	54
G	para menthenol mini bubble	Site 1	<i>Xyloborinus</i>	<i>saxesenii</i>	4
				TOTAL	61

