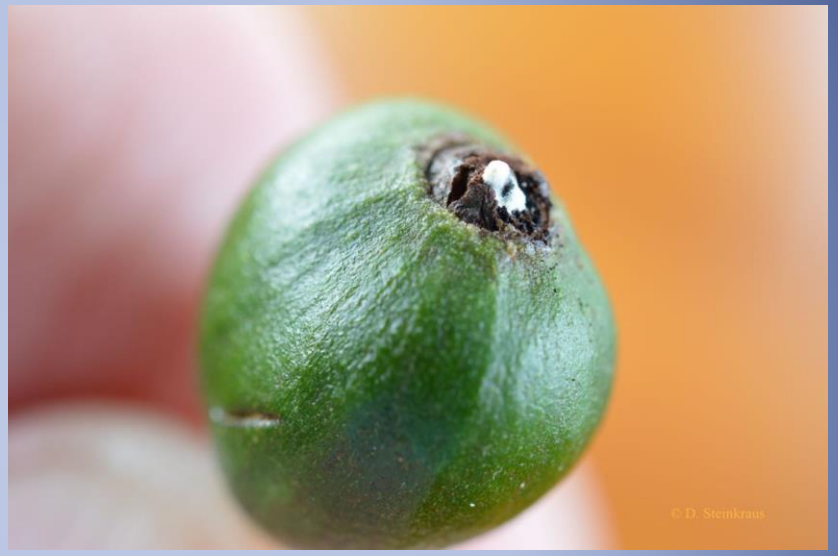
The Next Five Years of IPM Research and Implementation:
Inspect, Reduce, Remove

Robert G. Hollingsworth, Research Entomologist
US Pacific Basin Agricultural Research Center, Hilo, Hawaii

Project on Areawide IPM of Coffee Berry Borer in Hawaii and Puerto Rico

Funded through National Program staff at the USDA Agricultural Research Service



5-year program at about $1 million/yr

Approximately 15 scientists and extension workers have written proposals and are receiving money

We meet each year to give project updates and share information with the growers

Does coffee berry borer need an Areawide?

- Yes, to prevent pest spread to other islands
- Yes, to prevent mass emigration
- Yes, because different tactics are needed in different areas due to differences in climate and pest pressure

ARS may receive 5 years of new Areawide Funding

- There have been three previous years of funding under the Areawide. Not all of the money have been spent. Specific Cooperative Agreements are in place for many of the researchers through mid-2018.
- However, new money is needed to beef-up research programs for those researchers, to provide money for new researchers, and to fund new initiatives.
- Dr. James gave us the choice of putting together a one-year plan now and a more comprehensive plan in 2017, or putting together a comprehensive 5 year plan now. We did a little of both.

Proposal received this year for a demonstration of Frequent Harvesting Technique:

Reducing Coffee Berry Borer Populations and Increasing the Quality of Coffee Production by Improving Cultural Control Practices in Coffee Farms from Hawaii

Investigators:

Luis F. Aristizábal, IPM-CBB Consultor
Suzanne Shriner, CBB Grant Administrator, Synergistic Hawaii Ag Council
Robert Hollingsworth, USDA/ARS, Research Entomology

Collaborators:
Rondall Stevens, General Manager Ka'u coffee farm, Pahala, HI
Bod Nelson, Owner Lehuula coffee farm, Kona, HI

Contact information:
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Mid-Florida Research & Center
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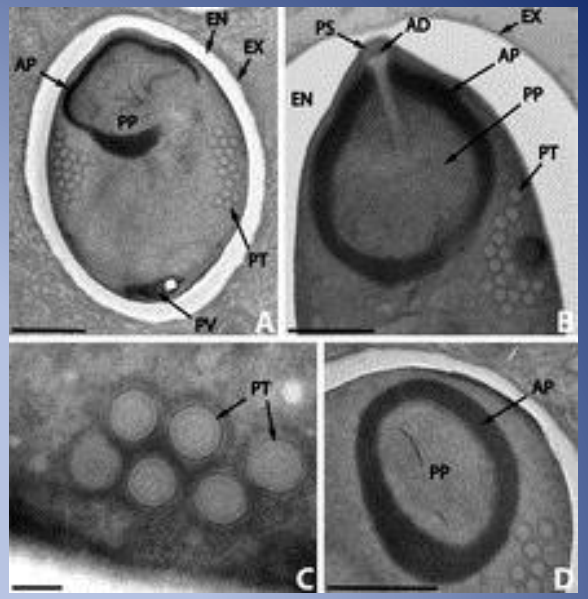
Have all the pathogens of CBB been found?

There may be protozoa (neogregarines), microsporidia, baculoviruses, could be discovered both in Hawaii and other areas of world that could be used in a classical biological control or inoculative technique to add stress, illness, mortality to the CBB population.

"The microsporidian *Mattesia* sp. was observed only once, while examining the adult borer's intestines coming from a population of laboratory-reared insects, kept at Cenicafé. Individuals of this host, affected by these protozoa, are relatively inactive and their reproduction is reduced or show inability to breed."

Nosema:

a genus of microsporidian parasites. The genus, circumscribed by Swiss botanist Karl Wilhelm von Nägeli in 1857, contains 81 species. Most parasitise insects and other arthropods, and the best-known Nosema species parasitisehoneybees, where they are considered a significant disease by beekeepers, often causing a colony to fail to thrive in the spring as they come out of their overwintering period.



Kingdom:	**Fungi**
Division:	Microsporidia
Class:	Dihaplophasea
Order:	Dissociodihaplophasida
Family:	Nosematidae

Name: Donald C. Steinkraus <steinkr@uark.edu>
Dept. of Entomology, 319 AGRI
Univ. of Arkansas, Fayetteville, AR 72701

Academic Record:

Ph.D.	Cornell University	1987
M.S.	University of Connecticut	1979
B.A.	Cornell University	1975

Photograph:

Primary Research Area: Biological control with pathogens & apiculture
Current Appointment: 55-85% Research, 0-35% Teaching, 15% Service

Professional Experience:

Rank/Position	Institution	Date	Research Areas
Full Professor	University of Arkansas	1999-date	Biocontrol & Apiculture
Associate Professor	University of Arkansas	1994-98	IPM & Insect Pathology
Assistant Professor	University of Arkansas	1989-99	Row Crop IPM
Research Associate	Cornell University	1987-89	Dairy/Poultry IPM

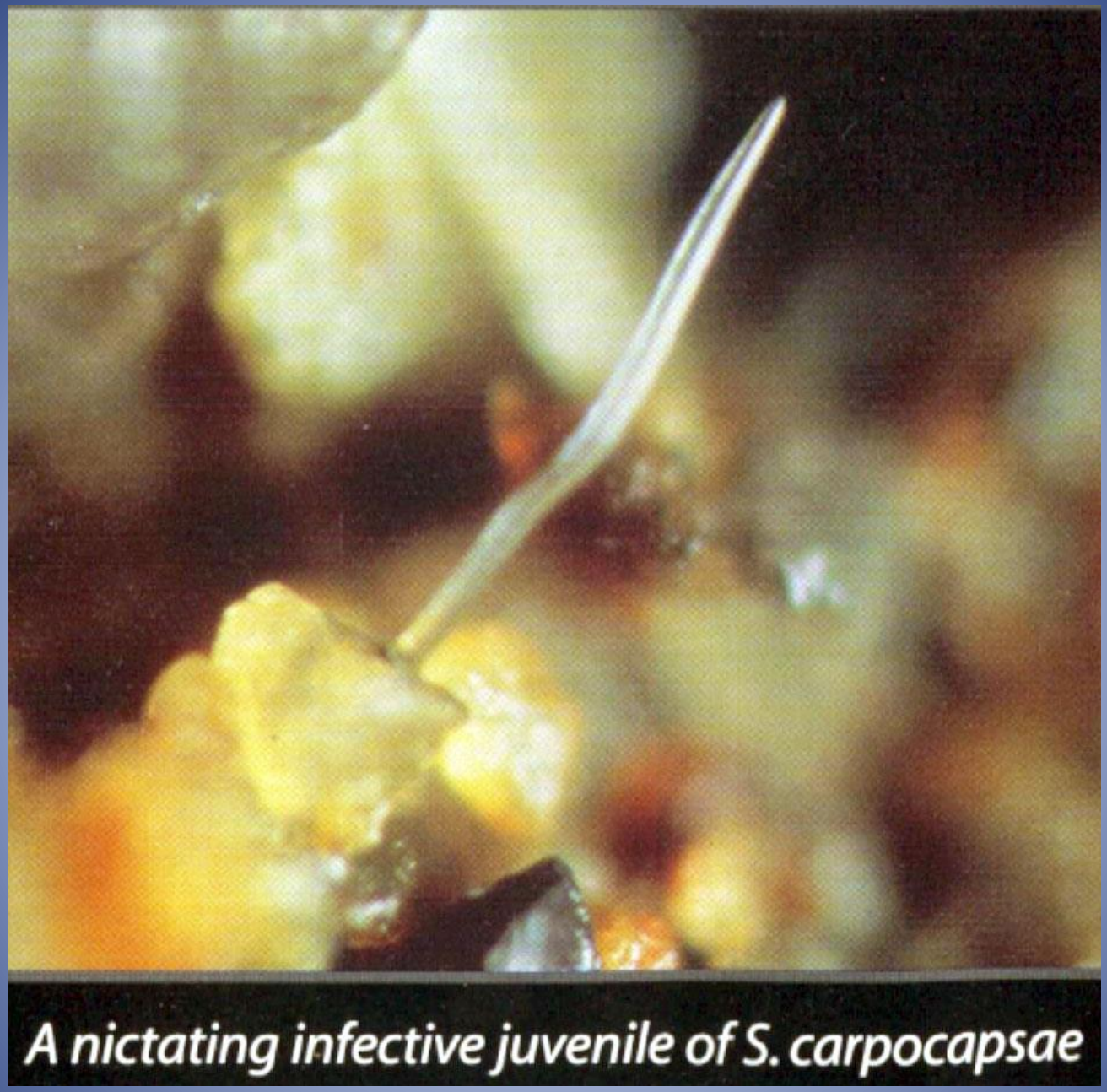
Predator Thrips

Adult

***Karnyothrips flavipes*, a predator thrips, is a biological control agent for Coffee Berry Borer in Kenya.**

***Karnyothrips* lay eggs inside infested coffee beans. Adults and larva thrips feed on CBB eggs and larvae.**

Infective juveniles of *Steinernema feltiae* from within *Galleria*.



An ambusher, it waits for a host to come by.

Nematodes could be ideal for killing CBB in rocky soil

bees and

Wild bees are disappearing

- In Hawaii Island……
- Varroa mite detected in 2008
- Small hive beetles found in 2010

- Old-timers (anyone who was farming coffee 8 or more years ago) reminisce about the hum that used to be.

Neelendra K. Joshi

Department of Entomology, 319 Agriculture Building, University of Arkansas, Fayetteville, AR.
Email: nkjoshi@uark.edu, Cell 814 380 4541

Education

2011 **Ph.D. (Dual Degree) – Entomology** and **Comparative & International Education**
The Pennsylvania State University, University Park, PA, USA

2001 **Master of Science Agriculture - Entomology**
G.B. Pant University of Agriculture & Technology, Pantnagar, India

1999 **Bachelor of Science - (Major: Zoology, Botany, & Chemistry)**
Kumaun University, Nainital, India

Research Focus

- Pollinator biology, ecology and ecosystem services, Pollinator and non -target arthropods' ecotoxicology and pesticide risk assessment, Pollinator conservation and management in economically important crops and other ecosystems. Integration of pollinator health into existing IPM programs and crop p roduction.
- Ecologically -based IPM in various crops, Insect ecology, Modeling insect phenology, Monitoring and sampling, Insecticide resistance, Development and implementation of IPM programs.

Professional Experience

2015 - Present **Assistant Professor** , *University of Arkansas (Entomology), Fayetteville, AR*

2011- 2015 **Postdoc. Research Scholar,** *Penn State University (Entomology), University Park, PA*

2005 - 2011 **Doctoral/Gr ad. Research Assistant,** *Penn State University (Entomology), PA*

2004 - 2004 **Senior Research Fellow,** *G.B. Pant University of Agriculture & Technology (Dept. of Entomology) - Hill Campus, UK, India.*

2002 - 2003 **Junior Research Fellow** , *H.N.B.G. University, (Dept. of Zoology), Tehri, UK, India*

2001- 2002 **Assistant Manager** , *Manjushree Plantations Limited (**Coffee**, Tea, Cardamom), New Hope, TN, India.*

Excerpt from proposal of Neel Joshi and Donald Steinkraus received this year

- Although there are a few species of coffee that are self-fertile, recent studies convincingly suggest that the yield of coffee (both self-fertile as well as self-sterile species) is significantly increased by flower visitation by honey bees (Klein et al. 2003b, Roubik 2002b) and different species of wild bees (Klein et al. 2003a). For instance, in case of the highland coffee (*Coffea arabica*) grown in Indonesia, the fruit-set had been reported to be increased by over 12 % when flowers were pollinated by bees (Klein et al. 2003b). In Panama, Roubik (2002b) found a 25 % increase in the mass of ripe berries when African honey bees dominated flower visitation in *C. arabica* plants. Roubik (2002b) also found a significant increase (49 %) in the abundance of ripe berries per flower in plants under open pollination. This research reveals that the bees not only significantly contribute to *C. arabica* fruit-set, but also consistently improve production (over 36%) in coffee farms (Roubik 2002b).

5 target areas of IPM research/implementation

Reducing pest populations through good sanitation and harvesting methods (strip picking, harvesting frequency, techniques to prevent coffee berries from ending up on the ground, mitigation measures for CBB in berries already on the ground)

5 target areas of IPM research/implementation

- Efficient use of *Beauveria* and other environmentally acceptable chemicals, including improved application and pest sampling methods

5 target areas of IPM research/implementation

Basic biological studies of the pest and natural enemies under Hawaii conditions (life history, life table or other demographic studies, infestation biology, emigration from feral coffee, seasonal mass immigrations, survival during periods when coffee berries are not available on trees)

Infestation biology and life history of CBB: New discoveries

(Desperate Times Require Desperate Measures)

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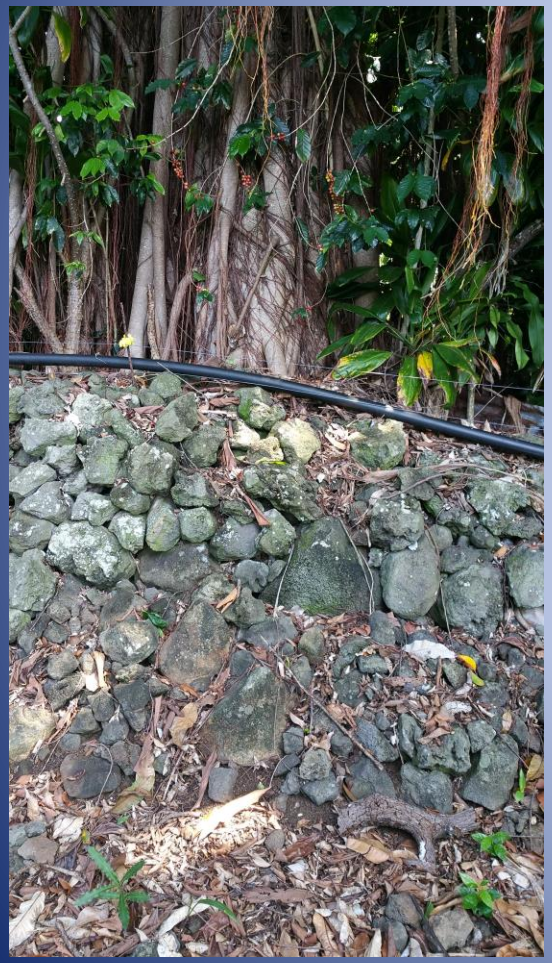

Fate of CBB in Berries with and without ground cover

Results After 4 weeks

Bob Nelson's Farm			Number of Adult Females per 10 berries				
Set up October 8, 2015							
Adult Beetles		15-Oct	23-Oct	29-Oct	4-Nov	SUBTOTAL	Beetles/Berry
Plot 1	Bare	15	39	24	26	104	2.6
Plot 2	Grass	74	11	27	7	119	3.0
Plot 3	Bare	15	20	13	27	75	1.9
Plot 4	Grass	40	7	2	1	50	1.3
					6 of 10 "rotten"		

Results from Bare vs. Groundcover

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					6 of 10 "rotten"		

12-Nov	18-Nov	25-Nov	2-Dec	8-Dec	16-Dec	SUBTOTAL	Beetles/Berry	TOTALS	
20	22	28	37	76	35	218	3.6	322	Bare
16	7	0	3	27	9	62	1.0	181	Grass
21	12	2	18	47	16	116	1.9	191	Bare
0	0	3	4	23	0	30	0.5	80	Grass
					4 berries				



- Upon emergence, F1 or F2 females may bore into berries of the same coffee plant (common), or colonize trees some distance away (rarely up to 500 meters away). Males never leave the fruit.
- There can be three to five generations per season. Up to a hundred beetles can be found in a single fruit.
- **The insect is very sensitive to desiccation and waits for the rains to leave the fruit.** The most affected areas in the crops are the shady and moist ones.


19
190
11
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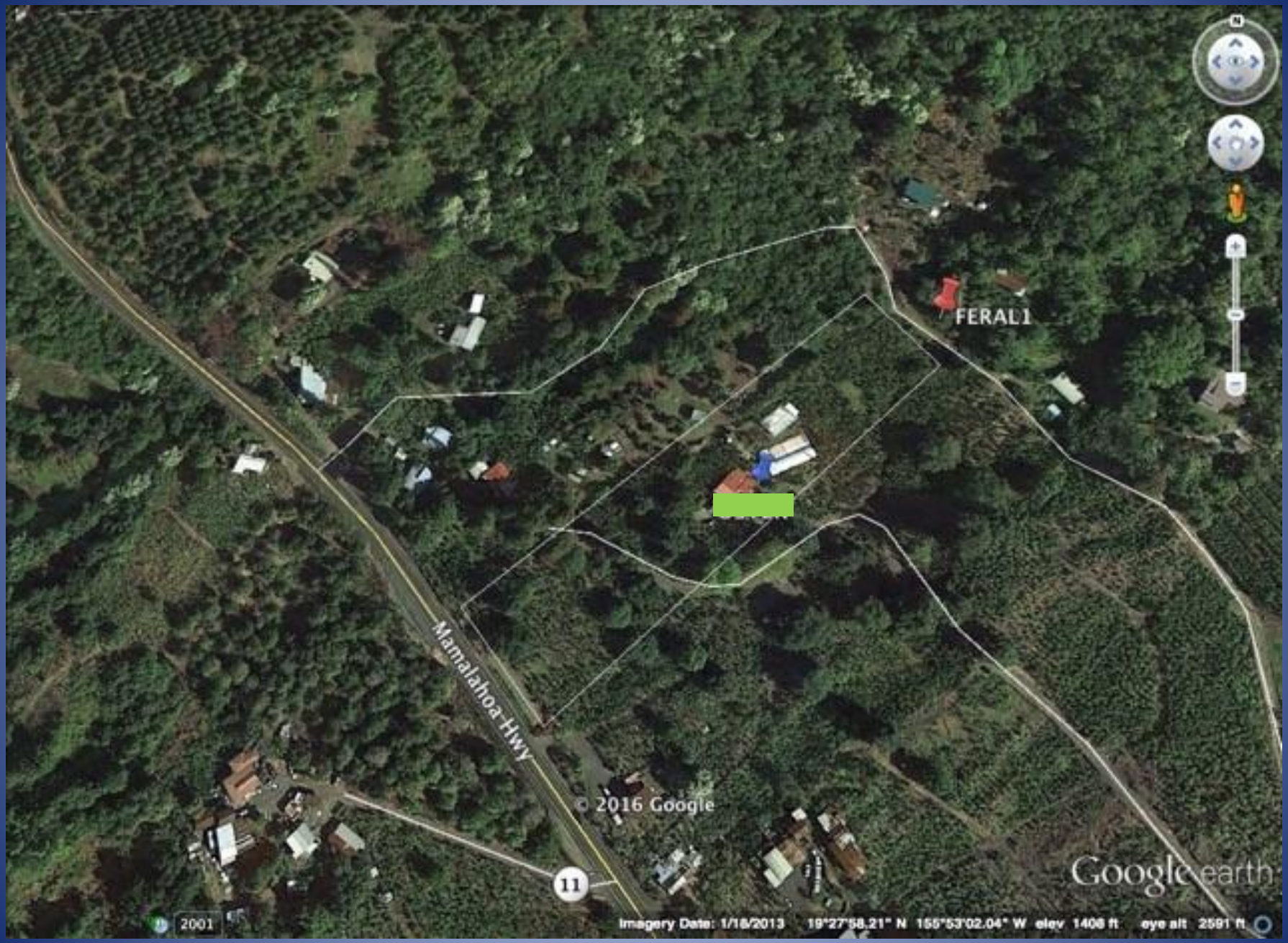
Data LDEO-Columbia, NSF, NOAA
Data MBARI
Image Landsat
Google earth
Imagery Date: 12/13/2015 19°28'27.01" N 155°30'13.40" W elev 10330 ft eye alt 75.42 mi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Mamalahoa Hwy
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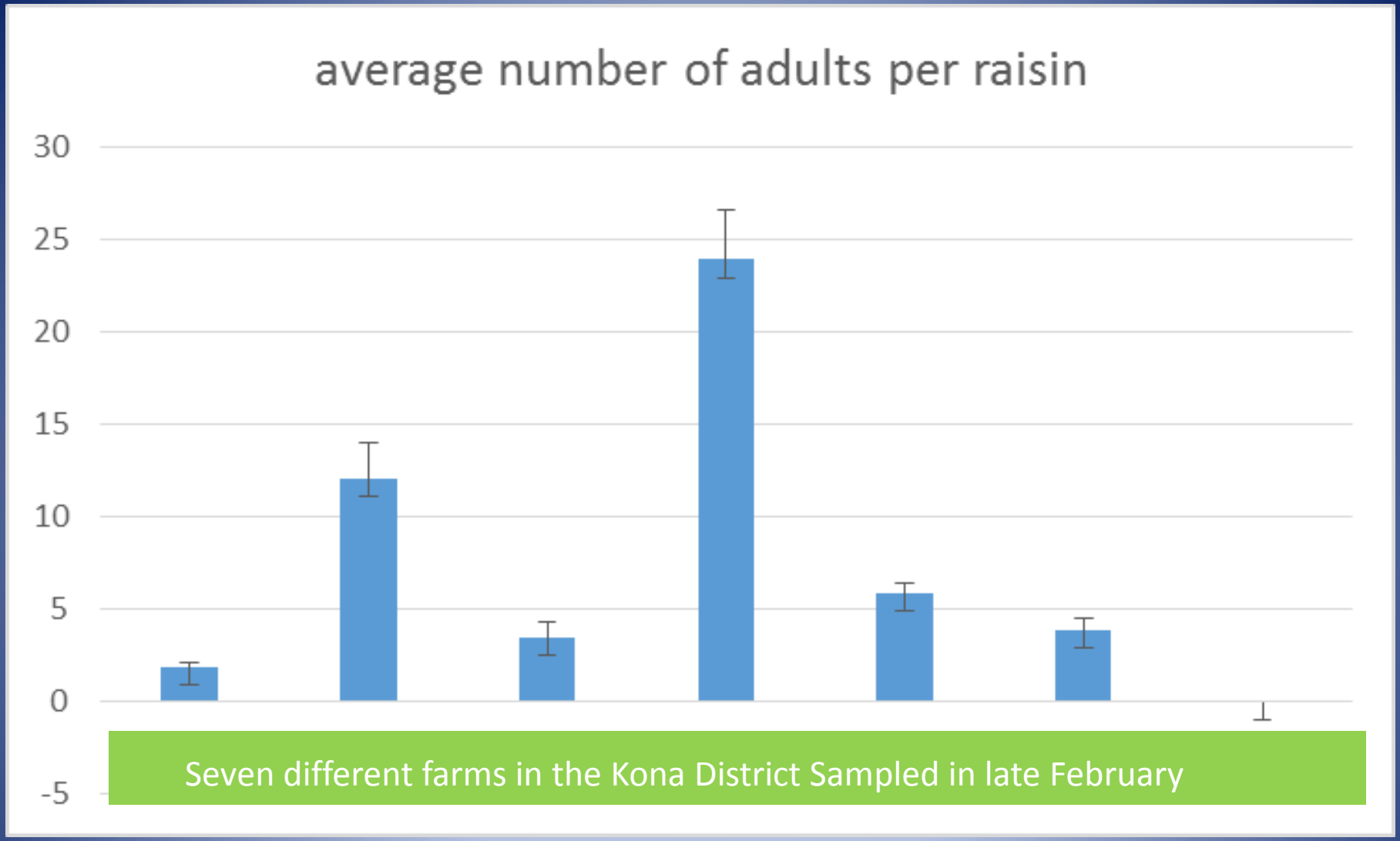
© 2016 Google
Google earth
2001
Imagery Date: 1/18/2013 19°27'58.21" N 155°53'02.04" W elev 1408 ft eye alt 2591 ft


average number of adults per raisin
30
25
20
15
10
5
0
-5
Seven different farms in the Kona District Sampled in late February

5 target areas of IPM research/implementation

- Development and demonstration of farming systems which document the cost, efficiency, and practicality of individual IPM components and include information on yield, quality and profit

5 target areas of IPM research/implementation

- Cultural methods to reduce pest incidence or facilitate IPM (planting density, pruning methods, shade, irrigation, windbreaks, ground covers and other inter-crops, techniques for synchronizing flowering)

Tactics for IPM implementation in Hawaii

Inspect: Use traps to detect movement, use infestation counts (% berries with holes, positions of beetles in berries)

Reduce: Well-timed Beauveria, sprays, pyronyl, Surround, pruning techniques, physical barriers, predators, repellents

Remove: frequent and thorough harvesting, strip picking, stumping, plant growth hormones for uniform flowering, ground covers

Square-Necked Grain Beetle, ***Cathartus*** *quadricollis*

Ethanol/methanol trap used for timing of *Beauveria* sprays

Ethanol/methanol trap used for timing of *Beauveria* sprays