USDA-Forest Service Project Proposal

March 23, 2015

1 Project Number

2 Project Title

Detector Beetles: Radio-Tracking Coconut Rhinoceros Beetles to Discover Breeding Sites

3 Fiscal Year of Project Submittal

FY2015

4 Expected Completion Date

FY2016

5 Status of Subject Species

non-native invasive

6 Brief Description of Project

Eradication and local extirpation of the coconut rhinoceros beetle (CRB) requires location and destruction of breeding sites where all life stages aggregate. Adult males and females find these sites during flight by detecting an aggregation pheromone and possibly other chemical and physical stimuli.

We propose a field trial on Guam to test the feasibility of locating CRB breeding sites by radio-tracking adults with miniature radio transmitters attached to them. Members of the research team have experience in radio-tracking insects and this technology is likely to work very well with this large beetle. The field trial will be performed on Guam during a 7 to 10 day period during FY2015. Additional funding for further research will be requested if the feasibility test is a success.

7 Project Objectives

- to develop radio tracking techniques to follow adult CRB in the field
- to find at least one undiscovered CRB breeding site

8 Justification and Urgency/Product Leveraging

- The detector beetle concept has potential as a rapid response tactic in a new CRB infestation. If only male detector beetles are used, this will not significantly increase fecundity and they will cause only minor, short-term damage.
- Radio-tracking beetles to find cryptic breeding sites may prove to be a critical tactic for eradication of CRB on Oahu
- The technique is scalable and can be automated: rapid surveys of large areas can be done by releasing large numbers of radio-tagged adult males and then tracking these using an aircraft based data-logging receiver or automated terrestrial receiver grid
- The technique is a very cost effective alternative to the use of detector dogs. The beetles require no training and care and maintenance costs are negligible.
- There are precedents for using one insect to find another at low population densities (e.g. philanthine wasps, *Cerceris fumipennis*, used to detect buprestid beetles, especially the emerald ash borer (Swink *et al.* (2013)).

9 Scope of Application

The scope of this project is limited radio-tracking adult coconut rhinoceros beetles in order to find aggregations at breeding sites. However, similar techniques could be developed for any large pest insects.

10 Measures of Success

10.1 Expected Outcomes

We expect to demonstrate the feasibility of detecting cryptic CRB breeding sites by tracking radio-tagged beetles.

10.2 Products and Due Dates

A ten-day intensive field trial will be done will be done on Guam during the first half of 2015 to test the feasibility of the detector beetle concept. A final report will be prepared within three months after conclusion of the field trial.

10.3 Benefits

Rapid detection and destruction of CRB breeding sites is critical to the success of CRB control and eradication programs. Tracking radio-tagged beetles may prove to be a cost-effective method of detecting CRB breeding sites at very low population levels. This highly sensitive detection methodology is particularly needed in the late stages of eradication projects.

11 Technology Transfer

After further development, it is hoped that CRB radio-tracking technology will be rapidly transferred to USDA APHIS and Hawaii Department of Agriculture staff working on the eradication project currently underway on the Island of Oahu, in and around Honolulu. All members of our proposed research team have served as subject matter experts for the Hawaii CRB Eradication Project and two of them (EJ and AH) live and work in Hawaii. Hawaii CRB Eradication Project managers and staff will be briefed and trained in the use of beetle radio tracking protocols.

Further refinement of tracking protocols, beyond the scope of this pilot study, will likely need to be undertaken to tailor this technology to the Hawaiian context. Radio-tracking equipment on Guam may be readily deployed following early detection of CRB on other islands in Micronesia.

12 Research Basis

Radio tracking has been used successful with several large scarab beetles in tropical areas, namely Taiwan (McCullough (2012)) and Papua New Guinea (Beaudoin-Ollivier *et al.* (2003)). McCullough (2012) was able to track 17 individual beetles with tracking times ranging from 1 to 10 days. In this study beetles were never tracked moving more than a half a kilometer. By contrast, Beaudoin-Ollivier *et al.* (2003) tracked 15 individual beetles, many of which flew out of range ($>$ 1 km, mostly females) shortly after being released. However, males that were able to be tracked, were observed in both feeding and breeding sites in a variety of microhabitats.

One of us (MS) has been working with radio tracking a large moth, the fruit piercing moth, *Eudocima phalonia*, over the last two years. While this moth is smaller than the

coconut rhinoceros beetle, it was easily able to carry the transmitter and performed well in a number of flight tests both in Hawaii and northern Australia. Moths with radio transmitters were released in northern Australia and followed over the course of several days through orchards, farmland, and open forested areas. This success with previous insect tracking gives us confidence that we can successfully track the coconut rhinoceros beetle in the field.

Insects have highly developed olfactory systems and search behaviors that allow them to find conspecifics, host and breeding sites, and/or prey. We are not the first to propose or develop techniques using one insect to find another. Swink *et al.* (2013) detailed the use of philanthine wasps, *Cerceris fumipennis*, to detect buprestid beetles, especially the emerald ash borer. Buprestid beetles can be can be difficult to find in the environment and especially so as a new invasive. Early detection of the emerald ash borer, with the help of these wasps, is an example of using an insect's behavior to help with delimitation of a low population density pest.

13 Methods

- Male beetles will be measured, weighed and flight tested beetles prior to selection for tagging, using Vander Meer (1987) as a guide.

- A miniature radio transmitter (Advanced Telemetry Systems (ATS) 2414) will be glued to the thorax of each selected beetle (Figure 1). Each transmitter has a unique frequency and is detectable for at least 0.5 km with ATS R410 scanning receivers.

- Beetles with transmitters will be released shortly after sunset in large open areas (e.g. golf courses) and tracked immediately with two person teams. Each team member equipped with a scanning radio receiver, a Yagi antenna, and a GPS receiver. Matt Siderhurst will bring two students, who are experienced radio-trackers, to Guam to assist in the field trial.

- Subsequent releases will test whether beetles can be found without continual following by tracking teams. The flight period for CRB is during three hours following sunset. This beetle does not fly during the day, so it should be possible to find the exact location of all detected radio tags during each day for several days after beetle release. We expect that some of the tagged beetles will be found at breeding sites.

- Beetle movements will be recorded as GPS waypoints and mapped using GIS software.

14 Appendix 1- Budget

14.1 Budget Request

	Item	Requested FHP STDP Funding	Other Source Funding	Source
FY 2015				
Administration	Salary	$0		
	Overhead	$0		
	Travel	$12,410		
Procurements	Contracting	$0		
	Equipment	$0		
	Supplies	$7,590		
Year Total		$20,000		

14.2 Budget Request Explanation

Travel: Roundtrip airfare and per diem for 10 days on Guam.

- Airfare for Matt Siderhurst and 2 students, VA-Guam: 3 * $1706.66 = $5120
- Per diem: 3 people * 10 d * $243 = $7290

Supplies: Radio-tracking equipment will be purchased from Advanced Telemetry Systems (ATS) to match the receivers and antennae owned by Aubrey Moore and Matt Siderhurst. All 4 tracking systems will be used in the field trial. GPS equipment will be borrowed from the Guam CRB Project.

- glue-on transmitters ATS A2414: 30 * $190 = $5,700
- Yagi antennas 162-166 MHz - ATS 13863: 2 * $120 = $240
- receivers - ATS R410: 2 * $825 = $1,650

15 Appendix 2 Cooperators

15.1 FHP Lead Contact

Sheri Lee Smith
USDA Forest Service, Pacific Southwest Region
Phone: 530-252-6667
E-mail: ssmith11@fs.fed.us
Fax:

15.2 Principal Investigators

Aubrey Moore
(PI responsible for fiscal management of grant)
College of Natural and Applied Sciences, University of Guam
Phone: 671-686-5664
E-mail: aubreymoore@guam.net
Fax: 671-734-1244

Matthew Siderhurst
Department of Chemistry, Eastern Mennonite University
Phone: 540-432-4382
E-mail: matthew.siderhurst@emu.edu
Fax: 540-432-4488

Eric Jang
USDA, ARS, Daniel K. Inouye U.S. Pacific Basin Agricultural Research Center
Phone: 808-959-4340
E-mail: eric.jang@ars.usda.gov
Fax: 808-959-4319

15.3 Cooperators

Arnold Hara
College of Tropical Agriculture and Human Resources, University of Hawaii
Phone: 808-981-5199
E-mail: arnold@hawaii.edu
Fax:808-981-5211

Roland Quitugua
College of Natural and Applied Sciences, University of Guam
Phone: 671-735-2093
E-mail: rquitugua@uguam.uog.edu
Fax: 671-734-1244

16 Appendix 3 – Literature Citations, Figures, Tables, Attachments, etc.

References

Beaudoin-Ollivier, Laurence, Bonaccorso, Frank, Aloysius, Michael, & Kasiki, Mathew. 2003. Flight movement of *Scapanes australis australis* (Boisduval)(Coleoptera: Scarabaeidae: Dynastinae) in Papua New Guinea: a radiotelemetry study. *Australian Journal of Entomology*, **42**(4), 367–372.

Goebel, FR, Sallam, N, Samson, PR, Chandler, K, *et al.* . 2010. Quantifying spatial movement of the greyback cane beetle in the sugarcane landscape: Data available and research needs. *Pages 71–83 of: Proceedings of the Australian Society of Sugar Cane Technologists*, vol. 32.

Hedin, Jonas, & Ranius, Thomas. 2002. Using radio telemetry to study dispersal of the beetle *Osmoderma eremita*, an inhabitant of tree hollows. *Computers and Electronics in Agriculture*, **35**(2), 171–180.

Hedin, Jonas, Ranius, Thomas, Nilsson, Sven G, & Smith, Henrik G. 2008. Restricted dispersal in a flying beetle assessed by telemetry. *Biodiversity and conservation*, **17**(3), 675–684.

McCullough, Erin L. 2012. Using radio telemetry to assess movement patterns in a giant rhinoceros beetle: are there differences among majors, minors, and females? *Journal of insect behavior*, 1–6.

Naef-Daenzer, B, Früh, D, Stalder, M, Wetli, P, & Weise, E. 2005. Miniaturization (0.2 g) and evaluation of attachment techniques of telemetry transmitters. *Journal of experimental biology*, **208**(21), 4063–4068.

O'Neal, ME, Landis, DA, Rothwell, E, Kempel, L, & Reinhard, D. 2004. Tracking insects with harmonic radar: a case study. *American entomologist*, **50**(4), 212–218.

Riecken, Uwe, & Raths, Ulrike. 1996. Use of radio telemetry for studying dispersal and habitat use of *Carabus coriaceus* L. *Pages 109–116 of: Annales Zoologici Fennici*, vol. 33. Helsinki: Suomen Biologian Seura Vanamo, 1964-.

Rink, M, & Sinsch, U. 2007. Radio-telemetric monitoring of dispersing stag beetles: implications for conservation. *Journal of Zoology*, **272**(3), 235–243.

Sato, Hirotaka, & Maharbiz, Michel M. 2010. Recent developments in the remote radio control of insect flight. *Frontiers in Neuroscience*, **4**(199).

Swink, WG, Paiero, SM, & Nalepa, CA. 2013. Buprestidae collected as prey by the solitary, ground-nesting philanthine wasp *Cerceris fumipennis* (Hymenoptera: Crabronidae) in North Carolina. *Annals of the entomological society of america*, **106**(1), 111–116.

Vander Meer, Robert K. 1987. Per cent emergent weight: a roadmap to adult rhinoceros beetle, *Oryctes rhinoceros*, behaviour. *Journal of insect physiology*, **33**(6), 437–441.

Figure 1: Greyback cane beetle with a miniature radio transmitter and antenna glued to its thorax.