

Status of a Major Outbreak of Coconut Rhinoceros Beetle, *Oryctes rhinoceros* Biotype G, on Guam and Attempts at Establishing Biological Control



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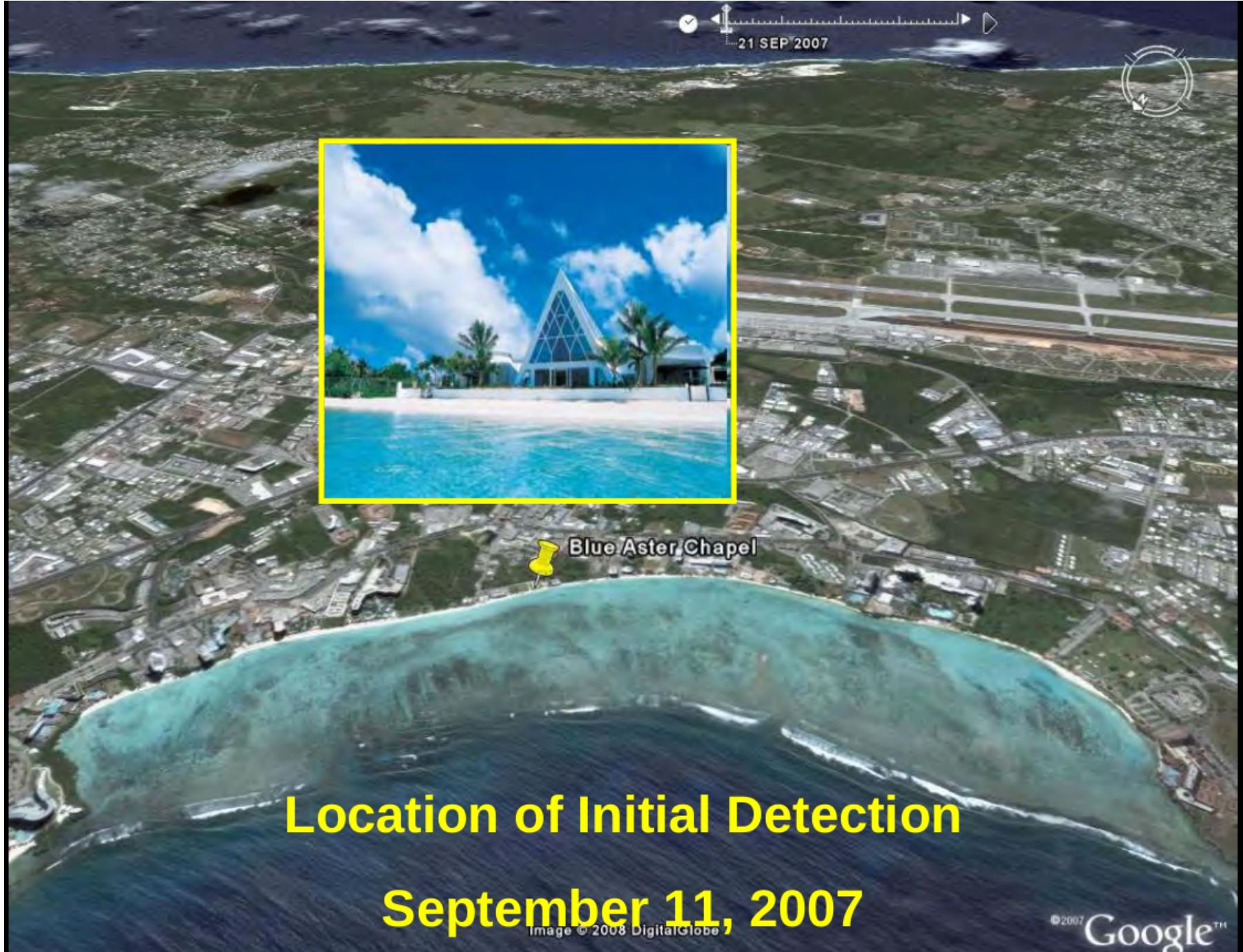
Outline

- **Introduction**
- CRB Invasion History
- CRB Population Dynamics
- Recent CRB Activity on Guam
 - Biological Control
 - Damage Survey
 - Online Resources

Guam







Location of Initial Detection

September 11, 2007
Image © 2008 DigitalGlobe

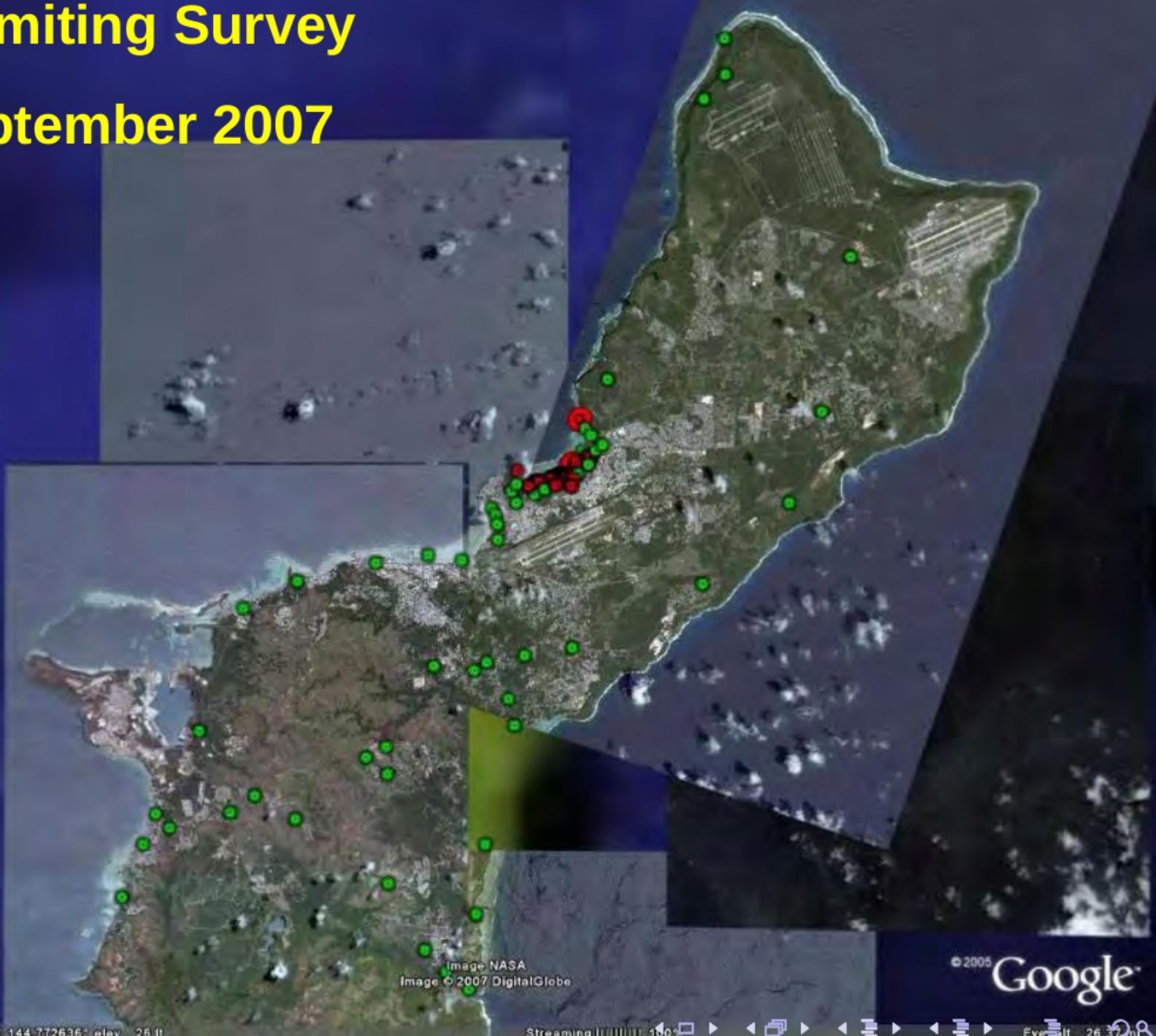
Pointer lat 13.505226° lon 144.802428°

Streaming | 100%

Digitized by Google

Delimiting Survey

September 2007



How to Eradicate CRB

- **Sanitation:** Locate and destroy all active and potential breeding sites.
- **Quarantine:** Close pathways to prevent re-introduction and accidental transport to uninfested areas.
- Note: Only one of many CRB eradication programs has succeeded (Niuatoputapu Is., aka Keppel Is., Tonga; 16 km²).

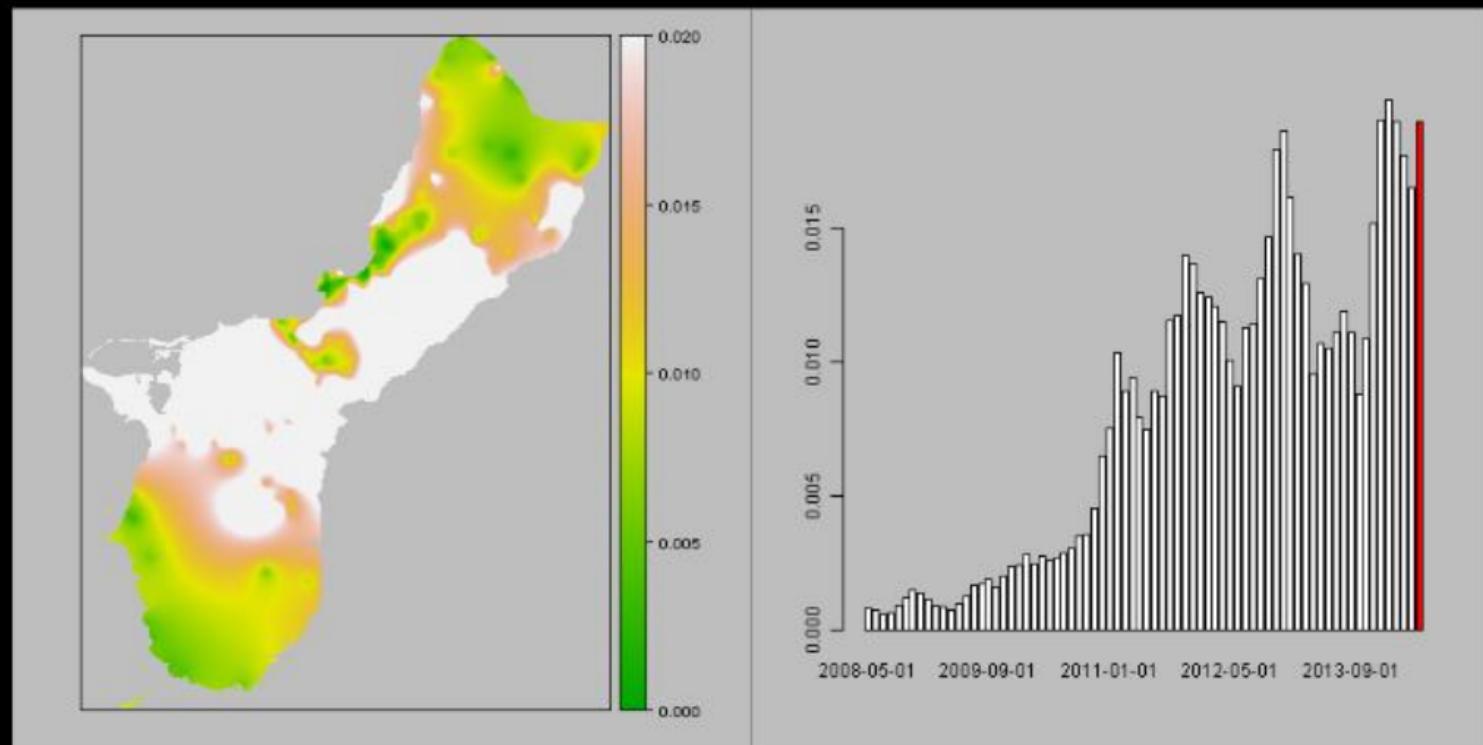
Initial Quarantine Area

September 2007



Guam Pheromone Trap Catch Data

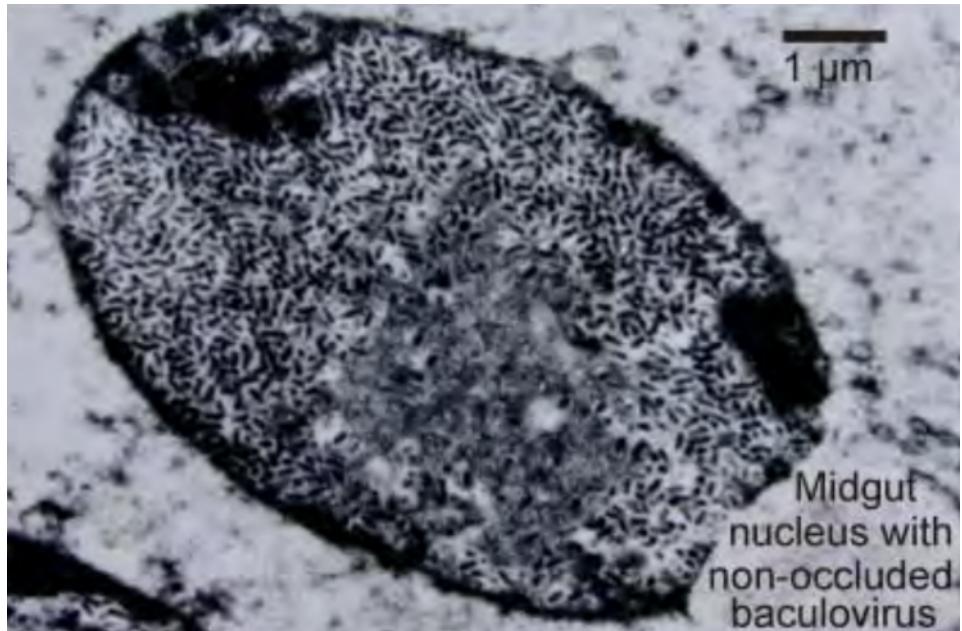
90 day trapping period ending on 01 Jun 2014



Mean number of beetles caught per trap-day

Biocontrol

Oryctes rhinoceros nudivirus
(OrNV)



Green muscardine fungus (GMF)
Metarhizium majus



Discovery of the CRB-G Biotype

Marshall, S. D. G., Moore, A., Vaqalo, M., Noble, A., & Jackson, T. A. (2017).

**A new haplotype of the coconut rhinoceros beetle,
Oryctes rhinoceros, has escaped biological
control by *Oryctes rhinoceros* nudivirus and is
invading Pacific Islands.**

Journal of Invertebrate Pathology, 149, 127–134.
<https://doi.org/10.1016/j.jip.2017.07.006>

Characteristics of CRB-G

- genetically distinct
- resistant to all available isolates of OrNV
- behavioral differences ???
 - not highly attracted to oryzalure
 - higher per-capita damage

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Coconut rhinoceros beetle invasion history

native range

first detected in the 20th century

first detected in the 21st century

open circle: population includes CRB-G biotype

filled circle: population is exclusively CRB-G biotype

© Mapbox © OpenStreetMap Improve the underlying map

North
Pacific
Ocean



map.geojson rendered with ❤ by GitHub

Data available at <https://github.com/aubreymoore/crbdist>

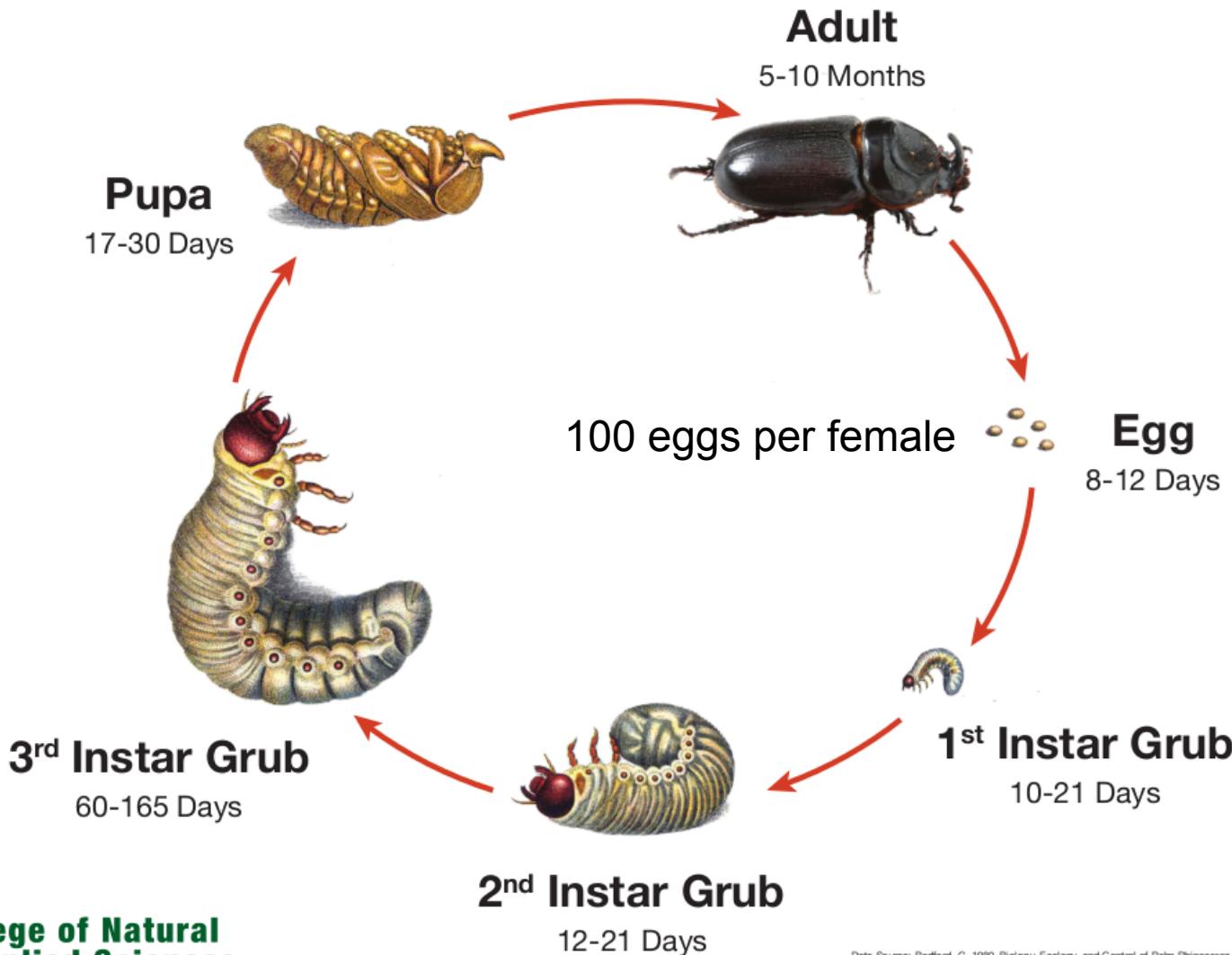
Screen capture from <http://aubreymoore.github.io/crbdist/mymap.html> 2018-08-05

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LIFE CYCLE OF THE COCONUT RHINOCEROS BEETLE

Oryctes rhinoceros



**College of Natural
& Applied Sciences**
University of Guam | Unibetsedåt Guåhan

Data Source: Bedford, G. 1980. Biology, Ecology, and Control of Palm Rhinoceros Beetles. *Annual Review of Entomology* 25: 309-339.

Published by the College of Natural & Applied Sciences, CNAS, University of Guam, in cooperation with the U.S. Department of Agriculture, under Dr. Lee S. Yudin, Director/Dean, University of Guam, CNAS, UOG Station, Mangilao, Guam 96923. Copyright 2016. For reproduction and use permission, contact CNAS-Media Events at events@cnas.gu.edu. (671) 735-2000. The University of Guam is an equal opportunity affirmative action institution providing programs and services to the people of Guam without regard to race, gender identity and expression, age, religion, color, national origin, ancestry, disability, marital status, sexual orientation, or status as a covered veteran. Find CNAS publications at cnas-ri.unig.edu.

CRB Population Growth May Be Explosive

| Generation | Number of Beetles |
|-------------------|--------------------------|
| 0 | 2 |
| 1 | 100 |
| 2 | 5,000 |
| 3 | 250,000 |
| 4 | 12,500,000 |
| 5 | 625,000,000 |
| 6 | 31,250,000,000 |
| 7 | 1,562,500,000,000 |
| 8 | 78,125,000,000,000 |

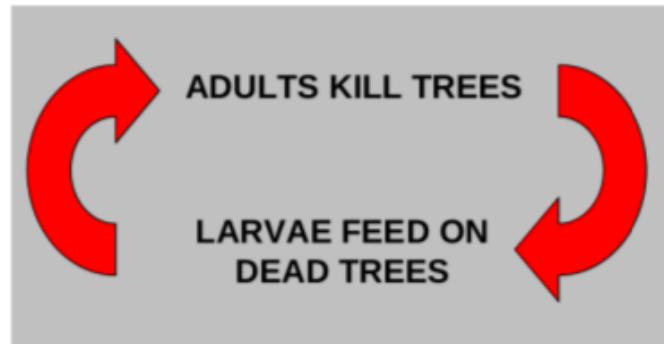


Figure : Coconut palms killed by *Oryctes rhinoceros* in Fiji (photo by Bedford)



The current outbreak was triggered by Typhoon Dolphin which visited Guam in May 2015. Adult CRB emerging from abundant breeding sites where numerous to start killing mature coconut palms.

Dead standing coconuts are now generating further generations of CRB which are killing even more palms.

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Recent OrNV / CRB-G Bioassay Results

Table 1: *Oryctes rhinoceros* nudivirus (OrNV) bioassay results summary.

| OrNV isolate | bioassay | method ¹ | beetles | replicates | virus mortality (<i>p</i>) ² | inactivated virus mortality (<i>p</i>) ³ |
|--------------|-----------------------|---------------------|---------|------------|---|---|
| DUG42 | DUG42[1] | injection | 30 | 2 | 40% (0.65) | 40% (0.65) |
| MALB | MALB[2] | injection | 30 | 2 | 50% (0.37) | 0% (1.00) |
| | MALBperOS[3] | per os | 13 | 1 | -60% (1.00) | 20% (1.00) |
| PNG | PNG[4] | injection | 81 | 4 | 90% (0.00) | 5% (1.00) |
| | PNGperOS[5] | per os | 21 | 1 | 0% (1.00) | 0% (1.00) |
| V23B | V23B[6] | injection | 66 | 4 | 88% (0.00) | 0% (1.00) |
| | V23BperOS[8] | per os | 32 | 2 | 80% (0.07) | 20% (0.69) |
| | V23-large_bioassay[7] | per os | 53 | 1 | 42% (0.00) | - |
| | V23_perOSIN[9] | per os | 16 | 1 | 60% (0.06) | - |

¹ Adult beetles were dosed either by direct injection of virus suspension into the haemocoel or by applying a droplet containing virus to mouthparts.

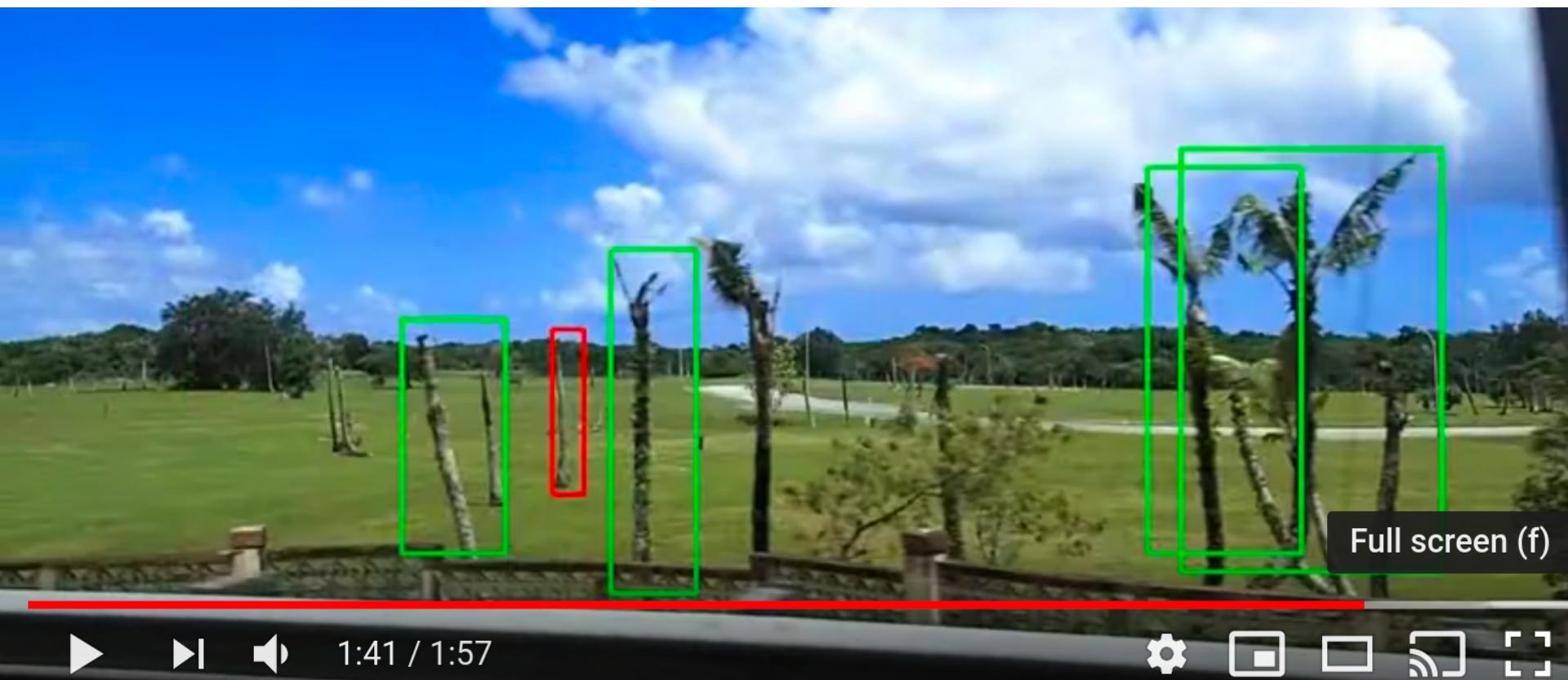
² Percent mortality in beetles treated with virus, adjusted for untreated control mortality; number in parentheses is the *p*-value resulting from a Fisher's exact test of significant difference between mortality of treated and untreated beetles.

³ Percent mortality in beetles treated with heat inactivated virus, adjusted for untreated control mortality; number in parentheses is the *p*-value resulting from a Fisher's exact test of significant difference between mortality of treated and untreated beetles.

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Automated Mapping of CRB Damage from Roadside Video Surveys



Screen capture from <https://www.youtube.com/watch?v=zzSorqcmt9U> 2019-11-04

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Online Resources

- CRB Bibliography
<https://github.com/aubreymoore/CRB-Bibliography>
- Interactive CRB Invasion History Map
<http://aubreymoore.github.io/crbdist/mymap.html>
- CRB Wiki Site
<https://guaminsects.net/CRBG>
- CRB-G Facebook Site
<https://www.facebook.com/groups/crbg07/>

