

Biological Invasion of Guam

A Presentation for the Indigenous Fellows Institute at Guam Community College

Aubrey Moore

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June 7, 2013

Biological Invasion of Guam



Presentation for the Micronesia Biosecurity Plan Meeting, Guam, Jan. 19, 2010

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Cooperative Extension Service / Western Pacific Tropical Research Center

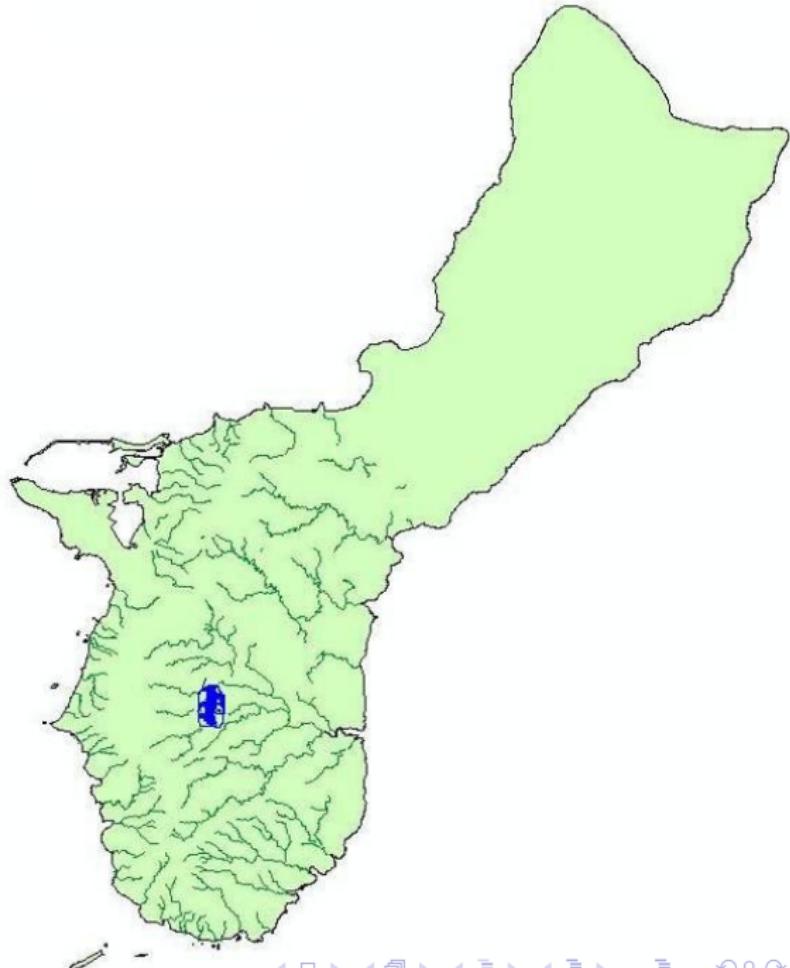
Guam's Physical Environment

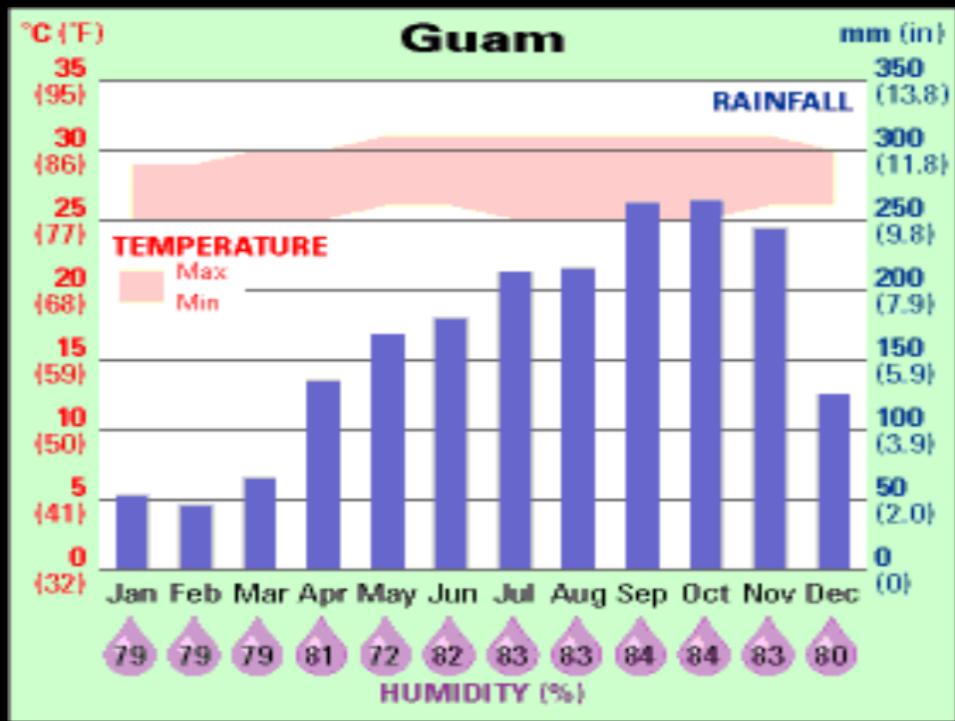
Age: 40 million years

Dimensions: 48 km long; 6-9 km wide

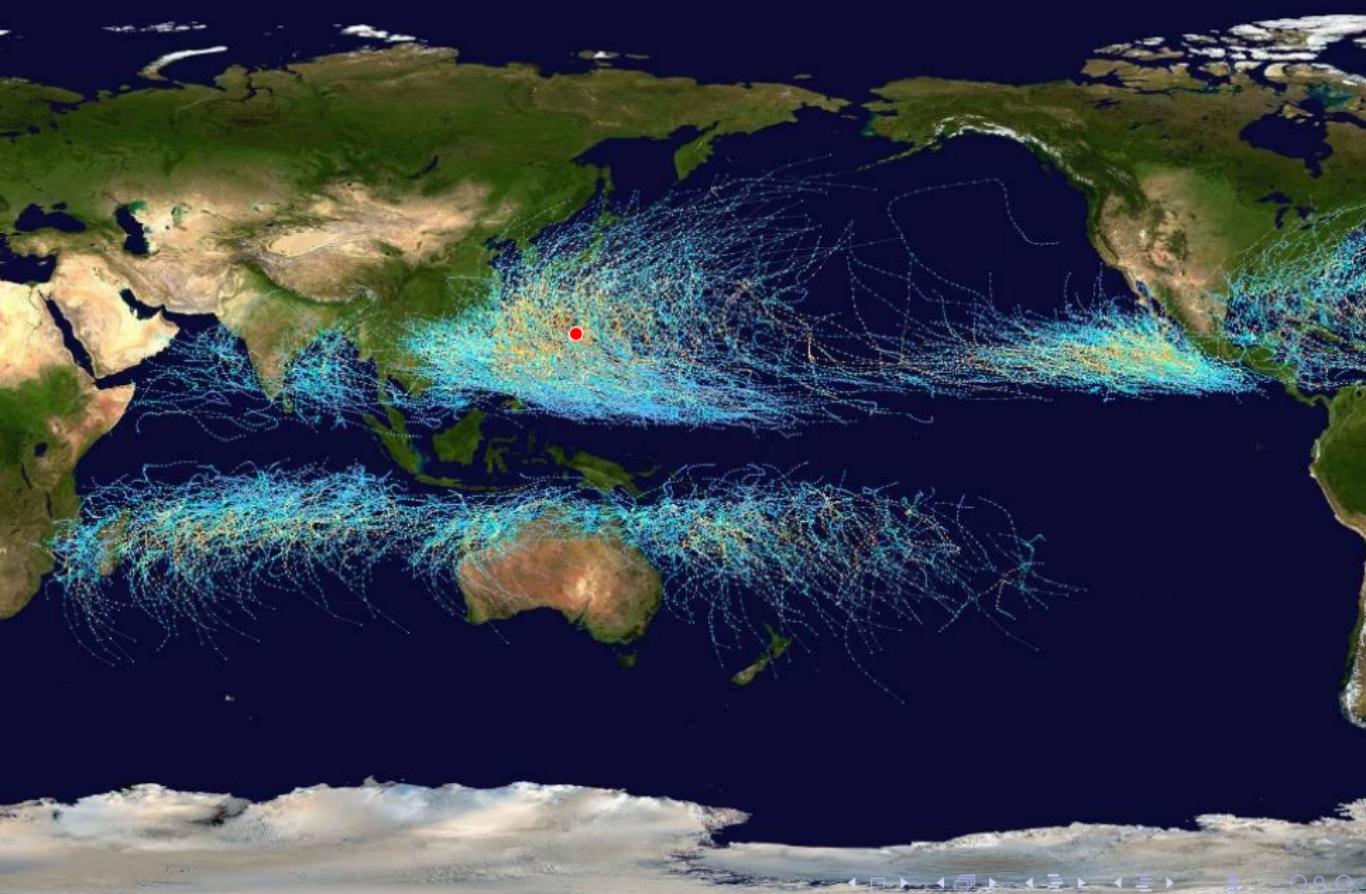
Area: 549 km²

Max. elevation: 407 m



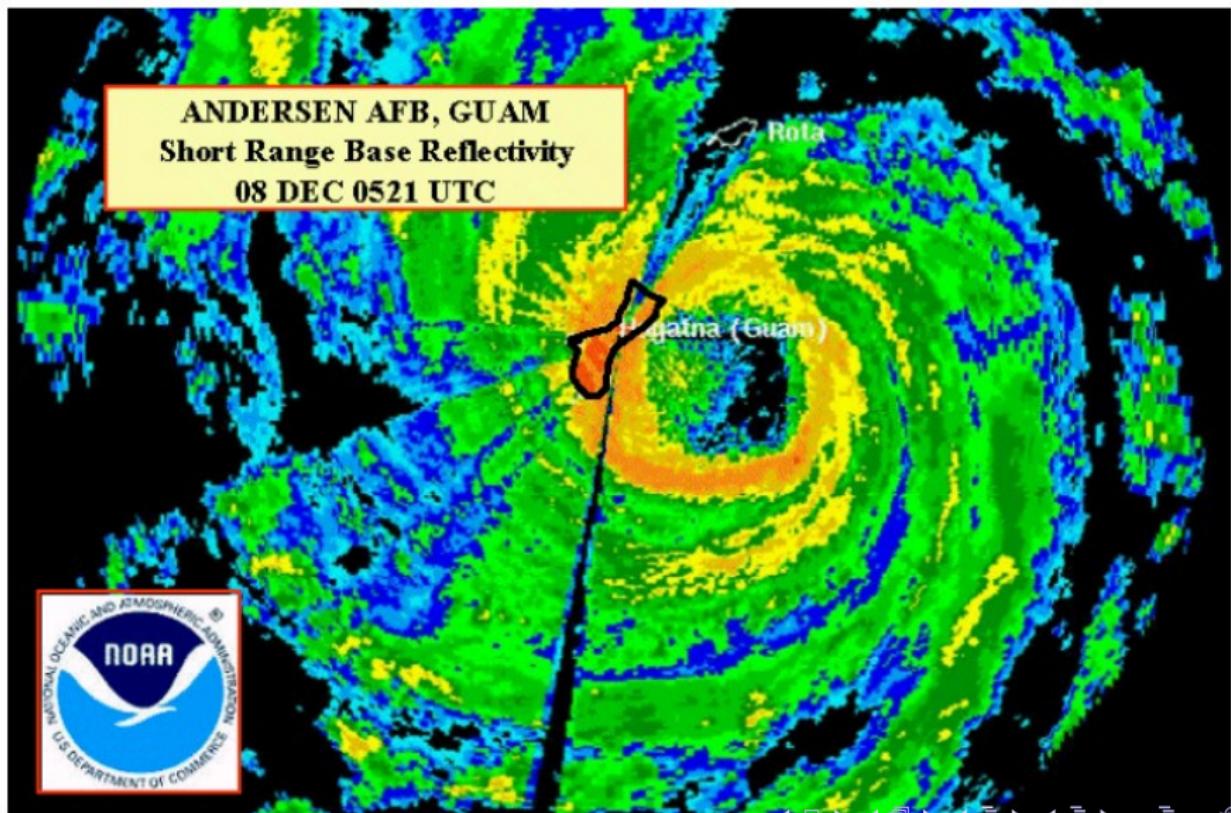


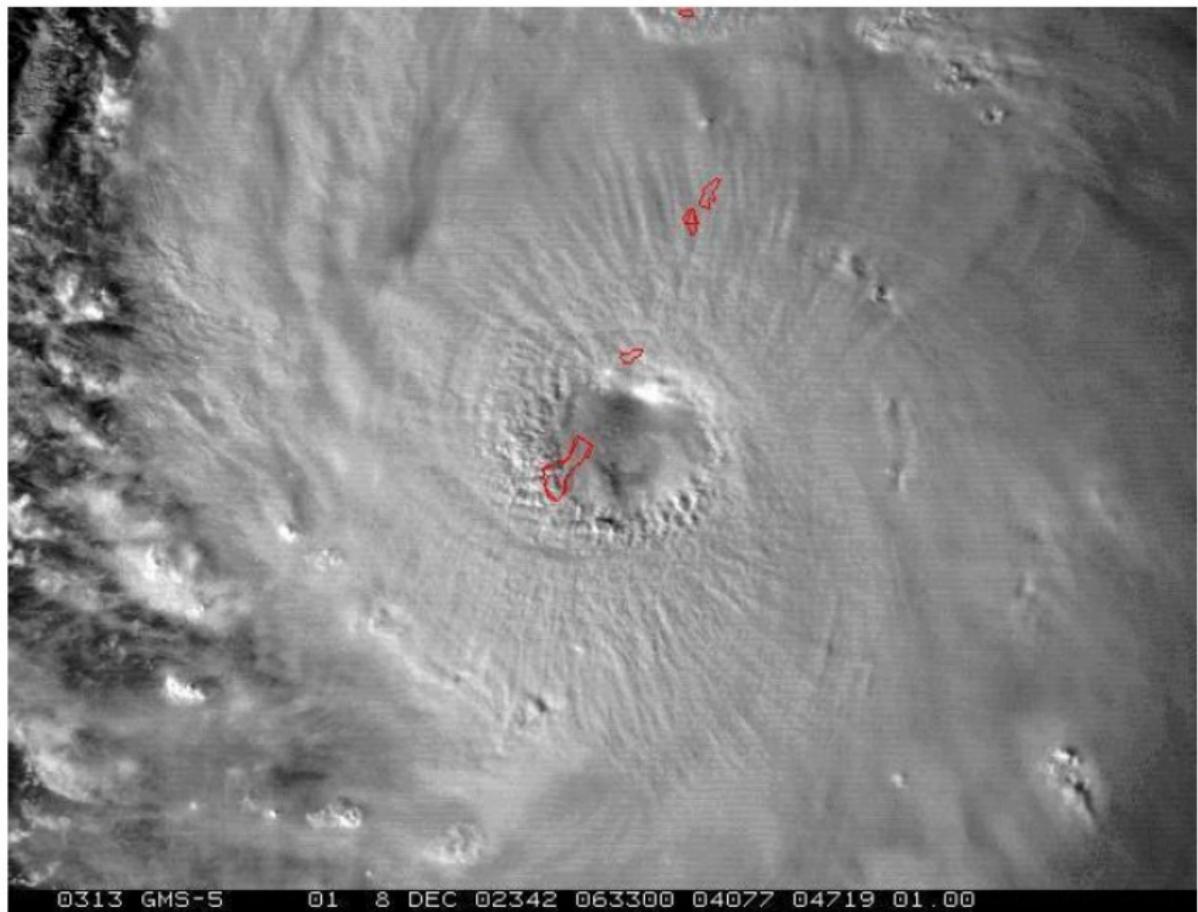
This map shows the tracks of all Tropical cyclones which formed worldwide from 1985 to 2005.



Super Typhoon Pongsona

December 8, 2002





0313 GMS-5 01 8 DEC 02342 063300 04077 04719 01.00

Visible satellite image of Pongsona as seen by the Japanese Geostationary Meteorological Satellite (GMS-5) at 4:30 p.m., December 8, 2002. The island of Rota is located just north of the eye. (Courtesy of the Wisconsin Co-operative Institute for Meteorological Satellite Studies)



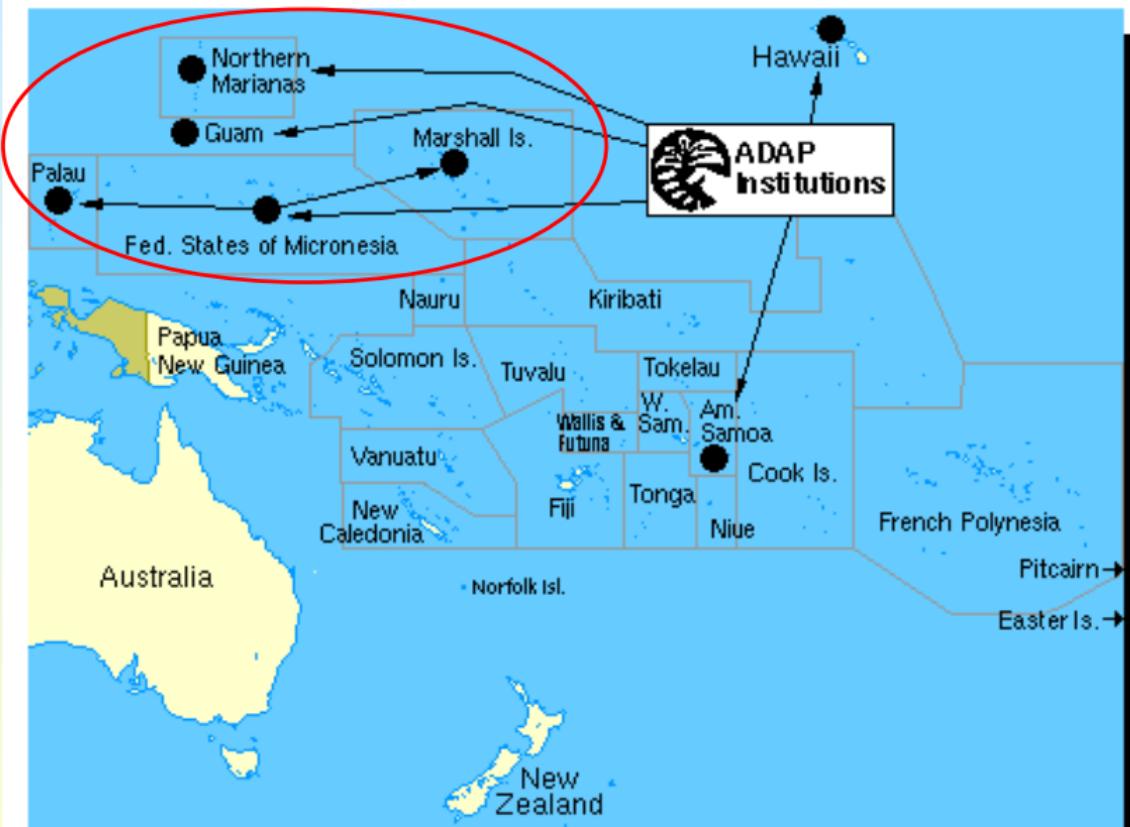


History of Guam

- Prehistory: 1,500 BC to 1521
- Spanish period: 1521 to 1898
- American prewar period: 1892 to 1941
 - Under an appointed naval governor
- Japanese occupation: 1941 to 1944
- American period: 1944 to present
 - Under an appointed naval governor until 1950
 - The organic act of 1950 gave residents US citizenship with limited political representation



US Land Grant Institutions





Air and sea traffic patterns in the Asia-Pacific region

"Invasive species" means an **alien** species whose introduction does or is likely to cause economic or environmental **harm** or harm to human health.

- Executive Order 13112 signed by President William Clinton on February 3, 1999.

“invasive species” = “exotic pests”



Brown tree snake
An invasive species



Ramphotyphlops braminus
with a penny for scale.

Blind snake
Not an invasive species

Why such a fuss about invasive species?

All animals and plants, or their ancestors, arrived on Guam arrived from elsewhere.

So, what's the fuss with invasive species?

Why such a fuss about invasive species?

Before man, 1 new species arrived on Guam every few thousand years

Currently, 1 new species arrives on Guam every few months

This is 10,000 times the natural rate!

Why such a fuss about invasive species?

Tropical island ecosystems are particularly susceptible to biological invasions for a couple of reasons:

Endemic species are at risk of extinction because they have not evolved defenses against alien predators, parasites, and diseases.

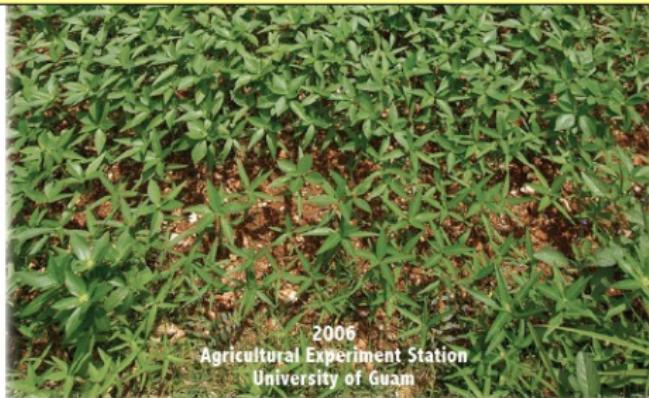
Much ecological and environmental damage is done when newly arrived species undergo an initial population explosion because:

- there are often no pre-existing natural biological control (parasites and predators)
- warm climate allows year round population growth

Plants (Weeds)



All of the 54 weeds listed in McConnell & Gutierrez 2006 are invasive species



2006
Agricultural Experiment Station
University of Guam

WEEDS OF GUAM

Weed #B2

Coccinia grandis

Cucurbitaceae

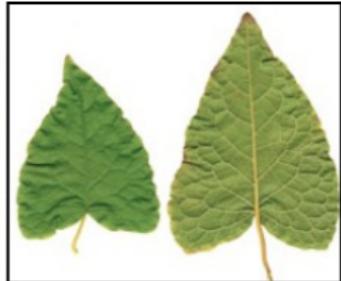


WEEDS OF GUAM

Weed #B1

Antigonon leptopus

Polygonaceae



Leaves with conspicuous veins



Fungi, Bacteria, Viruses

- 6 new plant pathogenic fungi were detected by UOG plant pathologists during 2007
- Most new fungi, bacteria, and viruses are detected only if they cause diseases to man, domesticated animals, or crops

Invasive Species in Guam's Marine Environment



There are now at least 73 species of non-native organisms found on Guam only in Apra Harbor, which implies they arrived via boat traffic.

-Brent Tibbatts, Guam DOA/DAWR,
personal communication





Image NASA
Image © 2007 DigitalGlobe

©2005 Google



Pointer 13°27'46.73" N 144°41'15.22" E

Image © 2007 DigitalGlobe

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Google



Pointer 13°27'41.43" N 144°40'13.09" E

Image © 2007 DigitalGlobe

© 2005 Google

Streaming 100% Eye alt 2848 ft



Image © 2007 DigitalGlobe

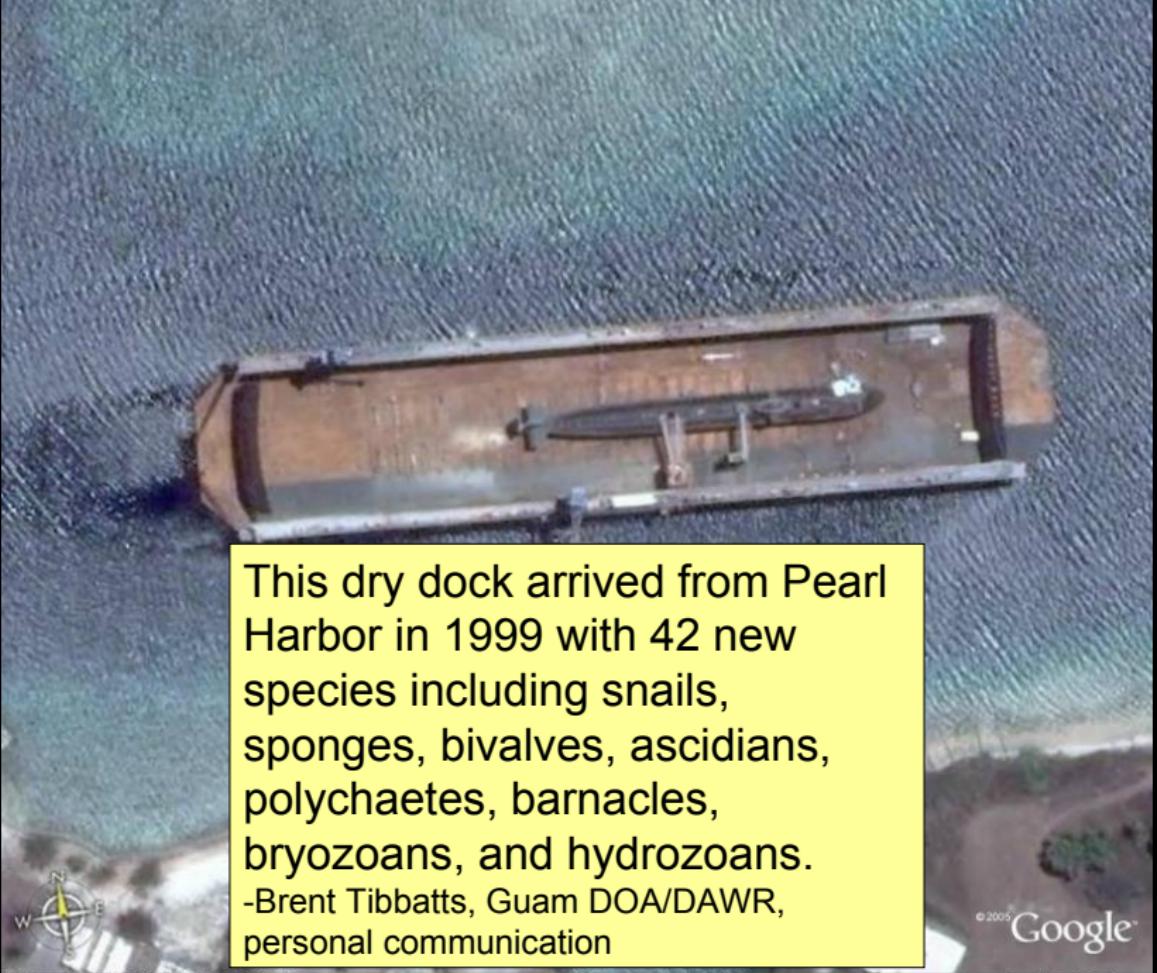
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Image © 2007 DigitalGlobe

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This dry dock arrived from Pearl Harbor in 1999 with 42 new species including snails, sponges, bivalves, ascidians, polychaetes, barnacles, bryozoans, and hydrozoans.

-Brent Tibbatts, Guam DOA/DAWR,
personal communication



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Mammals

- Man
- Ungulates
- Rodents

Ungulates





Before deer and pig fence erected March 2004 (NW Field AAFB)

22 months after deer and pigs excluded January 2006







Amphibians (Frogs & Toads)

- 13 invasive species (1 eradicated)
- Cane toad, *Bufo marinus*, introduced intentionally in 1937
- 8 new species of frogs detected on Guam between May 2003 and December 2005

Source: **Christy et al. 2007.** Recent records of alien anurans on the Pacific Island of Guam. Pacific Science 61(4) 469-483.





Reptiles (snakes, lizards, turtles)

19 invasive species



Insects

- **263 species of insects on Guam are listed as agricultural pests
>95% of these are invasive species**
- Including non-agricultural pests such as ants, termites, mosquitoes, and household pests invasive insect species on Guam probably exceeds 400

New Insect Pests Detected on Guam Since Jan. 2002

<i>Paracoccus marginatus</i>	papaya mealybug	2002
<i>Aulacaspis yasumatsui</i>	Asian cycad scale	2003
<i>Myllocerus sp.</i>	calamansi weevil	2004
<i>Pseudaulacaspis cockerelli</i>	false oleander scale	2004
<i>Metaleurodes cardini</i>	Cardin's whitefly	2004
<i>Nipaecoccus nipae</i>	coconut mealybug	2004
<i>Orthezia insignis</i>	greenhouse ensign coccid	2004
<i>Aleurotrachelus trachoides</i>	neotropical solanum whitefly	2004
<i>Chilades pandava</i>	cycad blue butterfly	2005
<i>Daphnis nerii</i>	oleander hawk moth	2005
<i>Quadrastichus erythrinae</i>	Erythrina gall wasp	2006
<i>Lepisiota frauenfeldi</i>	ant	2006
<i>Diaphorina citri</i>	Asian citrus psyllid	2007
<i>Tetraleurodes acaciae</i>	acacia whitefly	2007
<i>Henosepilachna sp.</i>	cucurbit lady beetle	2007
<i>Oryctes rhinoceros</i>	coconut rhinoceros beetle	2007

Nipaecoccus nipae, Coconut mealybug 2004







Why are Hemipterans so invasive?

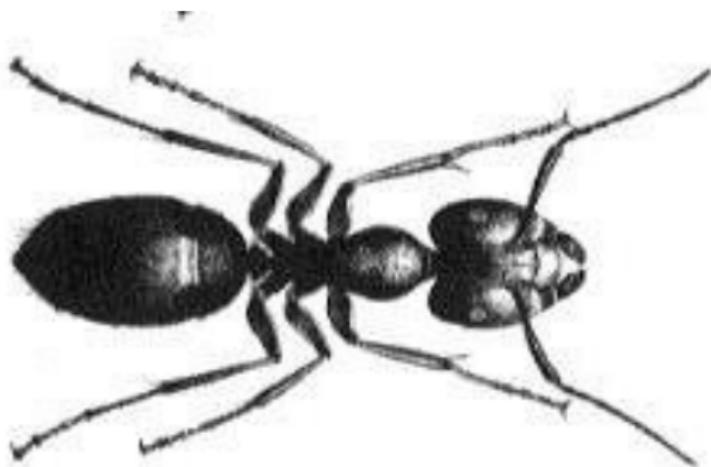
(The order Hemiptera include scales, mealybugs, whiteflies, aphids, psyllids, leafhoppers)

- Most are small and cryptic
- Many are not easily identified as insects
- Many reproduce without mating
- These sucking insects are often sedentary and are easily transported on host plants.

Ants

All ants on Guam are invasive species.

30 species



Ant
Lepisiota frauenfeldi
(Hymenoptera: Formicidae)



Year	2006
Programme	Pacific Invasive Ant Survey
Site name	Antonio International Airport
G	Guam

Risk area as defined - (draft boundary)

150 mts Buffer from Risk Areas (draft boundary)

Page 10





USDA-APHIS Interceptions of Insects on USAF Aircraft Flying from Guam to Honolulu

[\[1\]](#) [\[edit\]](#) Armed Forces Pest Management Board Technical Guide No. 31 RETROGRADE WASHDOWNS: Cleaning and Inspection Procedures Published and Distributed by the DEFENSE PEST MANAGEMENT INFORMATION ANALYSIS CENTER Forest Glen Section Walter Reed Army Medical Center Washington, DC 20307-5001 November 2004

[Appendix J - USDA APHIS History of Interceptions](#) [\[edit\]](#) contains a list of insects intercepted on USAF aircraft arriving in Honolulu from Guam.

■ Coleoptera

- Curculionidae
 - *Mylocoerus* sp. (10/27/1987; 6/10/1986)
- Elateridae
 - *Conoderus* sp. (6/11/1989)
- Chrysomelidae
 - *Atrica* sp. (10/11/1984)
 - *Rhyparida* sp. (10/18/1984)
- Scarabeidae
 - *Adoretus sinicus* (8/28/1987; 4/1/1990; 7/29/1990)
 - *Anomala* sp. (11/27/1986; 8/20/1987; 6/14/1985; 5/16/1990; 5/12/1989; 6/8/1992; 6/11/1990; 5/25/1991)
 - *Popilia lewisi* (7/22/1991; 8/2/1991; 6/8/1990)
 - *Protaetia orientalis* (11/22/1984; 5/10/1993)
- Tenebrionidae
 - *Caeidus* sp. (7/2/1990; 6/9/1990; 6/9/1990)
 - *Gonocephalum* sp. (4/8/1990; 6/15/1990; 6/15/1990)

■ Lepidoptera

- unidentified sp. (7/30/2003)
- Sphingidae
 - unidentified species (11/24/1987)
- Noctuidae
 - unidentified sp. (9/18/1987; 11/30/1984; 9/17/1989; 9/17/1989)
 - *Chrysodeixis chalcites* (11/11/1984)
 - *Helicoverpa armigera* (4/6/1986)
 - *Leucania* sp. (8/30/1987; 12/14/1985)
 - *Mocis frugalis* (9/18/1987; 7/6/1990)
 - *Platysenta* sp. (10/23/1986; 8/16/1987; 8/31/1987; 12/11/1984; 11/7/1984)
 - *Pseudaletia* sp. (9/4/1987; 3/31/1990)
 - *Spodoptera* sp. (4/21/1987; 9/20/1987; 5/9/1987; 8/17/1987; 7/10/1987; 12/14/1985; 8/28/1993; 6/29/1989; 6/30/1990)
 - *Spodoptera litura* (1/29/1985; 11/30/1984; 10/6/1984; 8/5/1986)
 - *Conisaniapunctifascia* (10/24/1987; 7/26/1988)



Popillia lewisi

1985 – 2003: found
only near runways at
Andersen Air Force
Base

2004: spread
throughout Guam



Protaetia orientalis

~1970: first detected
on Guam

2002: first detected
on Oahu at Hickam
AFB golf course



Brachycyttarus griseus

1976: first detected
on Guam



1984: first detected
on Oahu at Kaneohe
Marine Base

Aphids

All aphids on Guam are invasive species.

18 species



Mosquitoes

Most mosquitoes on Guam are invasive species.

14 invasive species



Important Invasive Insects on Guam



Melon fly

Important Invasive Insects on Guam

Pacific Fruit-Piercing Moth
Eudocimia fullonia



Important Invasive Insects on Guam



Philippine lady beetle





Undescribed wasp: (genus Selitrichodes,
Eulophidae: Tetrastichinae) Photo: A.
Moore, University of Guam, Extension



Asian Citrus Psyllid



Acacia Whitefly



Daphnis nerii, Oleander hawk moth 2005



Case Study: *Aulacaspis Cycad Scale*



Case Study: *Aulacaspis Cycad Scale*



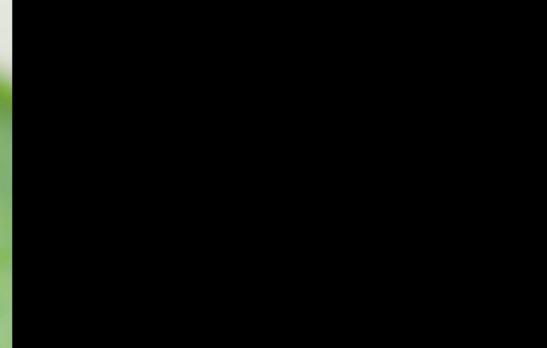
Case Study: *Aulacaspis Cycad Scale*



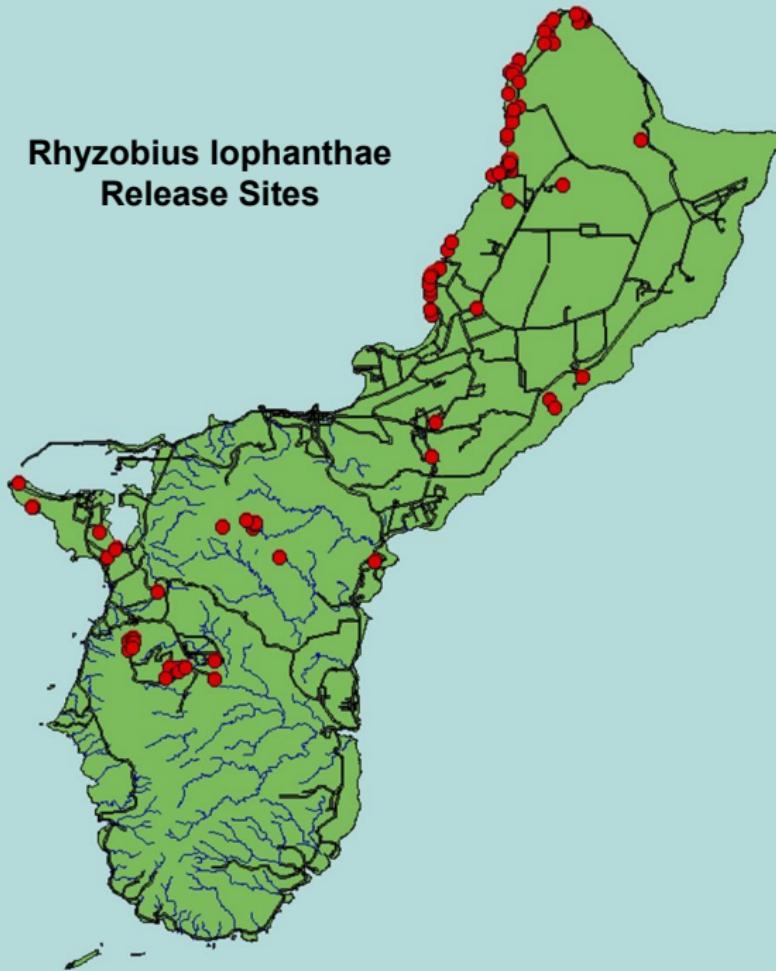
Timeline for Cycad *Aulacaspis* Scale

- Dec-2003 Detected in Tumon Hotel district on ornamental cycads
- Spreads to wild cycads island-wide within 1 year (*Cycas micronesica* is a major species in Guam's ecosystem)
- Feb-2004 A lady beetle, *Rhyzobius lophanthae*, is released for biocontrol
- 2006 *Cycas micronesica* listed as a “Threatened Species”





Rhyzobius lophanthae
Release Sites





Fadang plants flush at start of 2005 rainy season





Cycad Blue
Butterfly

Chilades pandava

New cycad growth defoliated by *Chilades pandava* larvae



Chilades pandava larva on *Cycas micronesica* with attendant ant,
Aplopololepis gracilipes



A Coalition of Invasive Species Attacks Guam's Native Cycads

Aubrey Moore*, Ross Miller, and Thomas Marler

Western Pacific Tropical Research Center, University of Guam, Mangilao Guam 96923

A 2002 forest survey listed *Cycas micronesica* as the most numerous tree-sized plant in Guam's forests. In 2006 *C. micronesica* was placed on the IUCN Red List of Threatened Species in response to high mortality from simultaneous attack by recently introduced invasive species including the cycad aulacaspis scale (CAS), *Aulacaspis yasumatsui*, the cycad blue butterfly, *Chilades pandava*, and a lepidopteran leafminer, *Erechthias* sp. The coccinellid, *Rhyzobius lophantae* was established as an effective biological control agent for CAS. However, the cycads continue to decline due to damage from other herbivores. This poster summarizes the major ecological relationships between *C. micronesica* and the invasive species which threaten its existence.

2005
Predator

Rhyzobius lophantae
Coccinellidae



2003
Herbivore

Aulacaspis yasumatsui
Diaspididae



Endemic Plant

Cycas micronesica



Attendant Ants



Anoplolepis gracilipes
Iridomyrmex anceps
Paratrechina longicornis
Pheidole megacephala
Pheidole megacephala
Pheidole occatoria

Tetramorium indicae
Tetramorium melanocephalum

2005
Herbivore

Chilades pandava
Lycaenidae



2003
Herbivore

Erechthias sp.
(Tineidae: leafminer)



LEGEND

Invasive species

Endemic species

Introduced
biocontrol agent

Endemic Parasitoid

Trichogrammatidae
guamensis
Trichogrammatidae



Reference:

Marler, T.E. and R. Muniappan. 2006. Pests of *Cycas micronesica* leaf, stem, and male reproductive tissues with notes on current threat status. *Micronesia* 39: 1-9.

Acknowledgments:

This project was partially supported by grants from the US Forest Service and the US Fish & Wildlife Service.

Herbivore

Dihammus marianarum
Cerambycidae

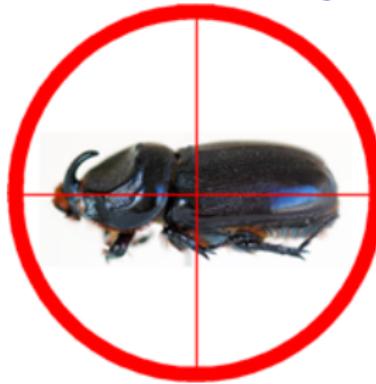


Omnivore

Sus scrofa
Feral pig



Update on the Guam Coconut Rhinoceros Beetle Eradication Project



Regional Invasive Species Meeting, Guam, March 2013

Prepared by Aubrey Moore
University of Guam

First Coconut Rhinoceros Beetle
Collected on Guam
11-Sep-2007, Tumon Bay



Oryctes rhinoceros Distribution









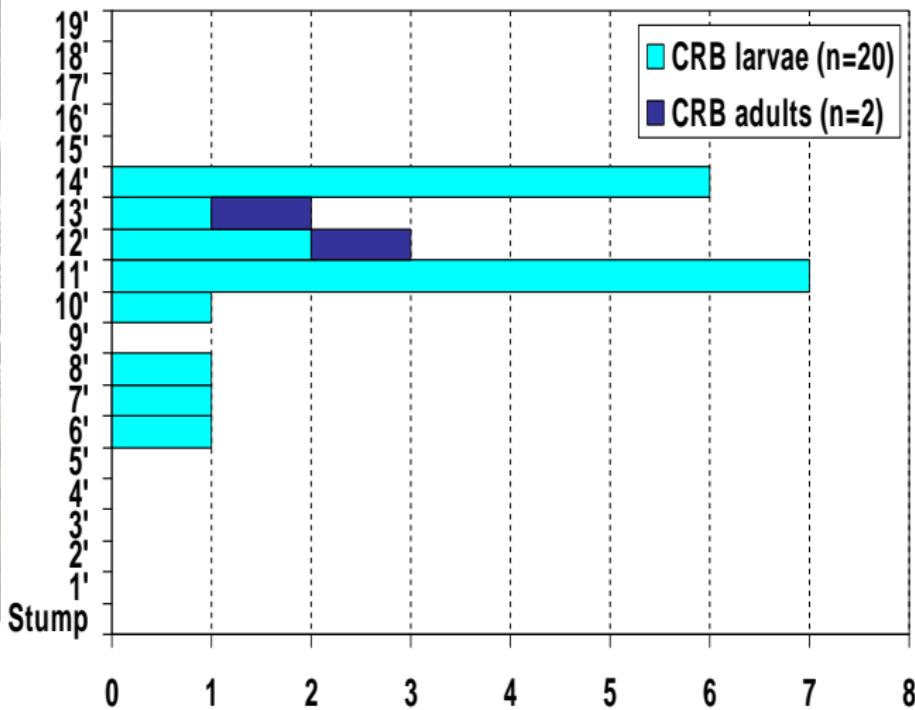








Vertical Distribution of CRB Larvae & Adults in Standing Dead Coconut Trankilidat, Guam; 25 Oct 2007



Novel CRB Behavior on Guam: Arboreal Development

CRB extracted from the crowns
of 121 felled coconut palms



Eggs	99
L1	40
L2	72
L3	210
Pupae	25
Adult males	34
Adult females	30
Total	510
Mean per tree	4.21

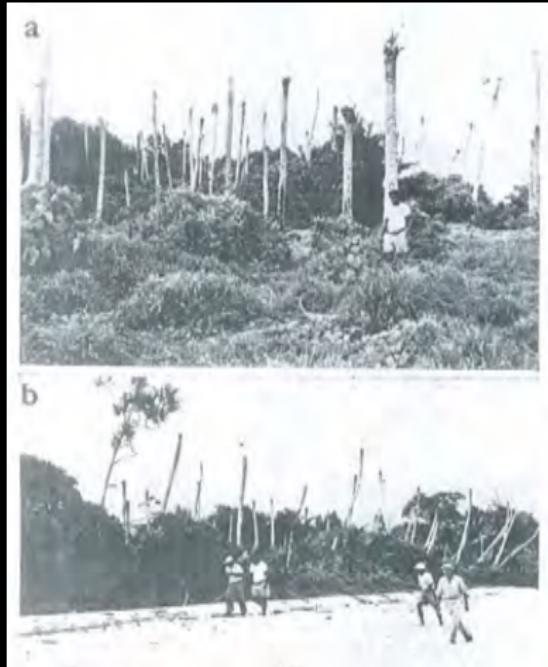


ADULTS KILL TREES

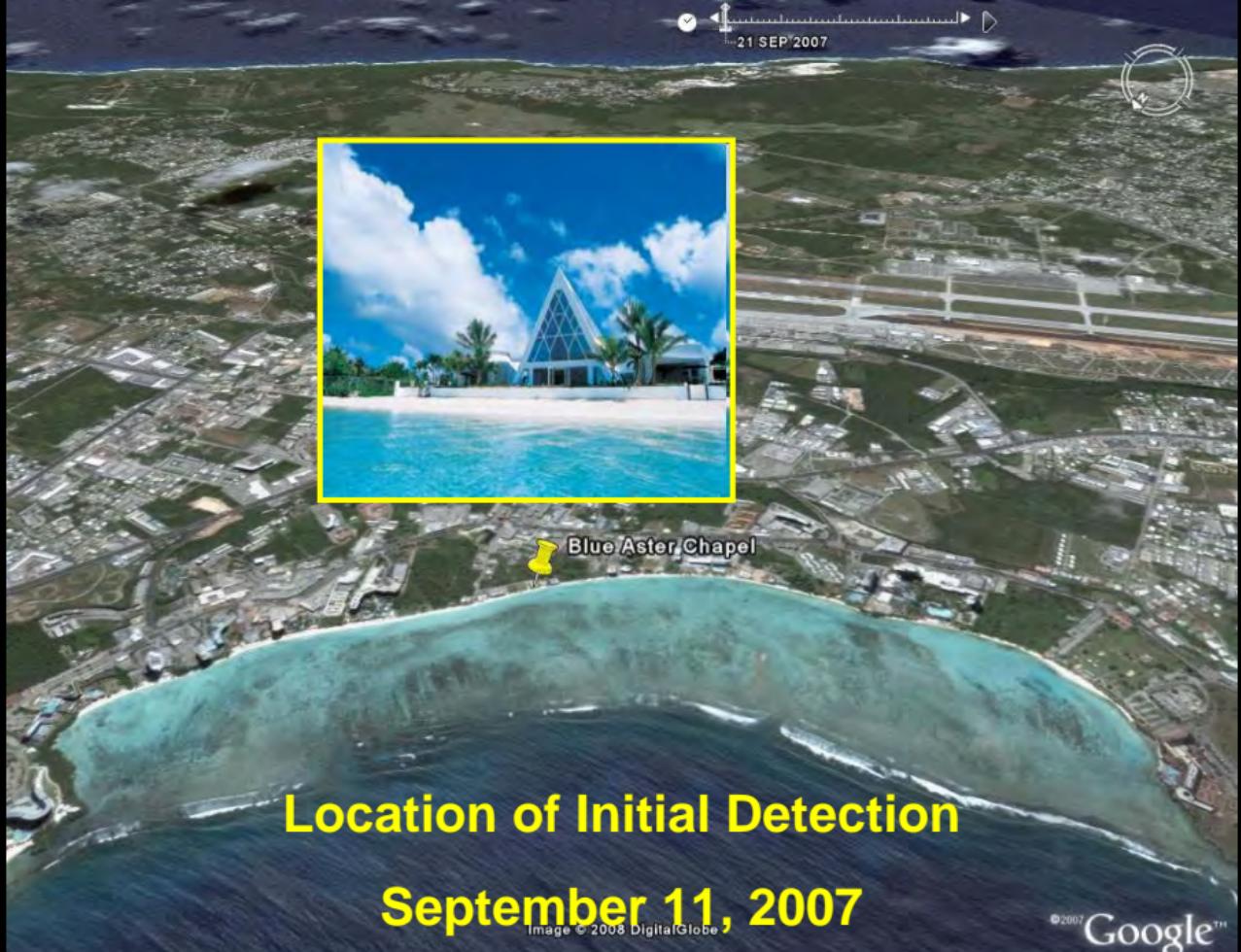
LARVAE FEED ON
DEAD TREES



Coconut palms killed by *Oryctes rhinoceros*; Viti Levu Island, Fiji; 1973
Source: ?



Coconut palms killed by *Oryctes rhinoceros*; Peleliu Island, Palau 1951
Source: Gressitt 1953



Location of Initial Detection

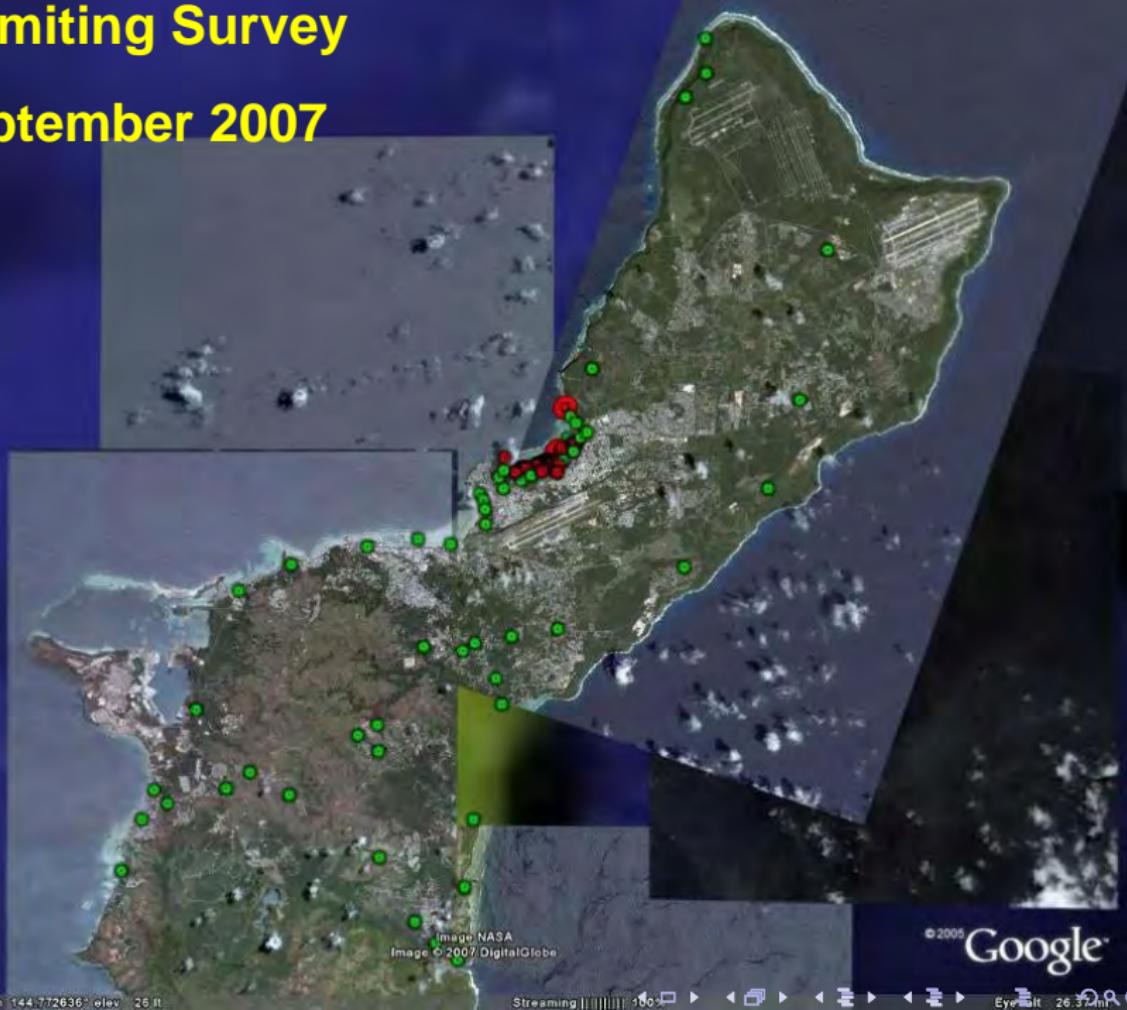
September 11, 2007
Image © 2008 DigitalGlobe

Image © 2008 DigitalGlobe

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Delimiting Survey

September 2007



Guam Coconut Rhinoceros Eradication Project

ORGANIZATION

Partners:

USDA-APHIS

Guam Dept. of Agriculture

University of Guam

Funding:

USDA-APHIS

US Forest Service

GovGuam



Guam Coconut Rhinoceros Eradication Project

TACTICS

Quarantine

Limit accidental transportation to uninfested parts of Guam.

Pheromone Traps

Capture adults and detect spread of the beetle population

Sanitation

Kill immatures and remove breeding sites

Detector Dogs

Efficient discovery of breeding sites.

Chemical Control

Injectable systemics for adults; spot treatments for breeding sites.

Biocontrol

Autodissemination of *Oryctes* virus



Initial Quarantine Area

September 2007



PHEROMONE TRAPS

- Mass trapping unsuccessful
- Traps useful for monitoring



Trap Data Entry Form

Mozilla Firefox

File Edit View History Delicious Bookmarks Tools Help

http://guaminsects.net/orycles/upload_site_visit_gpx_3.php

New_guinea_sugarcane... Encyclopedia of Life F... webtip UOG mail Guam mail label printer weather Insect World Agriculture and Natural... We Are Guahan

http://guaminsects.e_visit_gpx_3.php

Upload Trap Visit GPX file to Database

Trapper(s):

Trap Visit Date:

Choose a GPX file to upload:

Online Trap Data Report



Visualization of Trap Catch Data

Aubrey Moore

Guam Coconut Rhinoceros Beetle Eradication Project



Generated 2013-06-03 11:40:09

Path: C:/Documents and Settings/Administrator/My Documents/CRB monthly surveillance reports/map dev

R script: makeMaps.R

Brew file: makeBeamer.txt

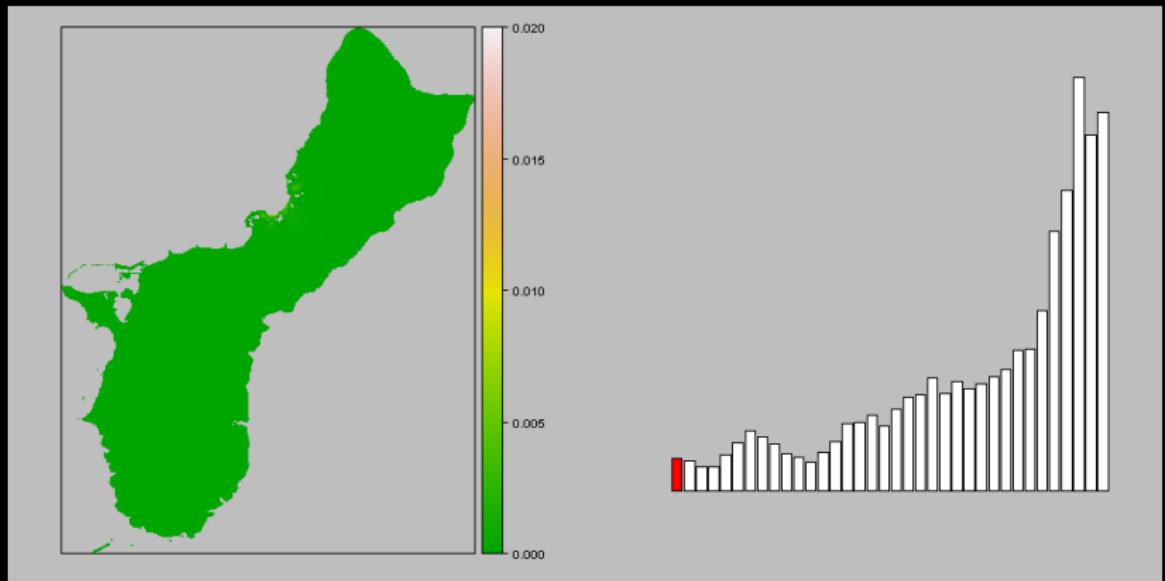
Introduction

- ▶ The following frames show spatial-temporal changes in numbers of CRB adults caught in pheromone traps.
- ▶ Note that trap catches on Guam are very low: the scale runs from 0 to only 0.02 beetles per trap day, a trap rate of only one beetle every 50 days.

Methods

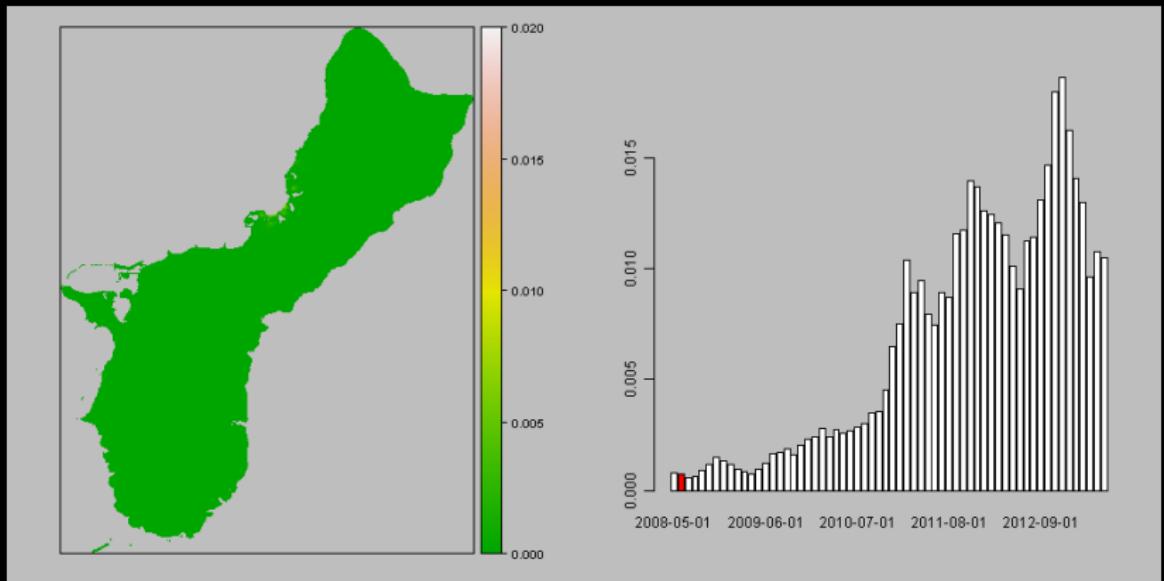
- ▶ Interpolated raster maps were made using an R script which:
 1. Accesses georeferenced data stored in the CRB project's online MySQL database.
 2. Processes the data using the GRASS6 GIS
 3. Writes the \LaTeX code which generated this PDF document.

90 day trapping period ending on 01 May 2008



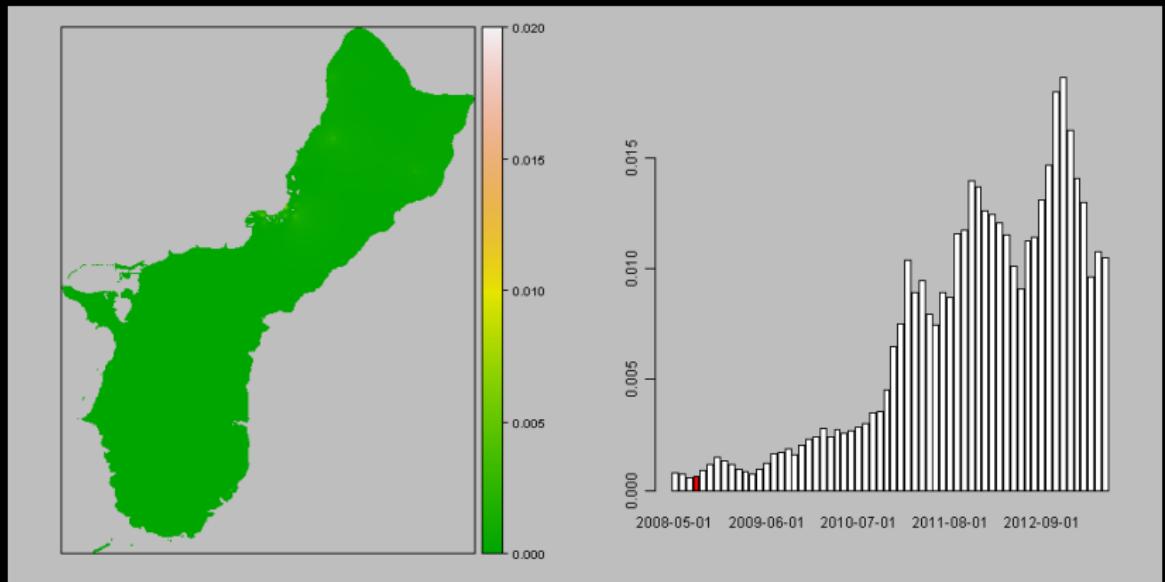
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2008



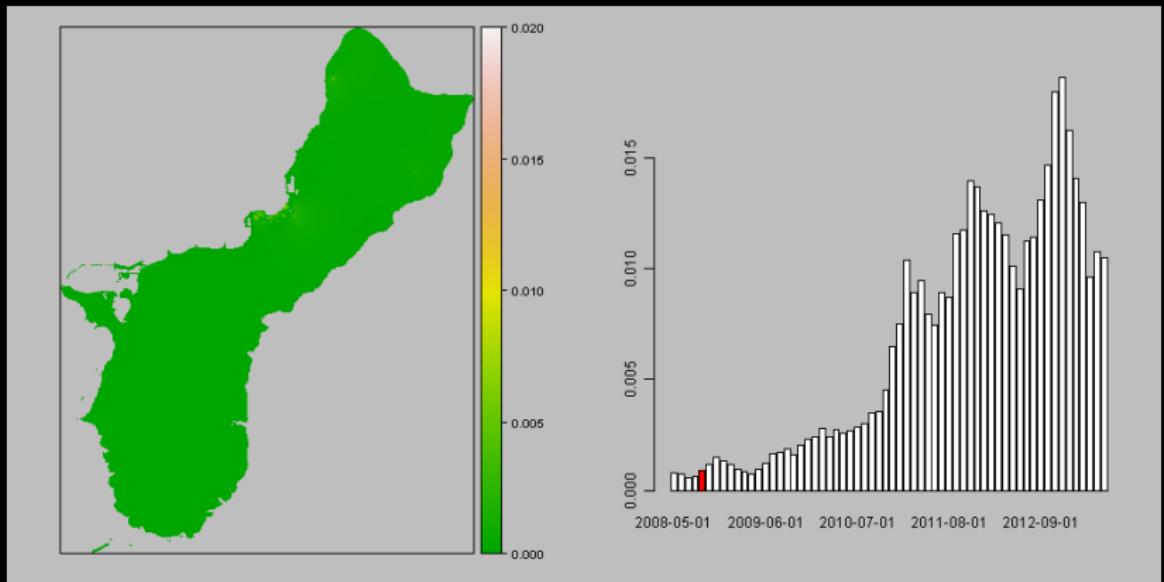
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2008



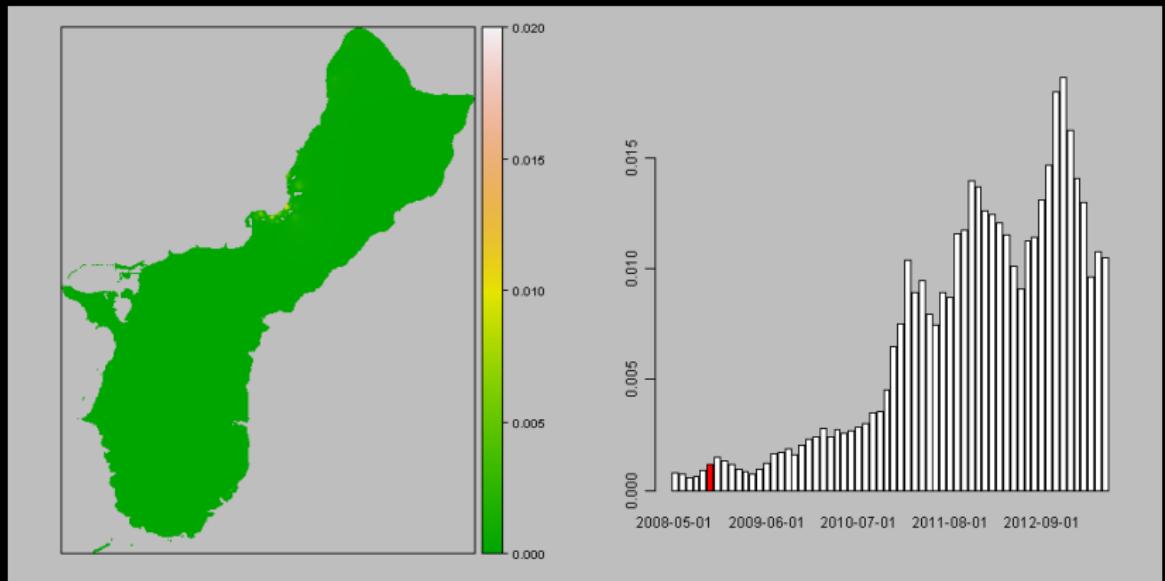
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2008



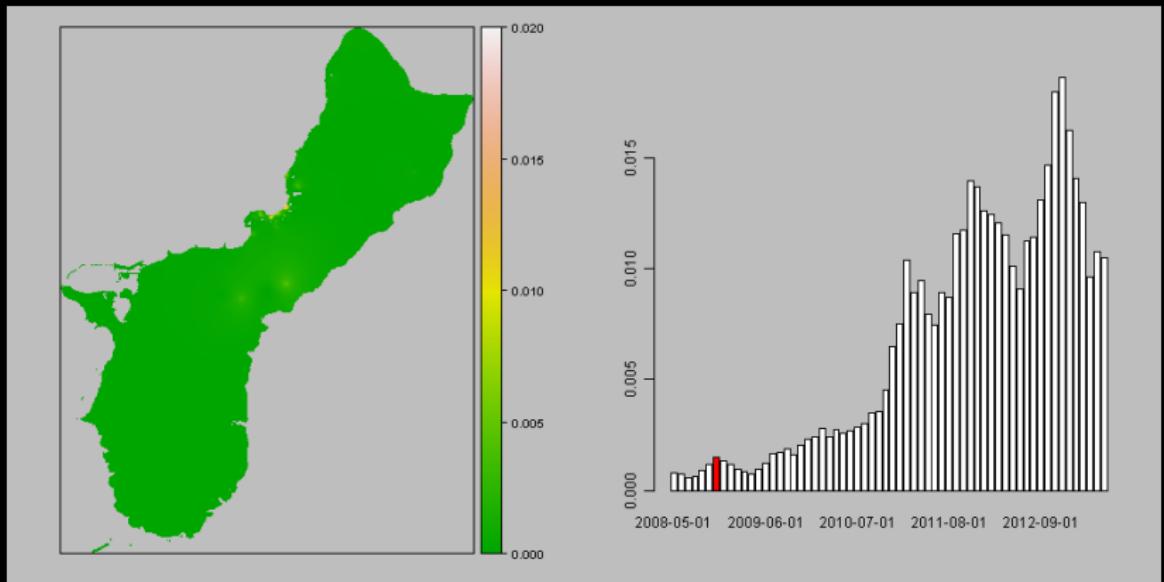
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2008



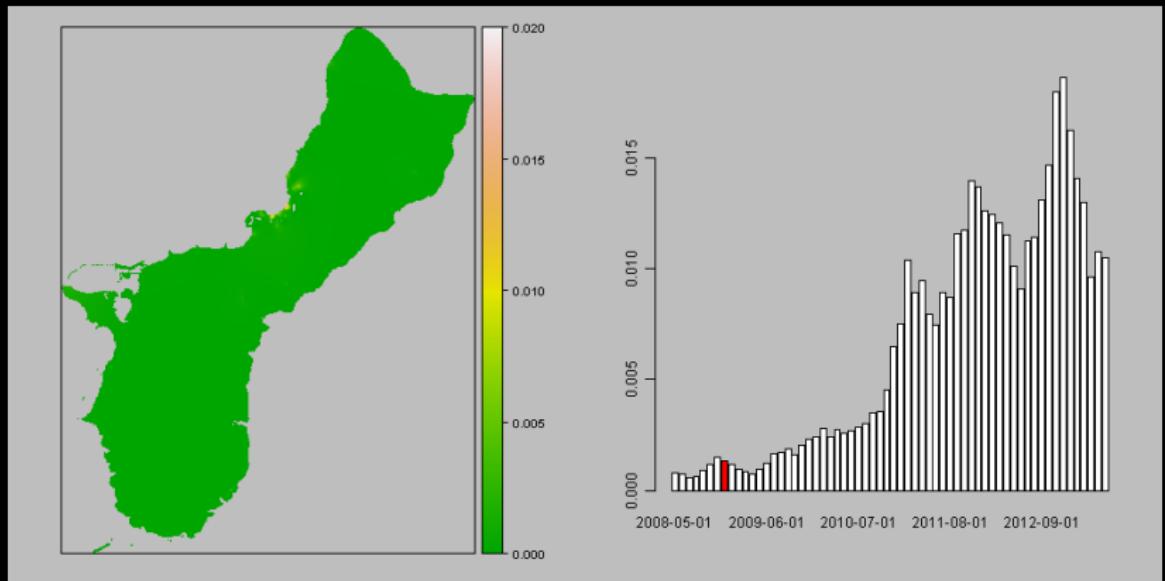
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2008



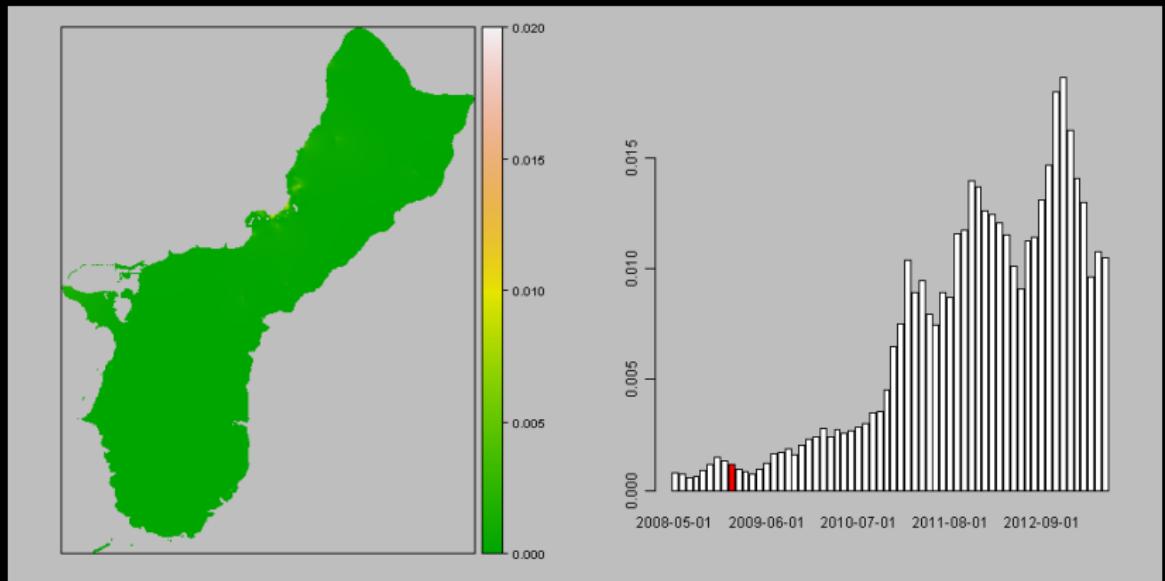
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2008



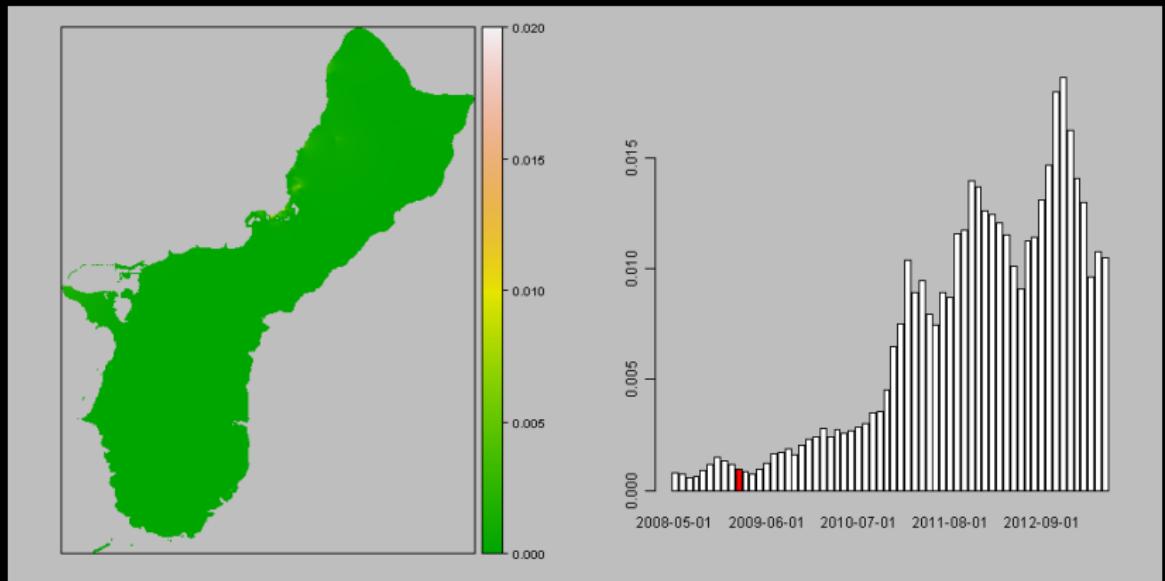
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2009



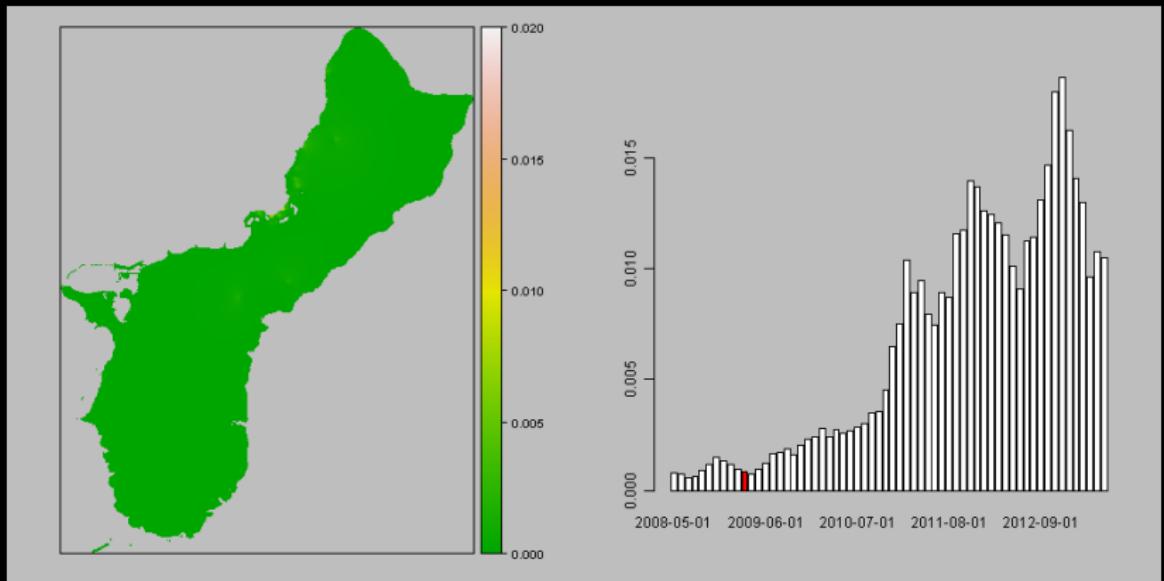
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2009



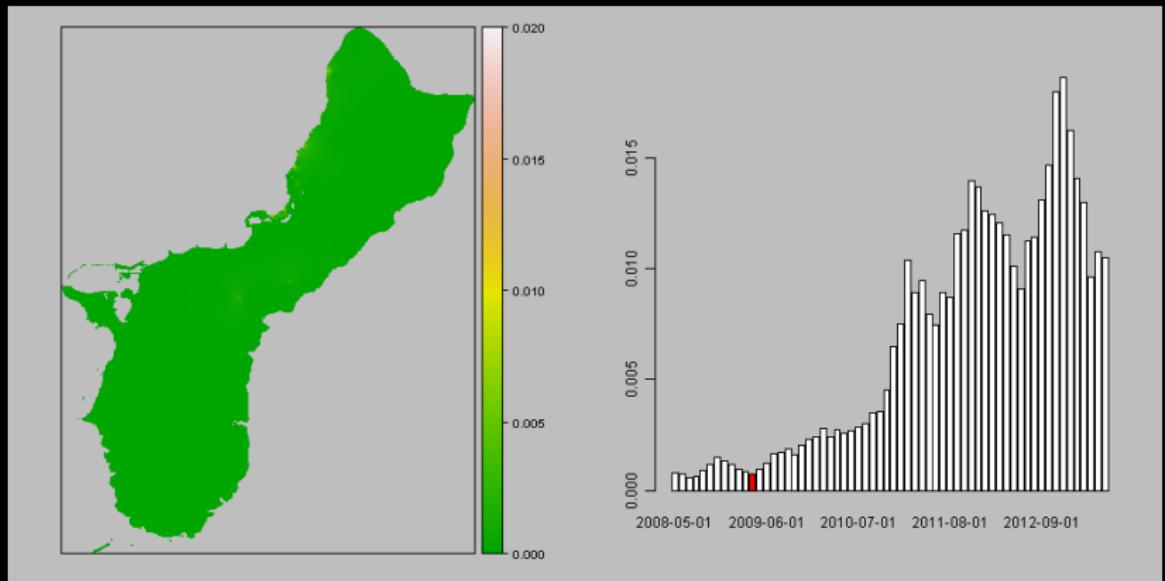
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2009



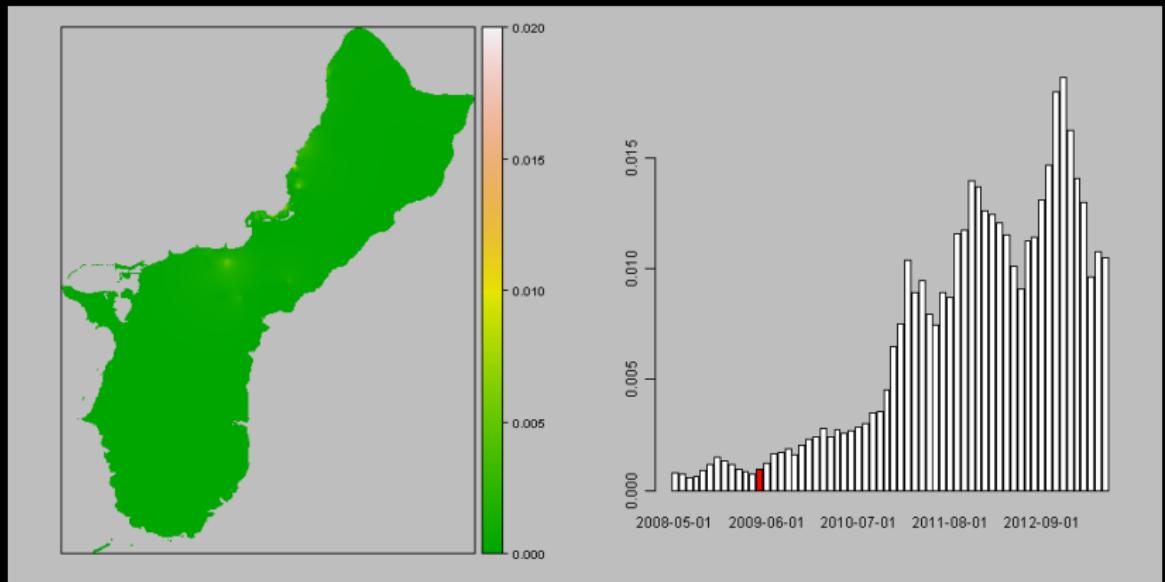
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2009



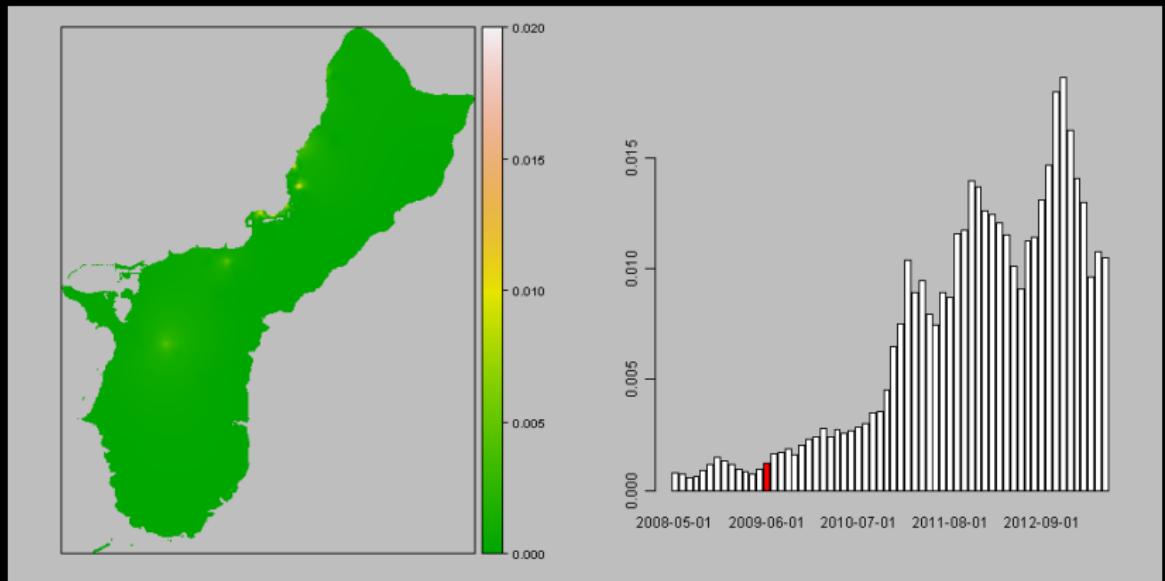
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2009



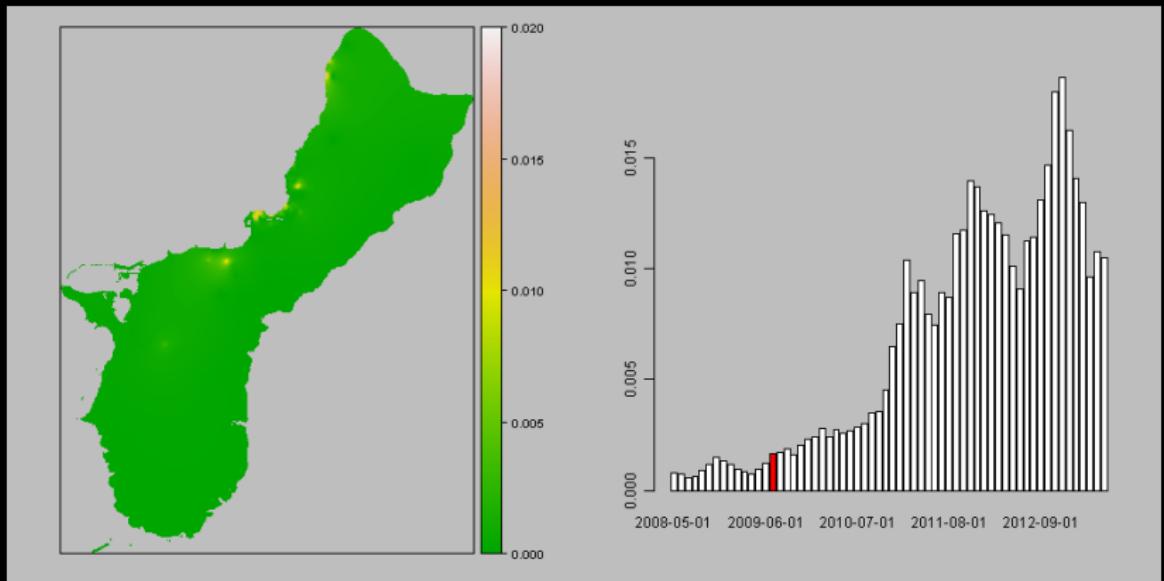
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2009



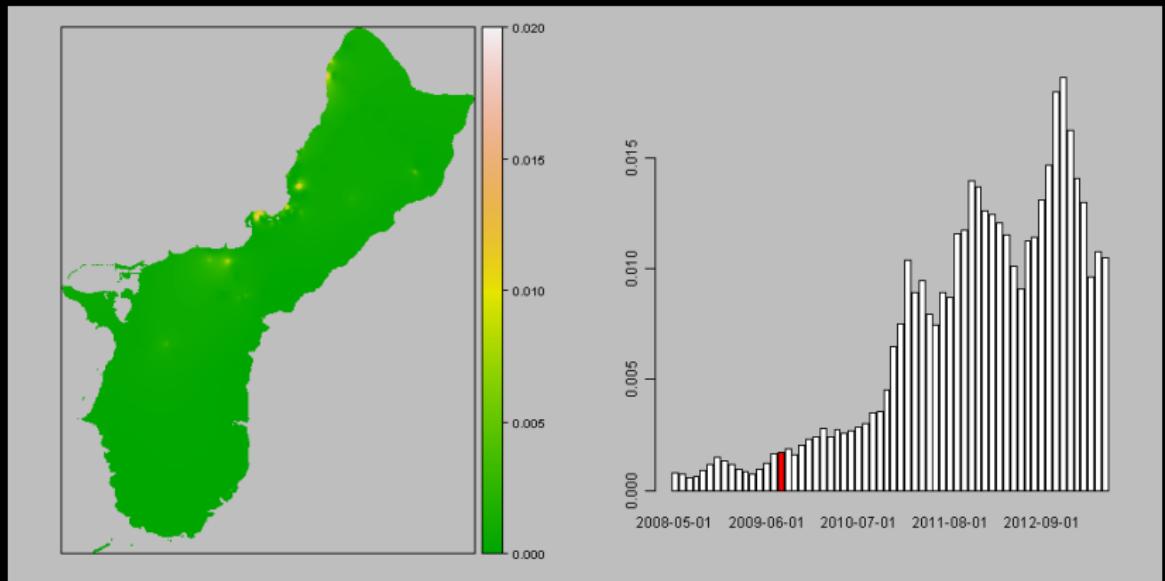
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2009



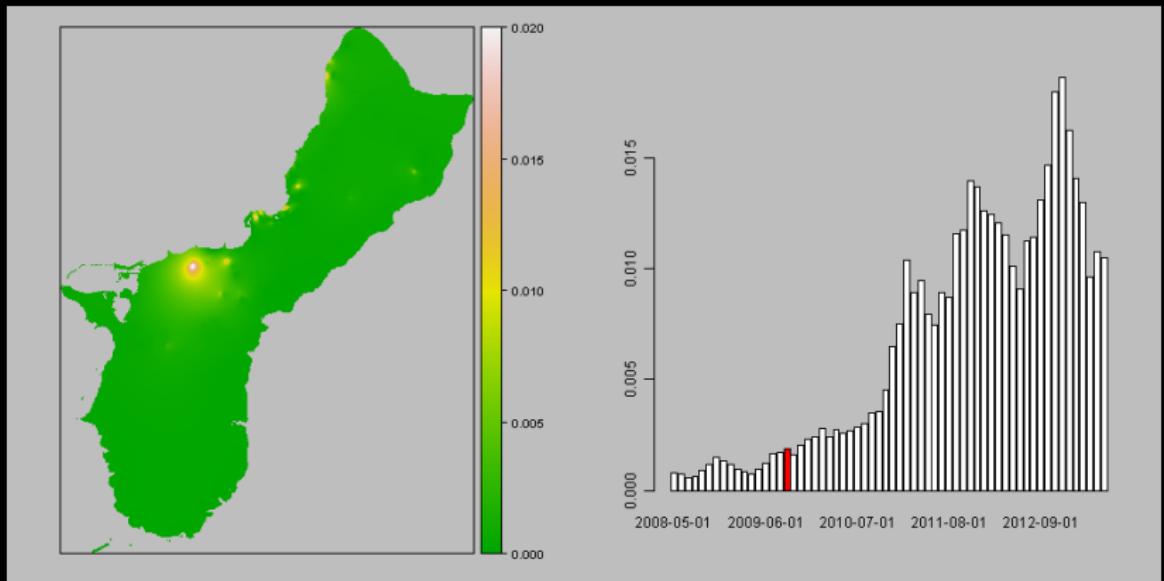
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2009



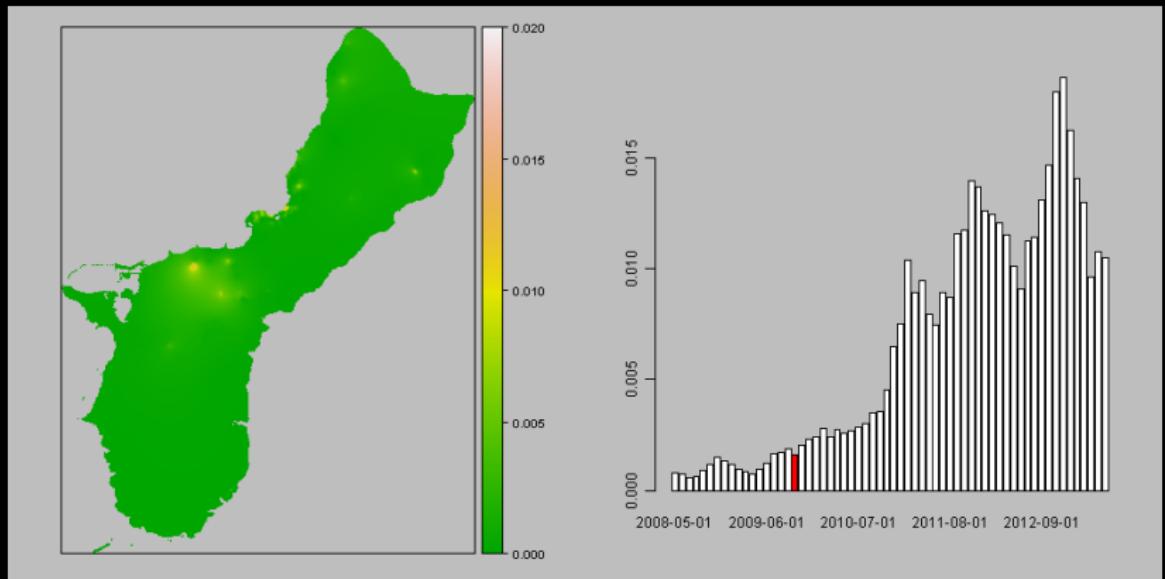
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2009



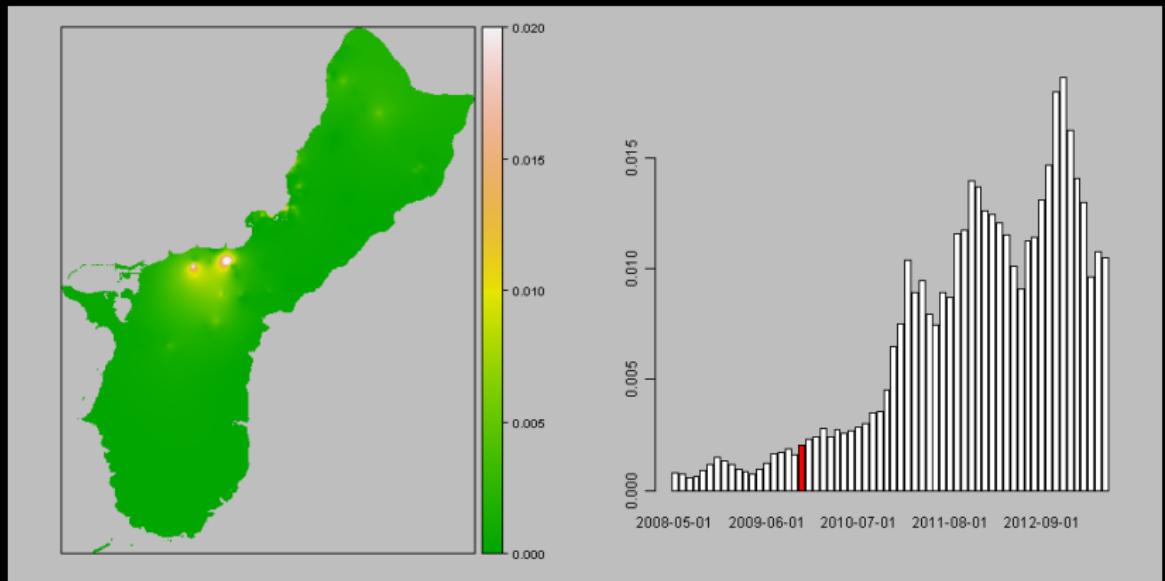
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2009



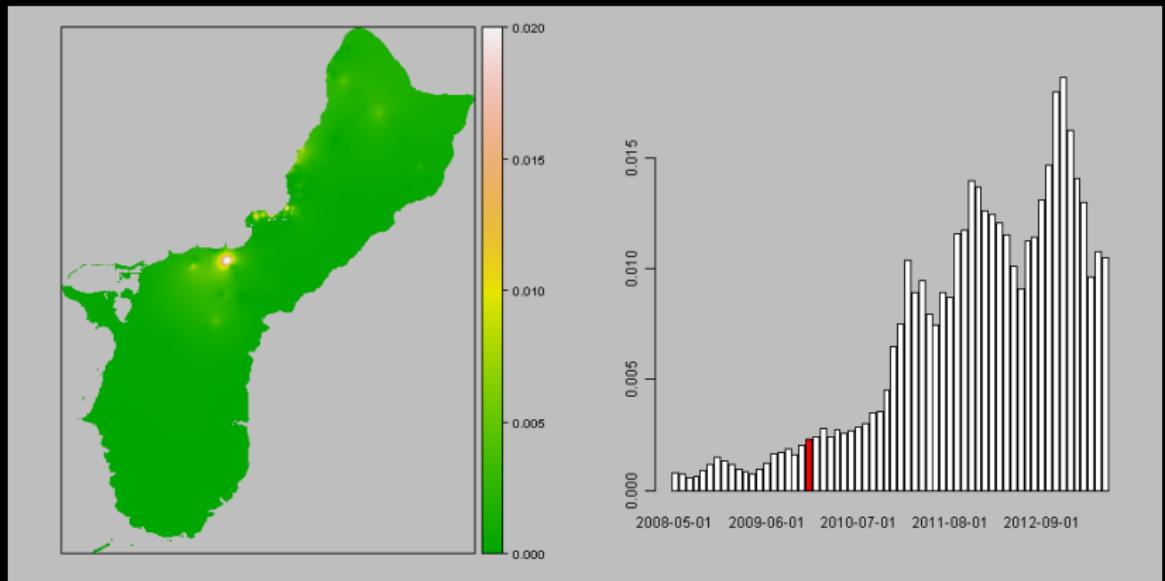
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2009



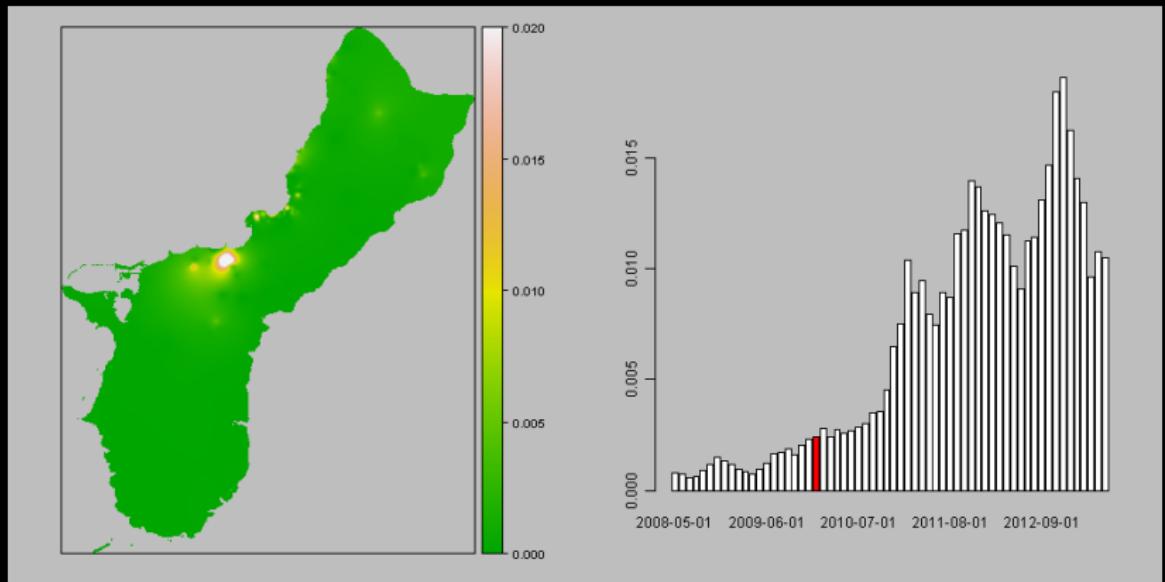
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2009



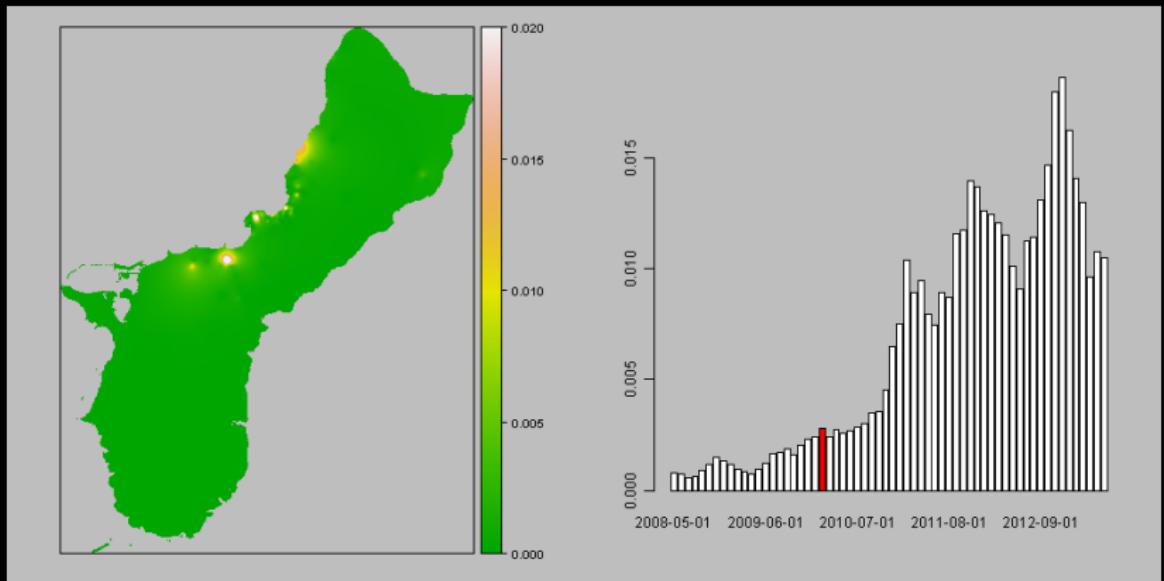
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2010



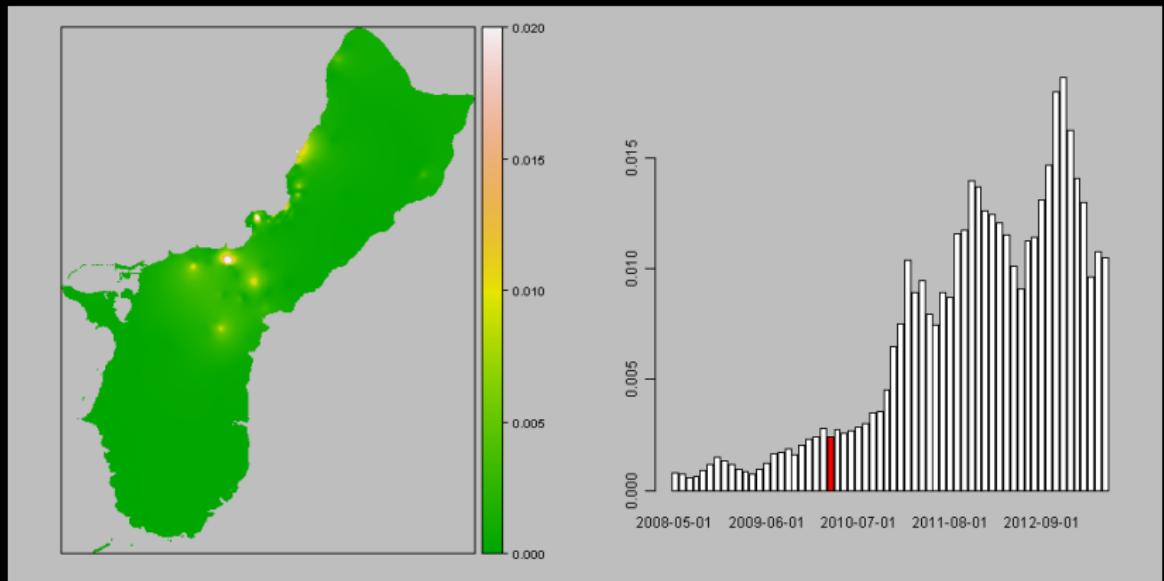
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2010



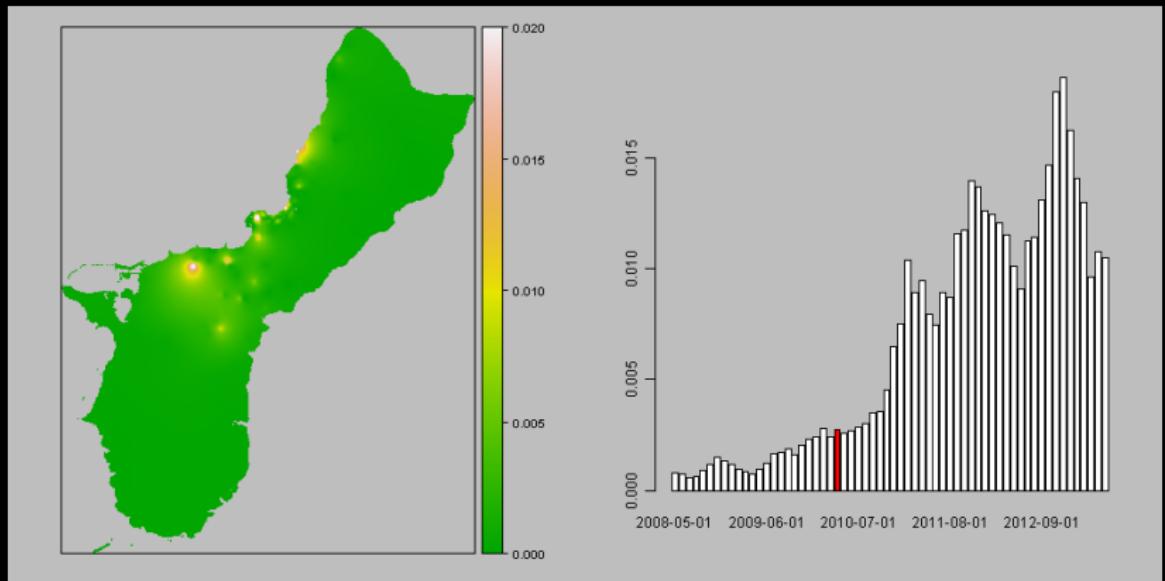
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2010



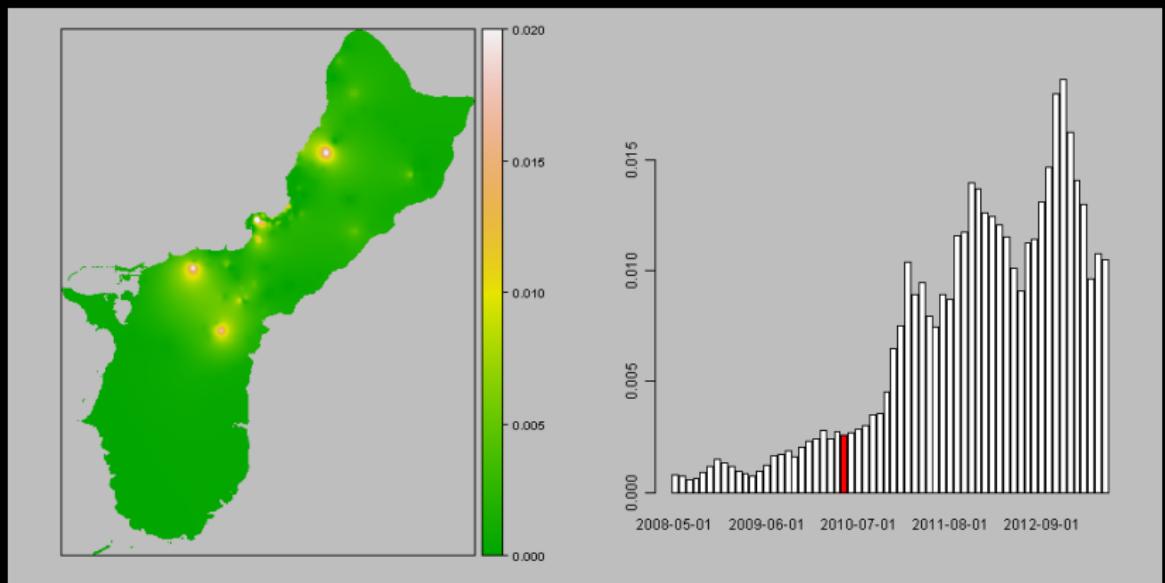
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2010



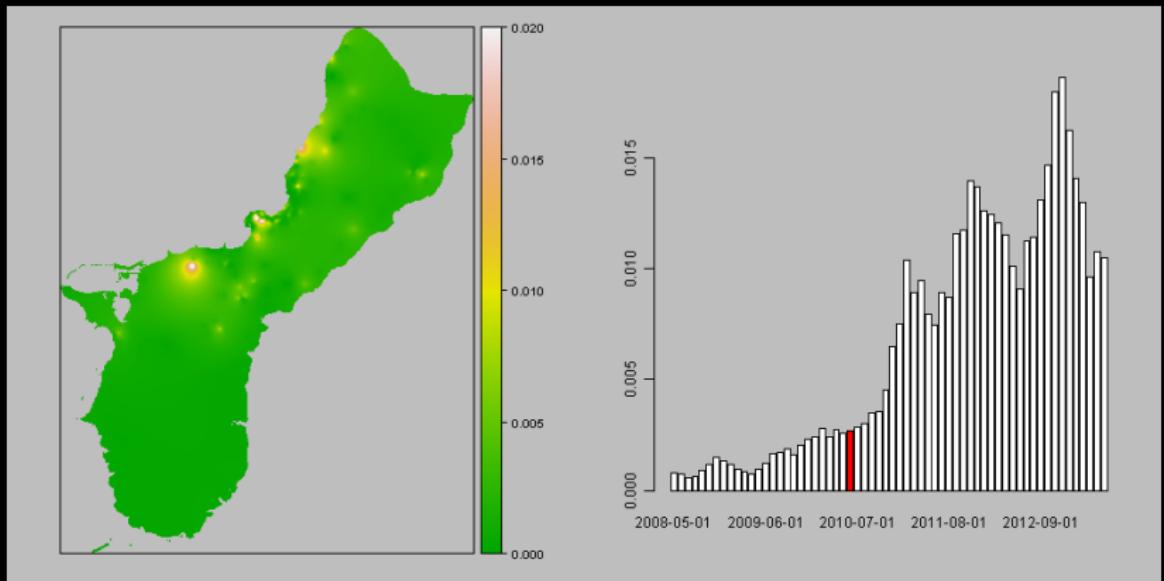
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2010



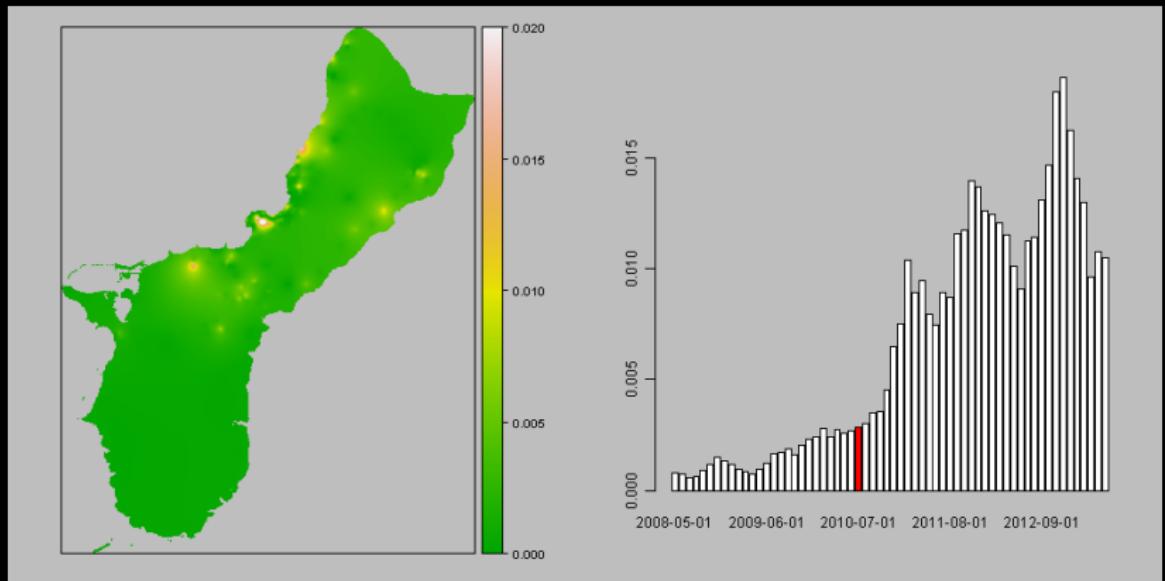
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2010



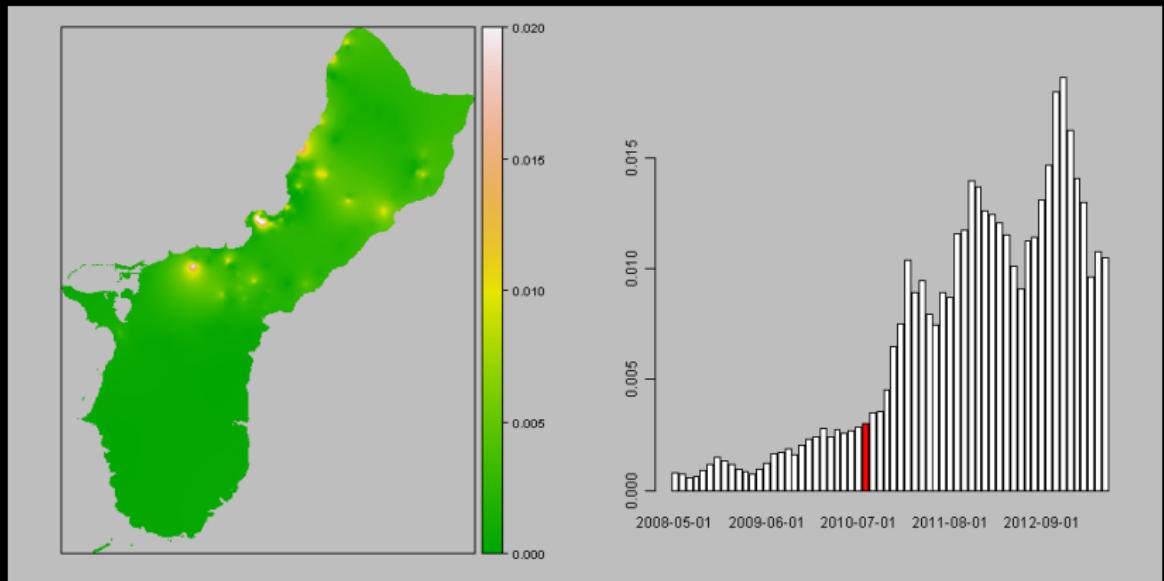
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2010



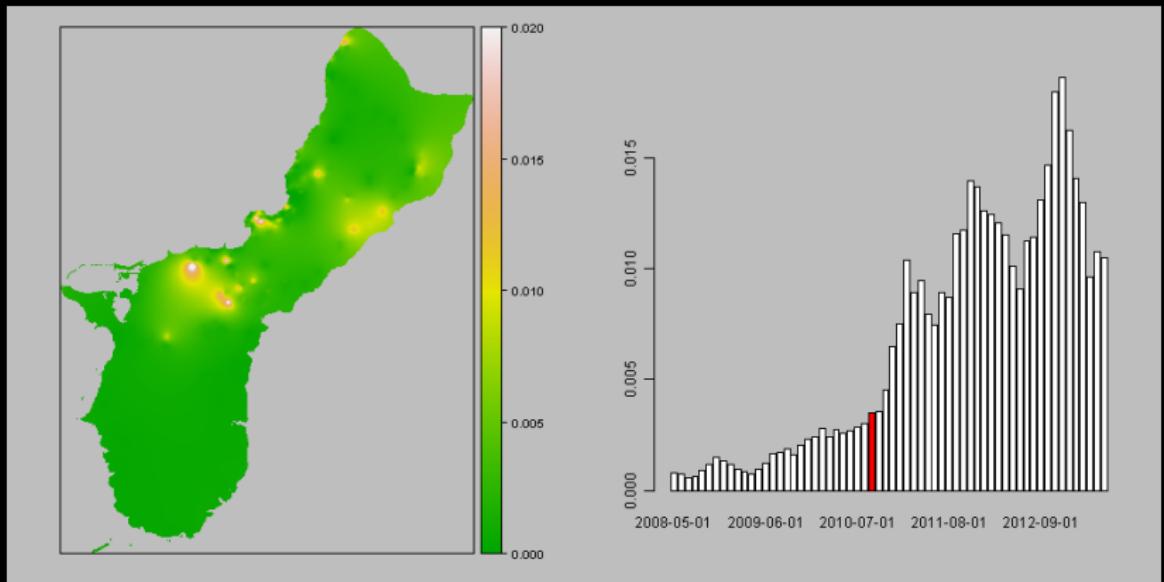
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2010



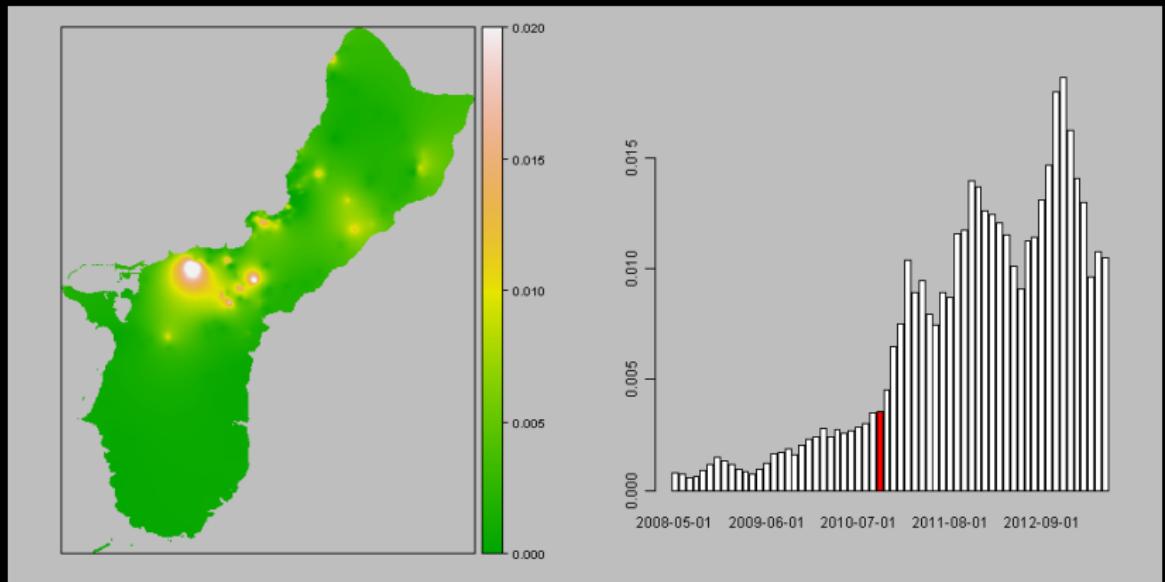
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2010



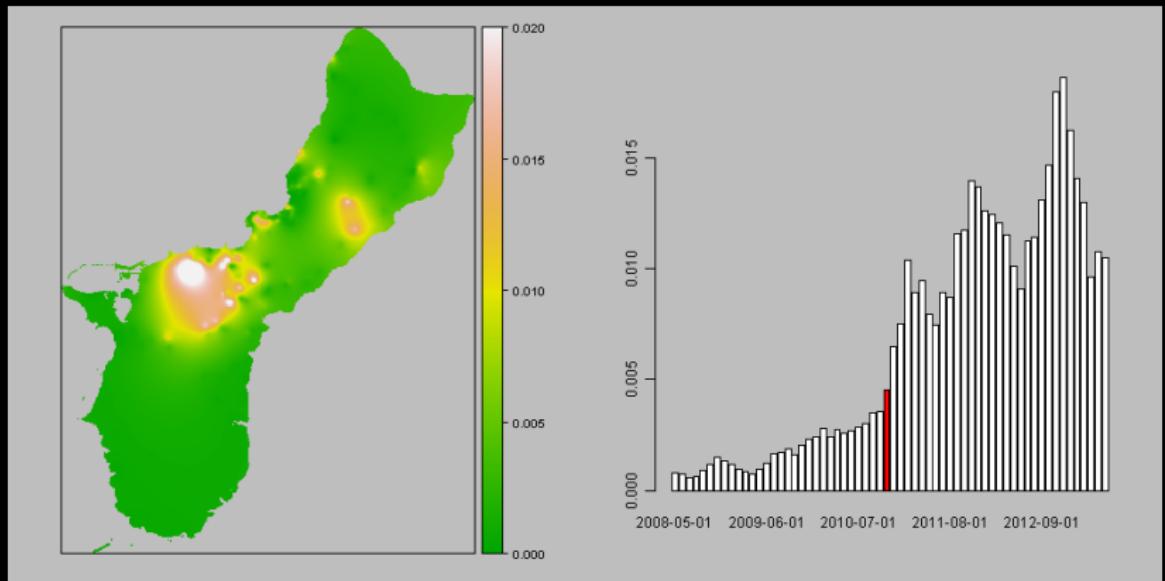
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2010



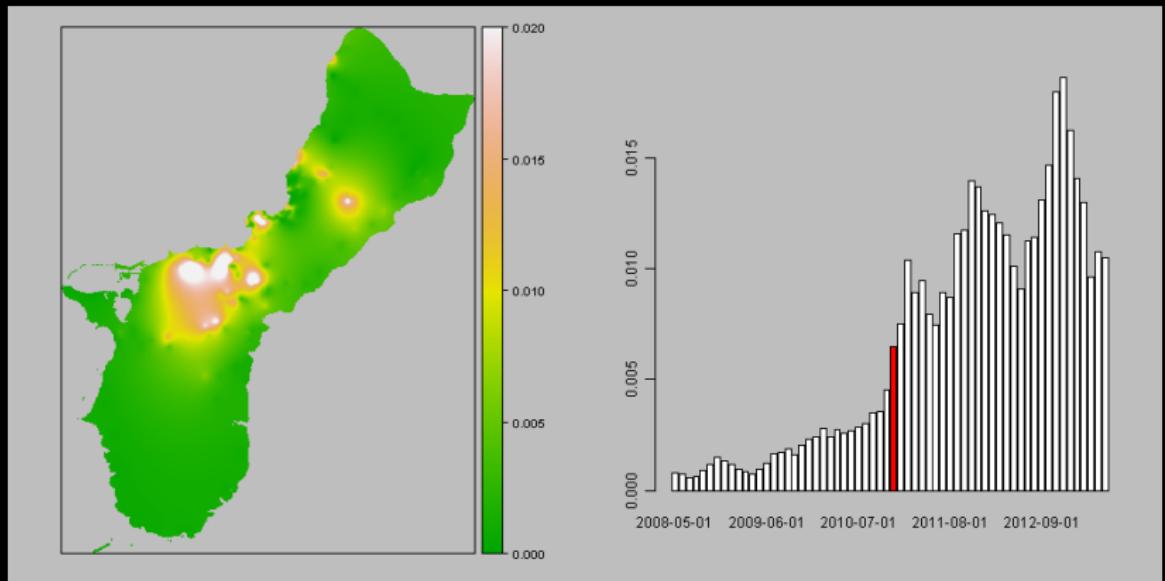
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2010



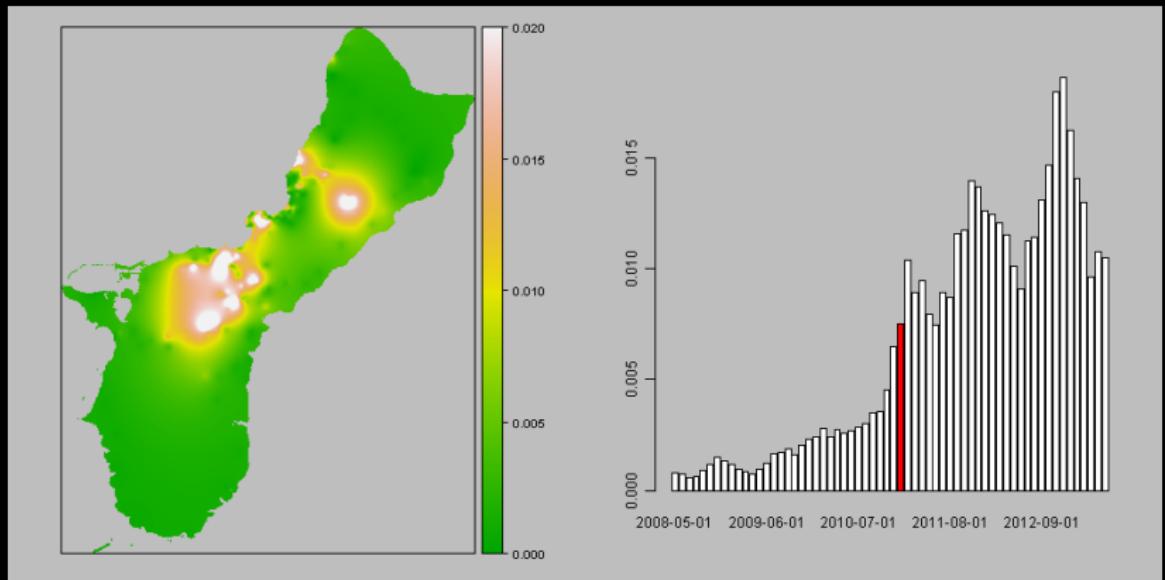
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2010



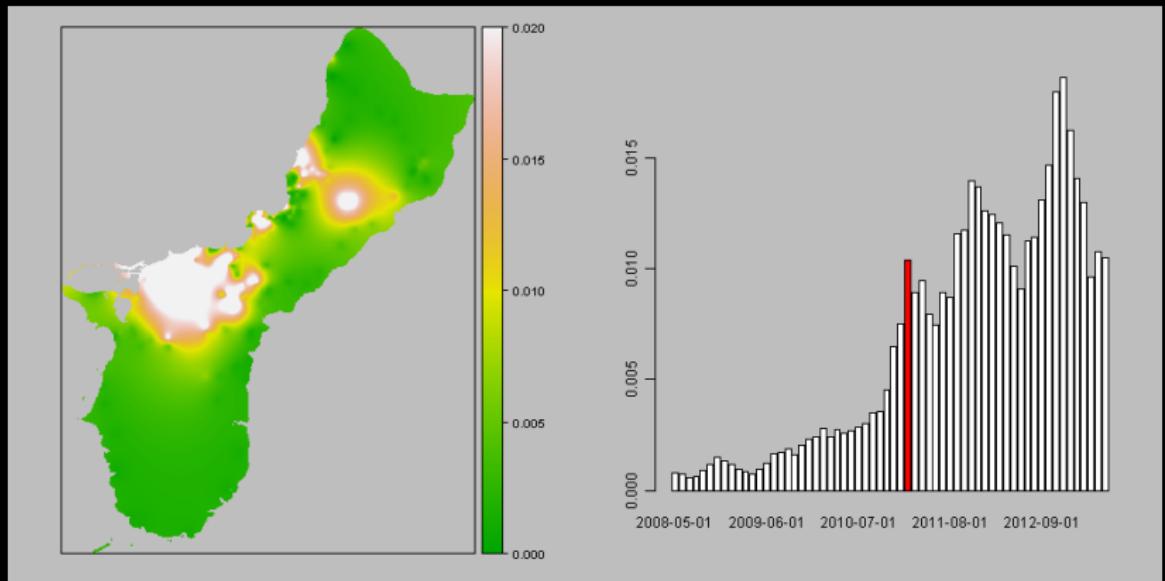
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2011



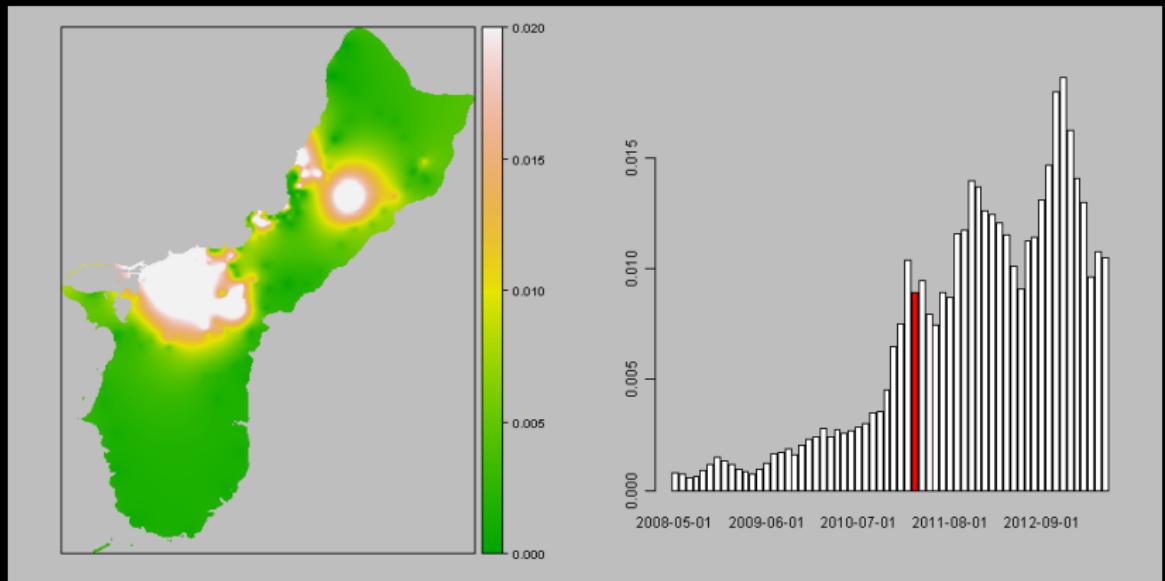
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2011



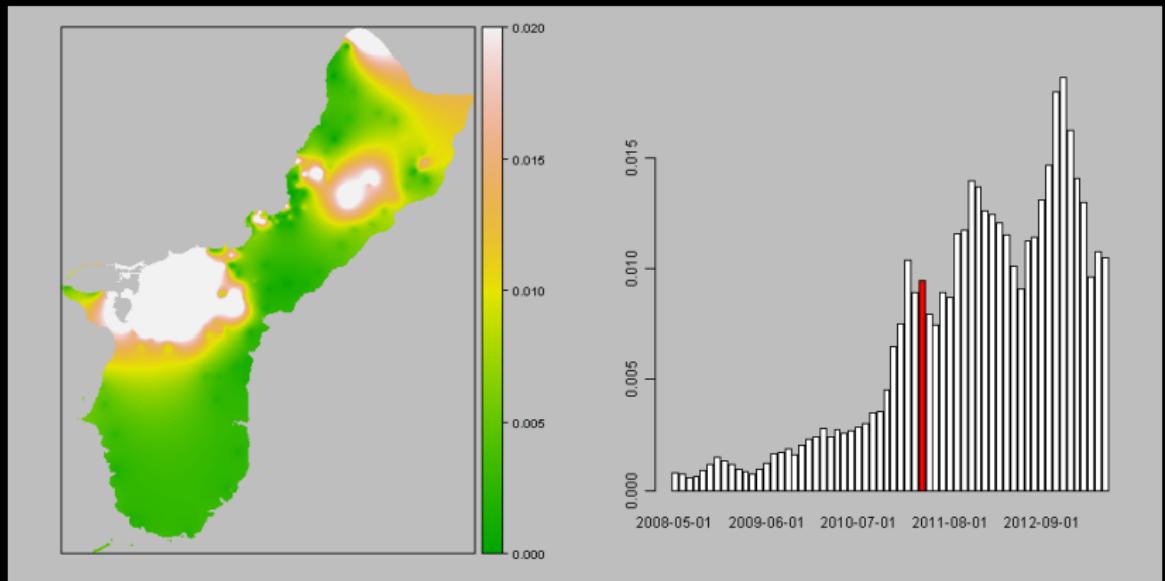
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2011



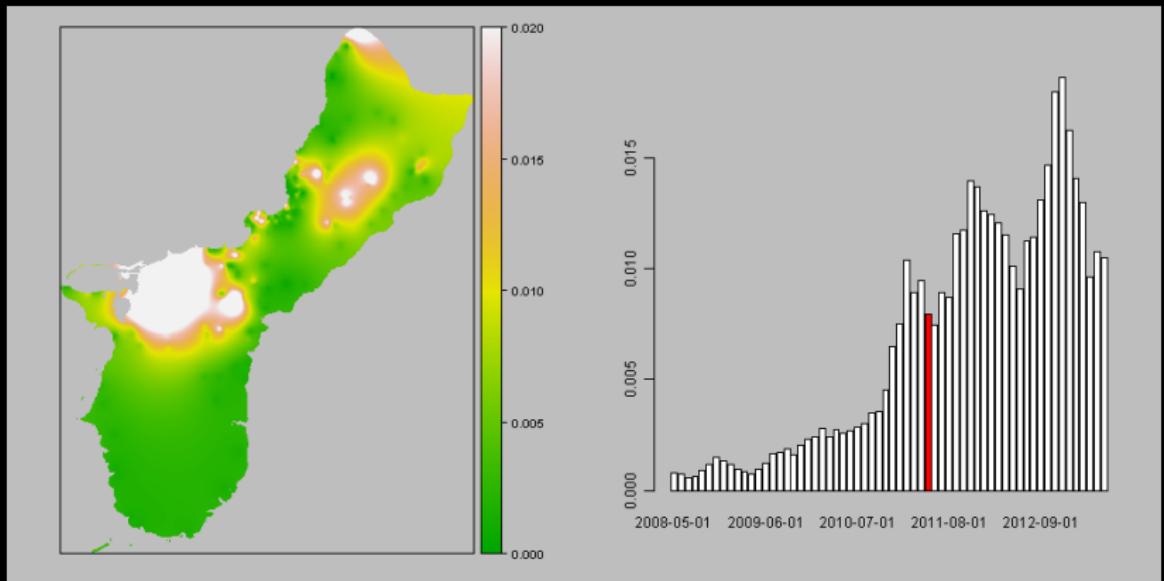
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2011



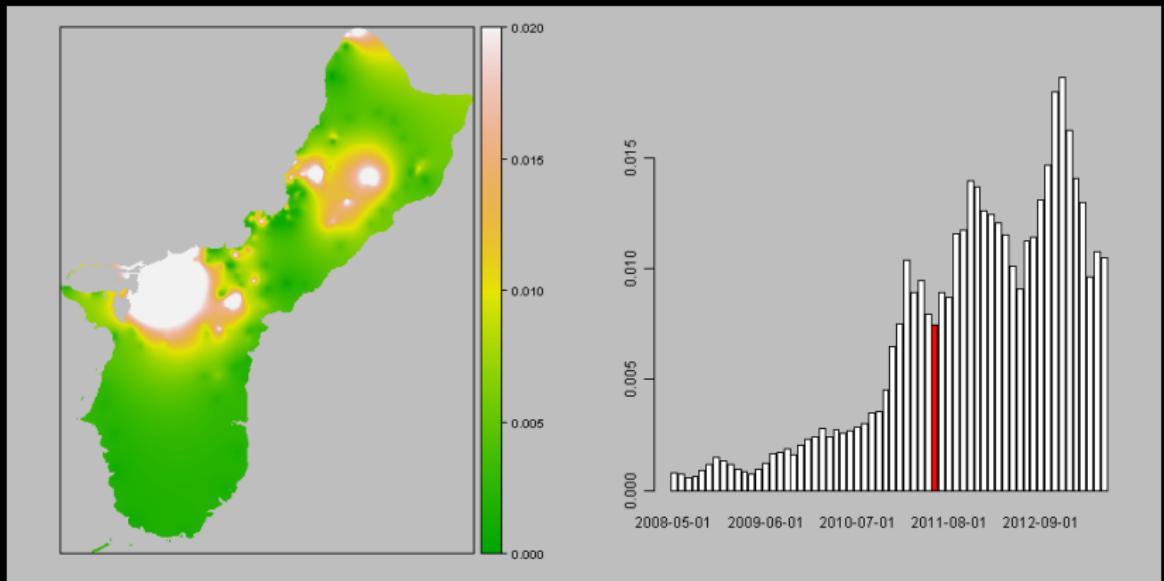
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2011



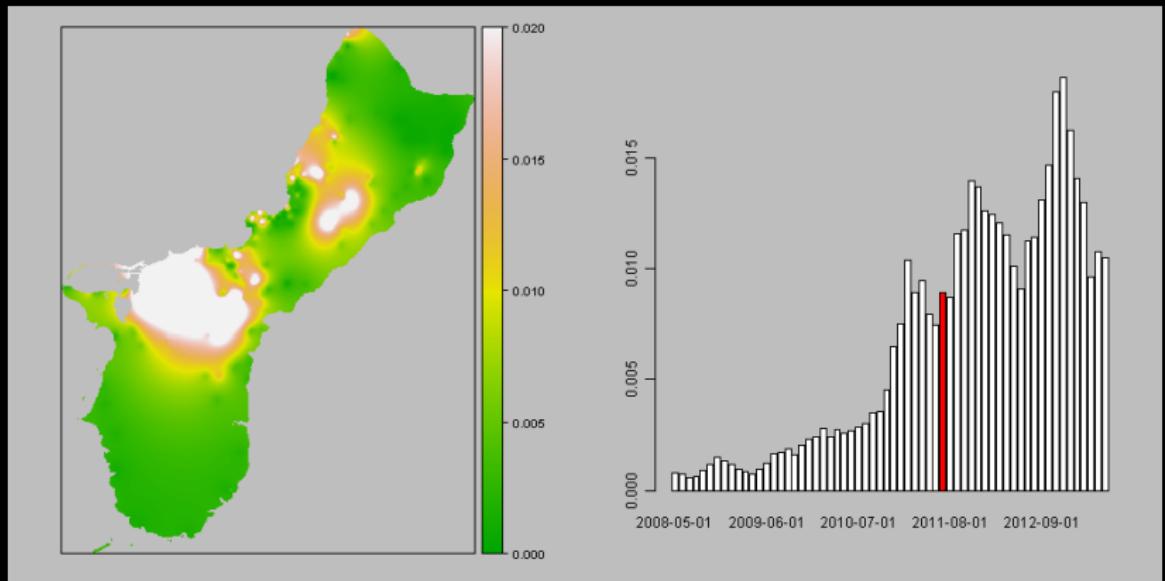
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2011



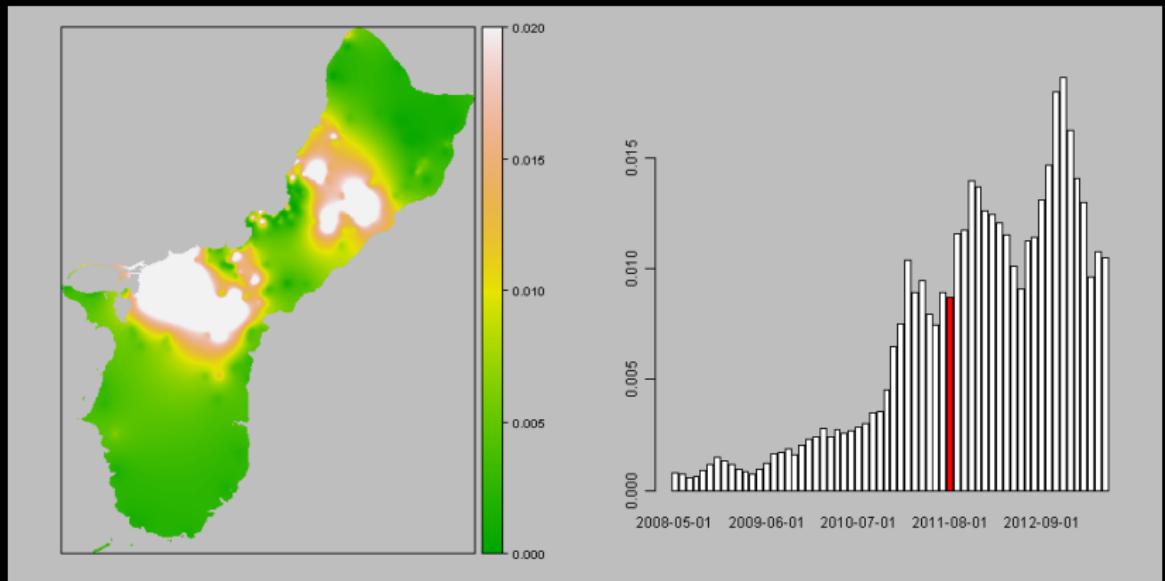
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2011



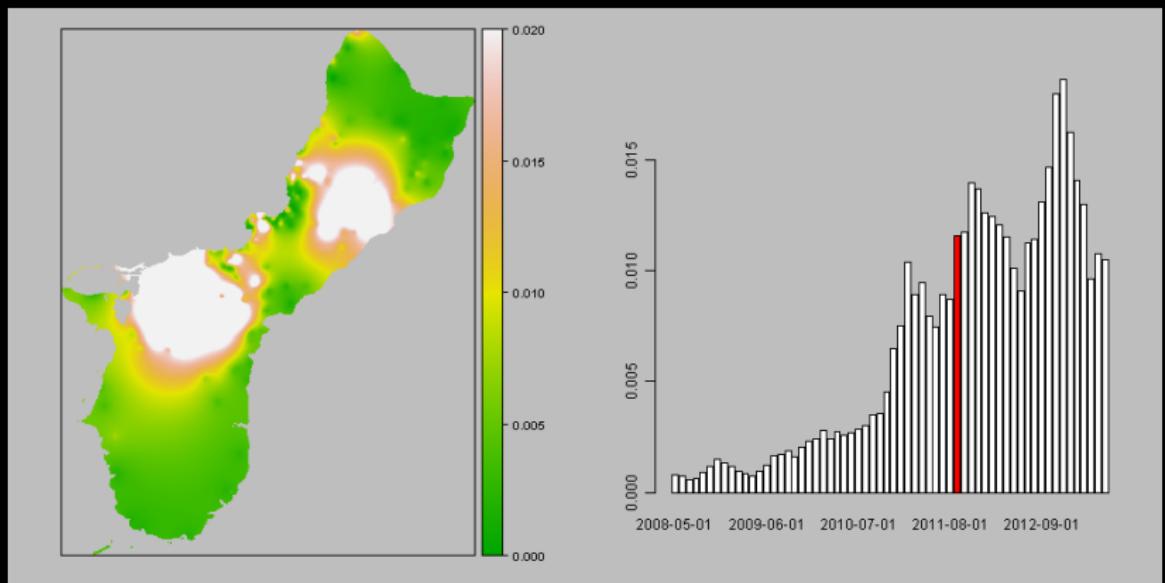
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2011



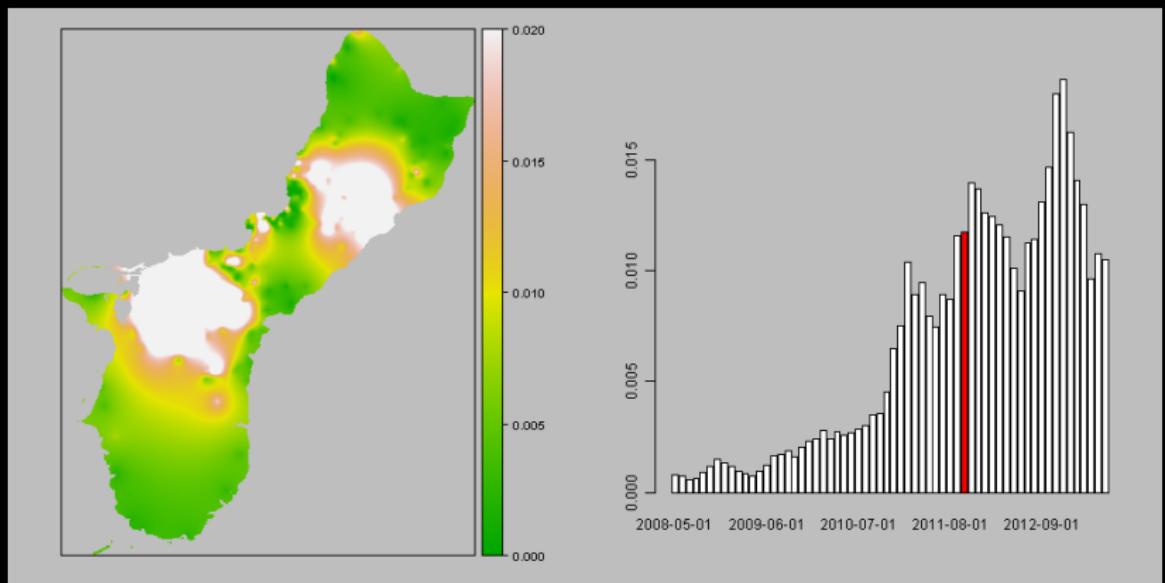
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2011



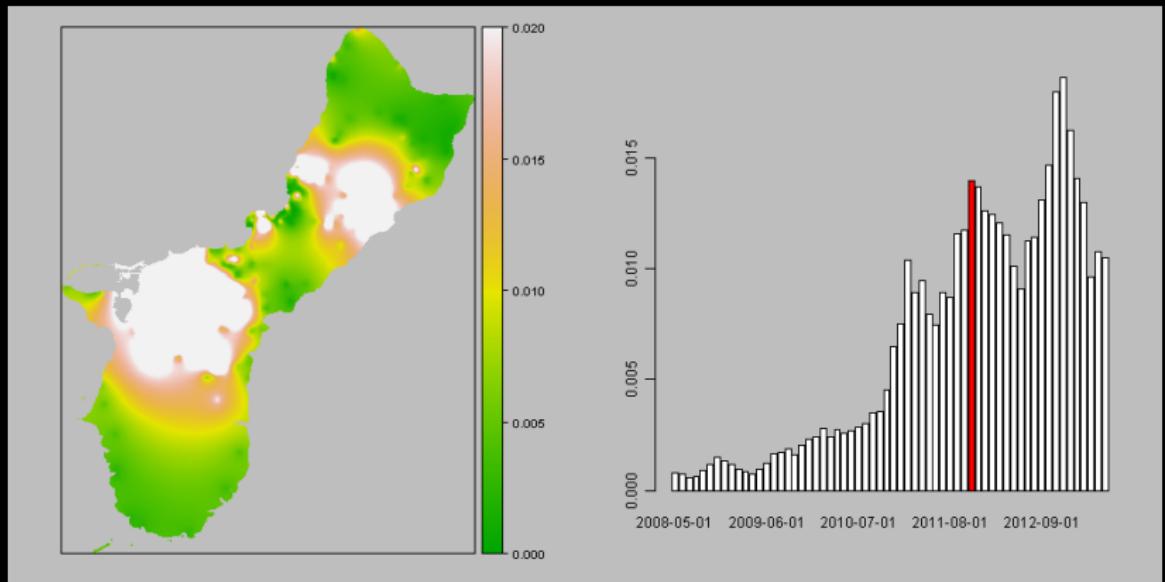
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2011



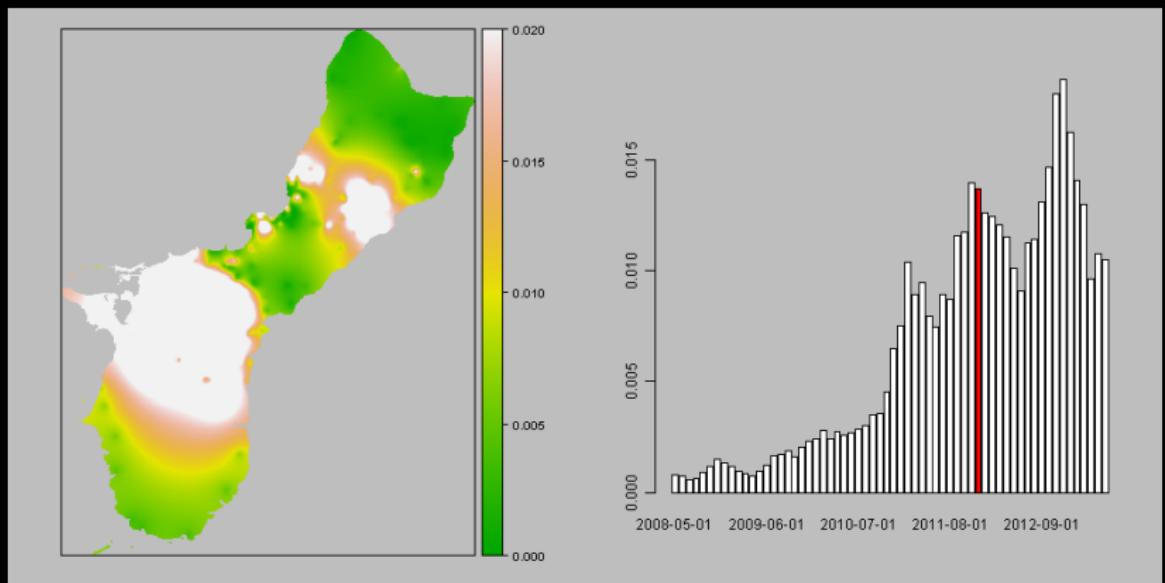
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2011



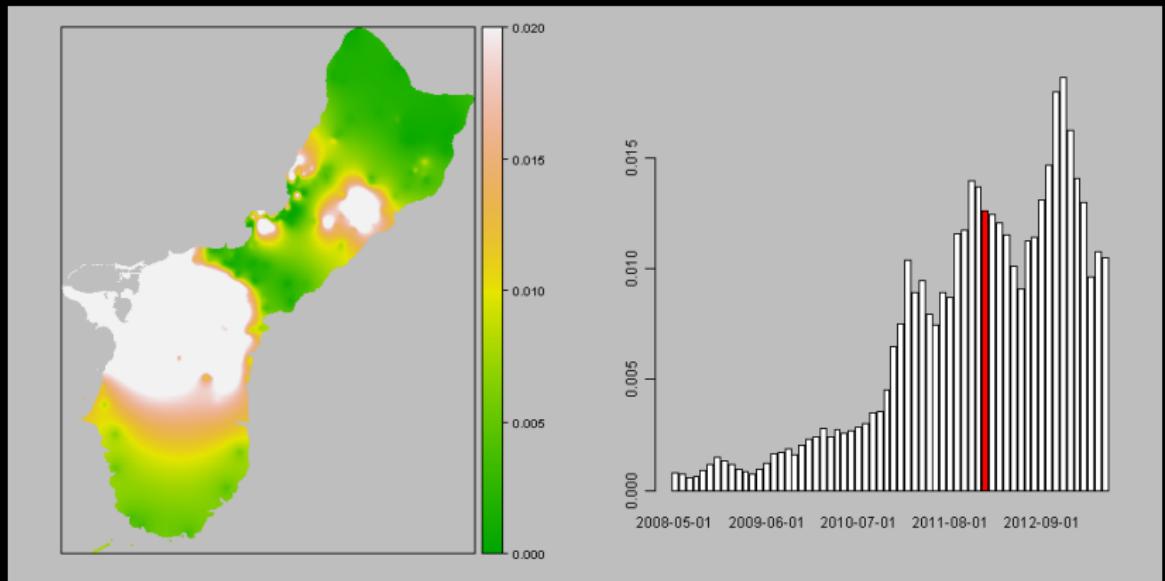
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2011



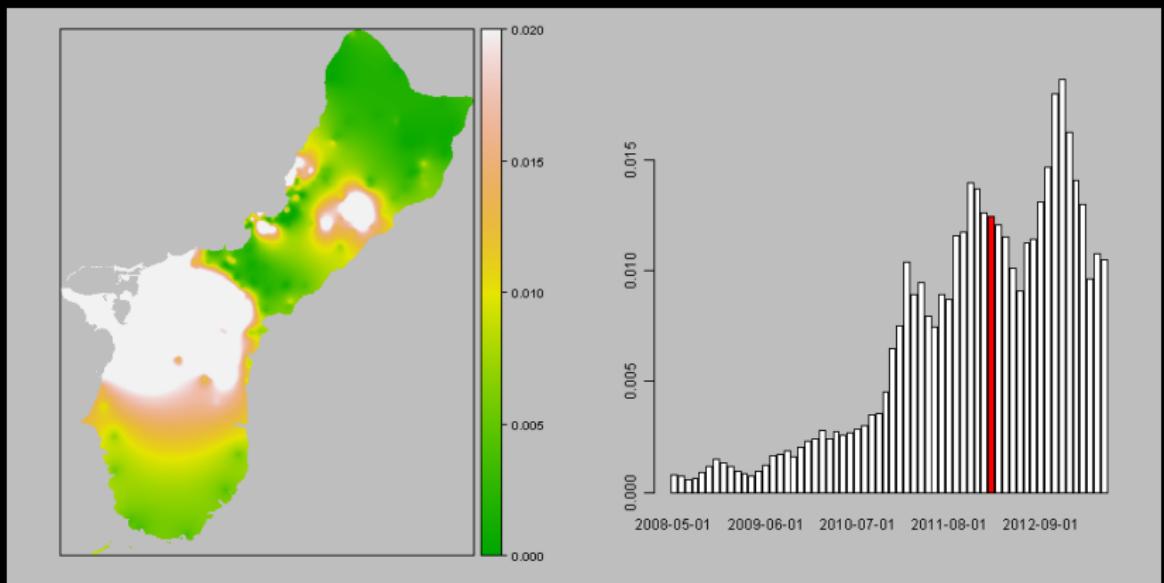
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2012



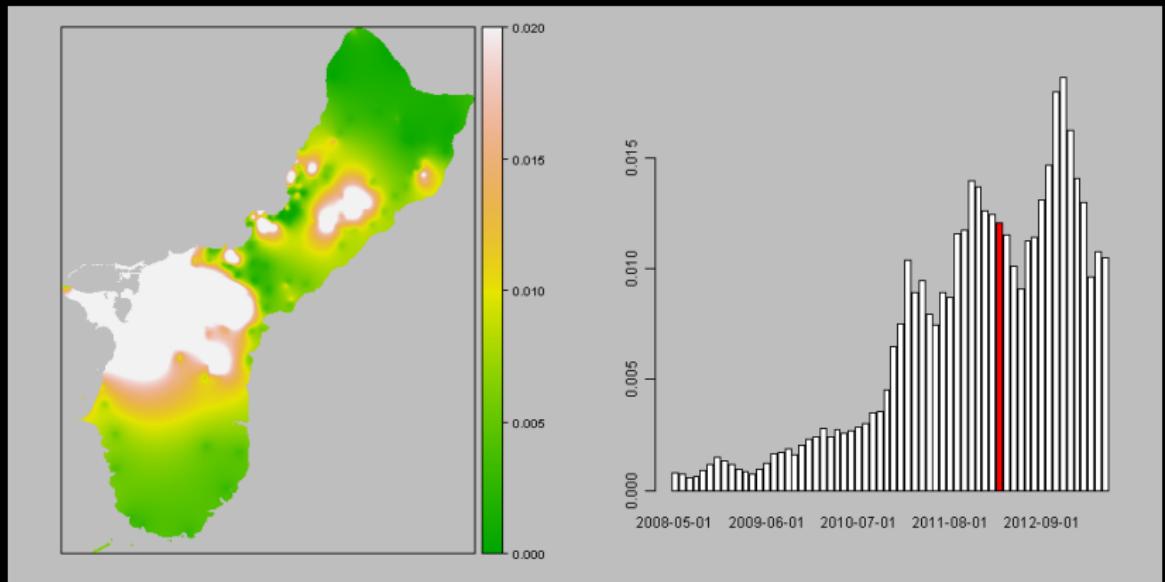
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2012



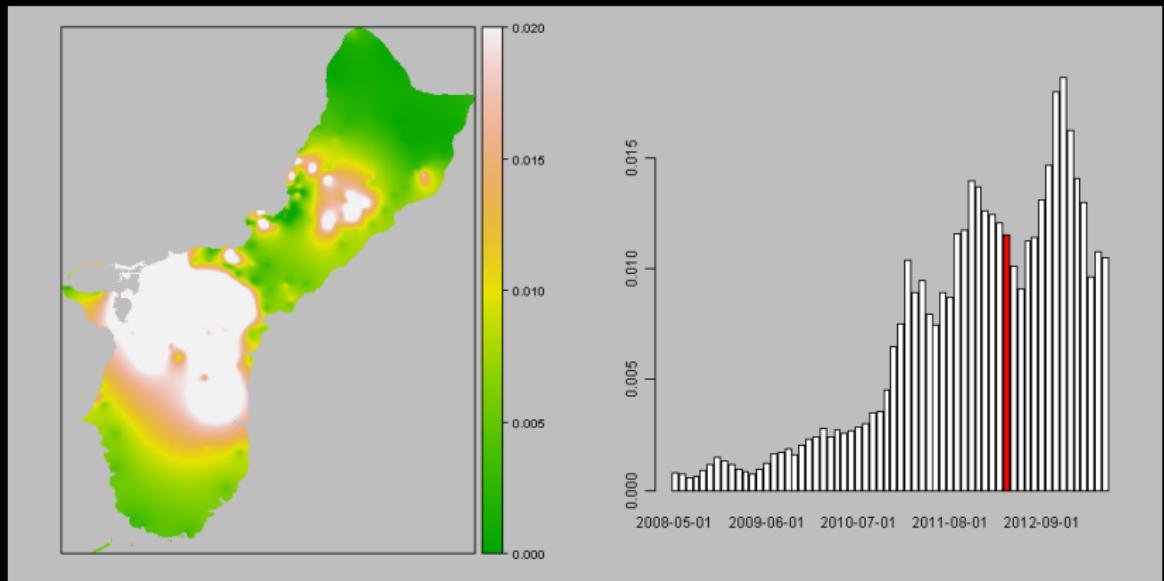
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2012



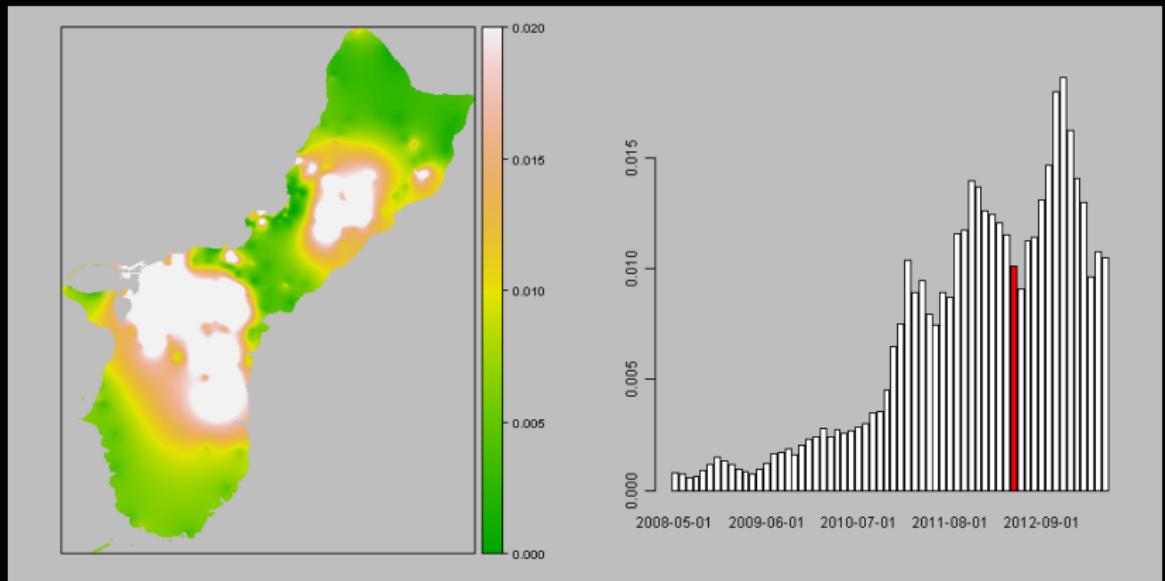
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2012



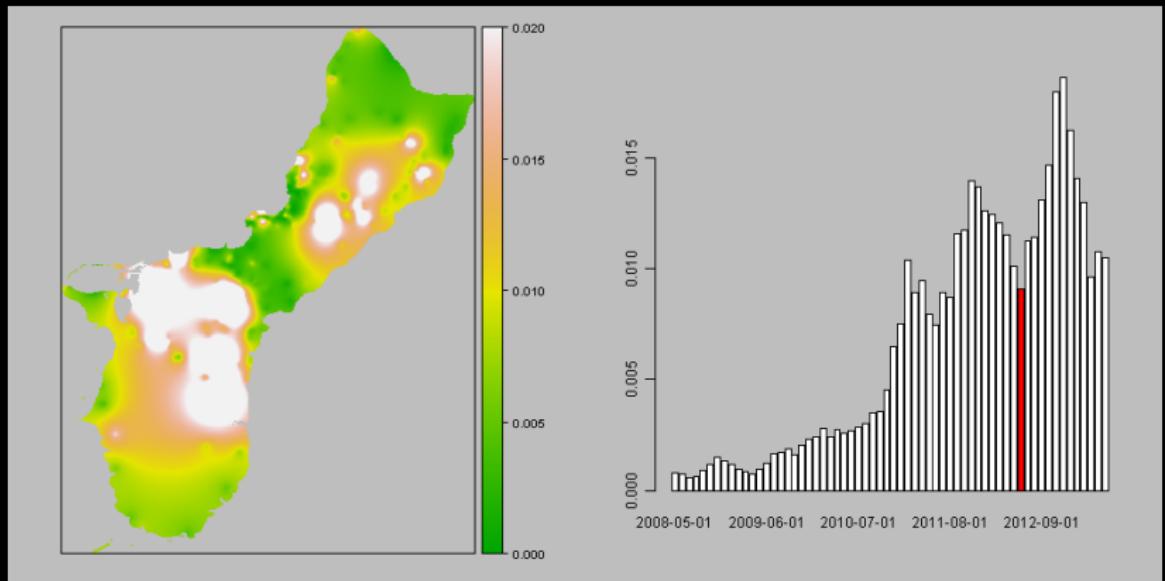
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2012



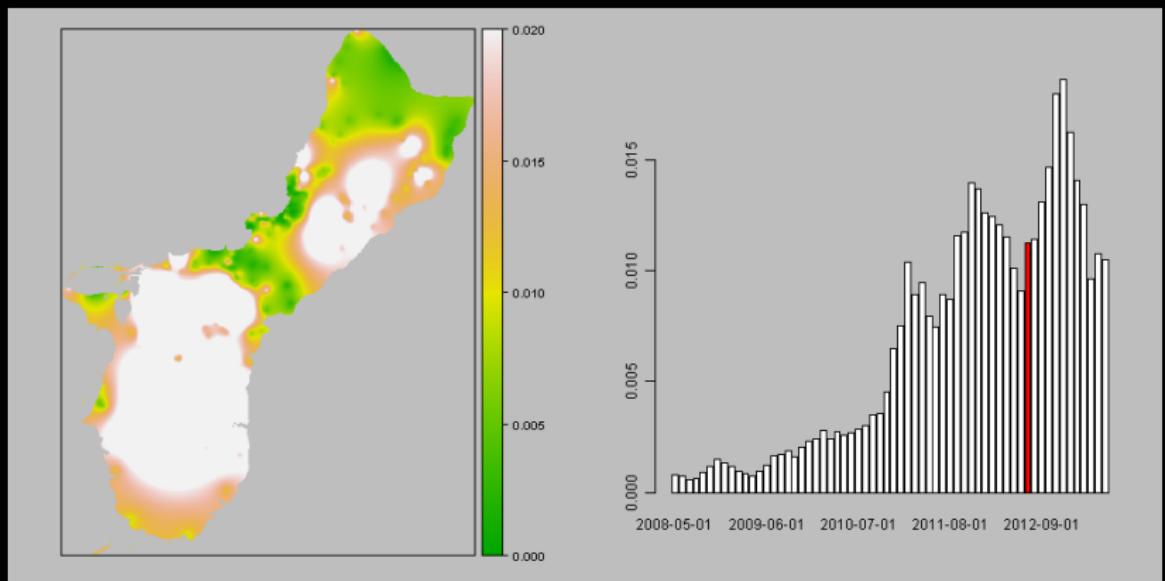
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2012



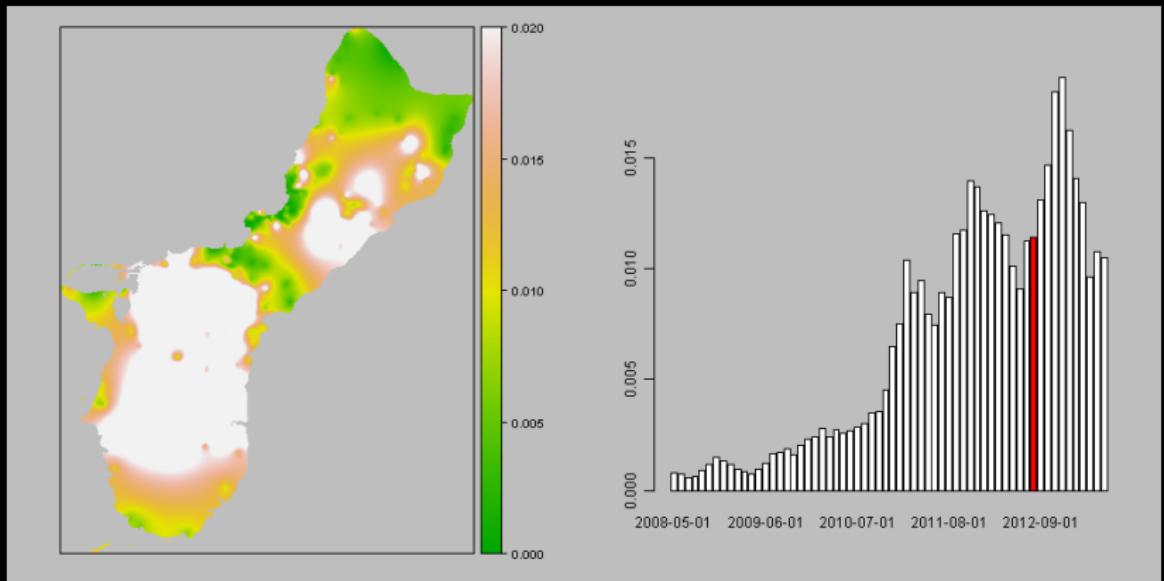
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2012



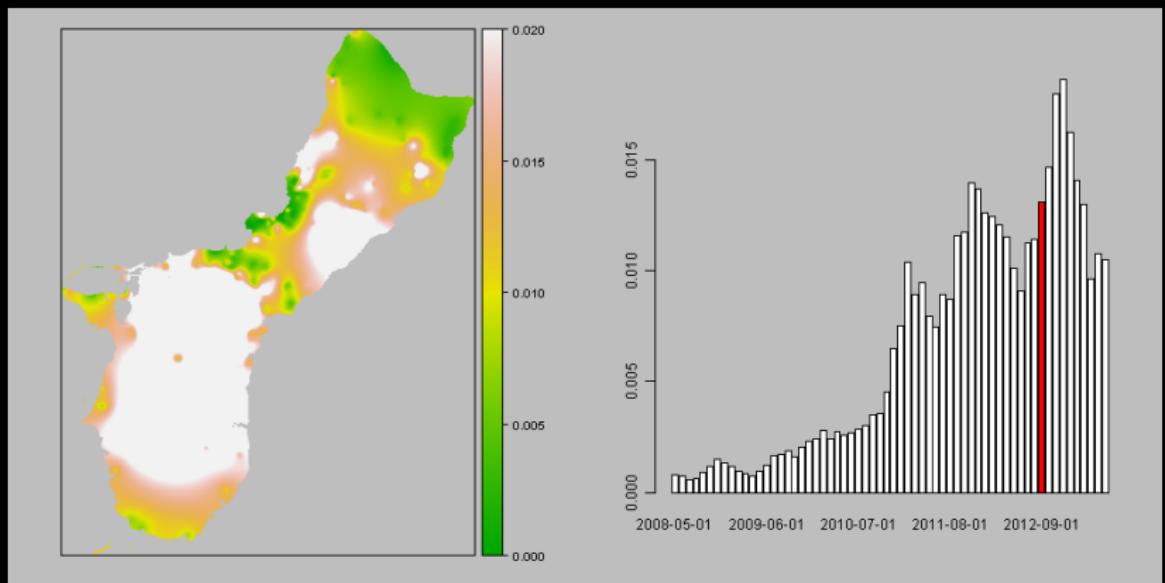
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2012



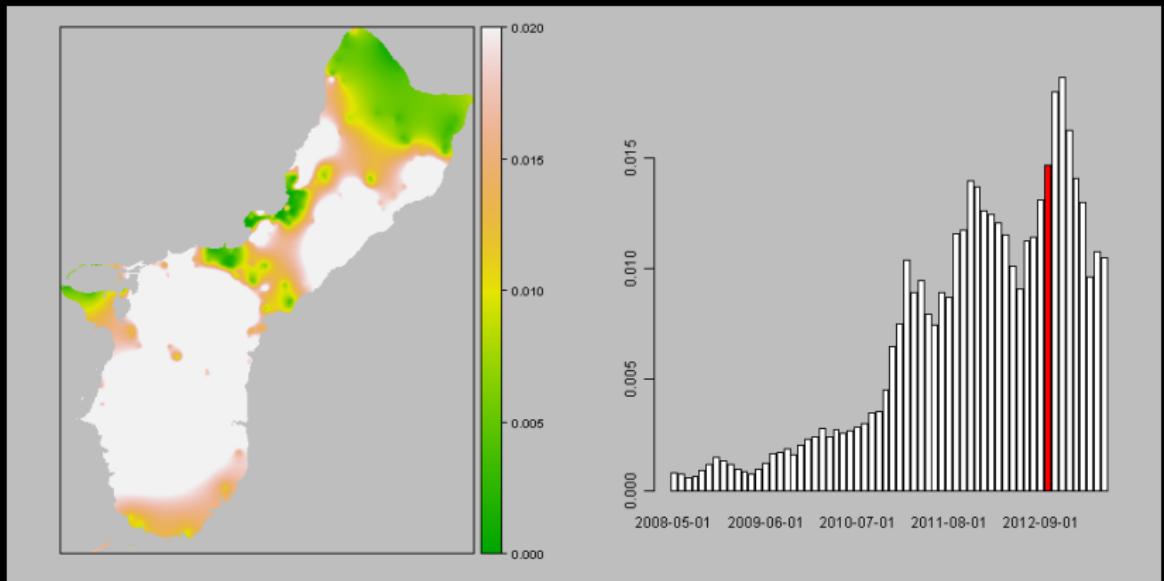
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2012



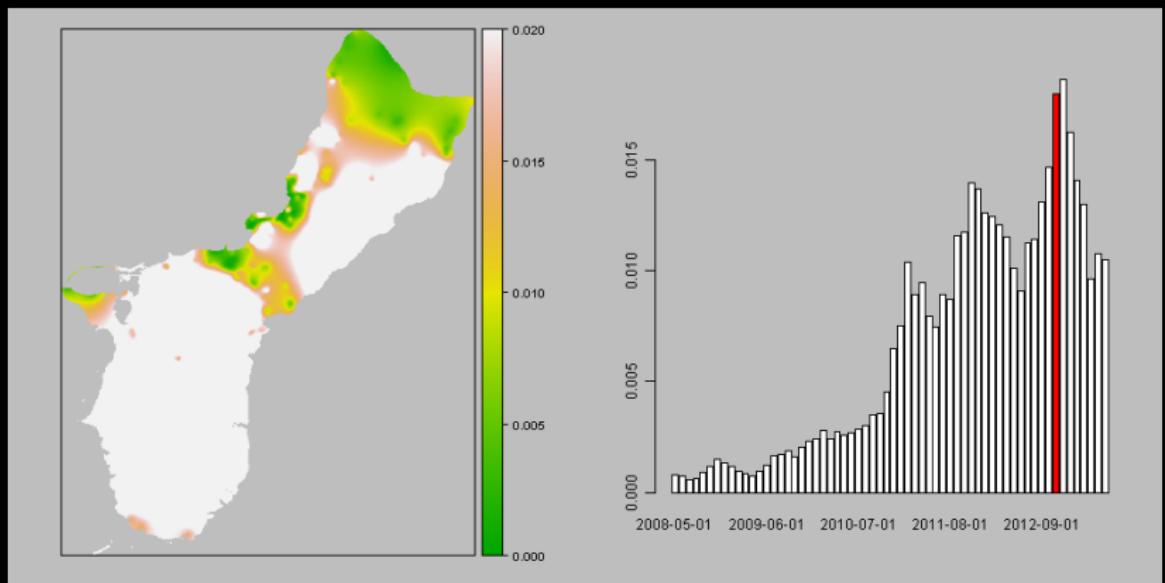
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2012



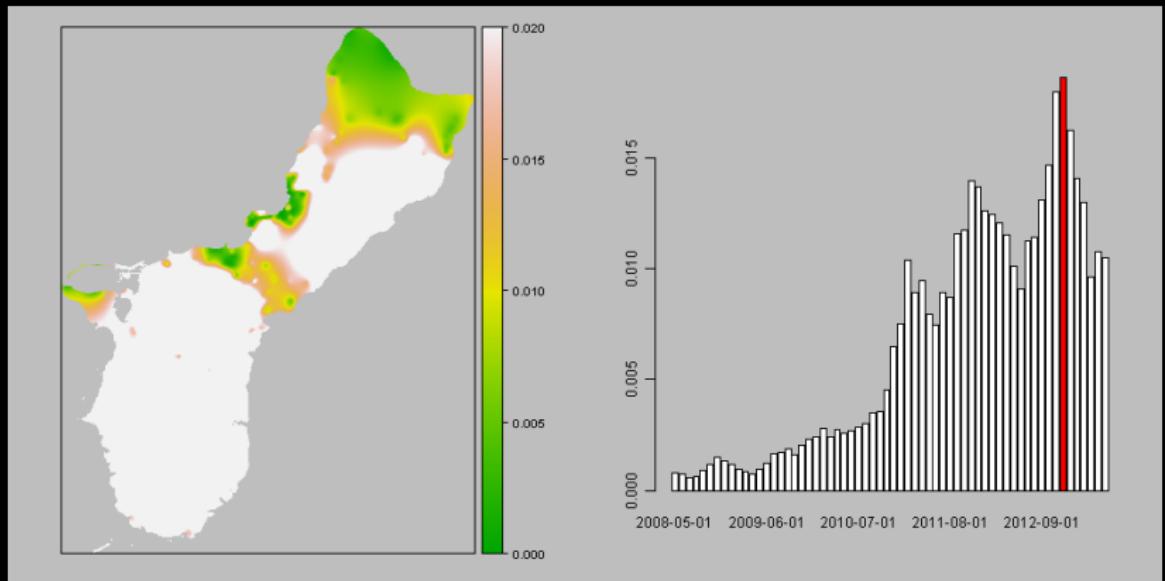
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2012



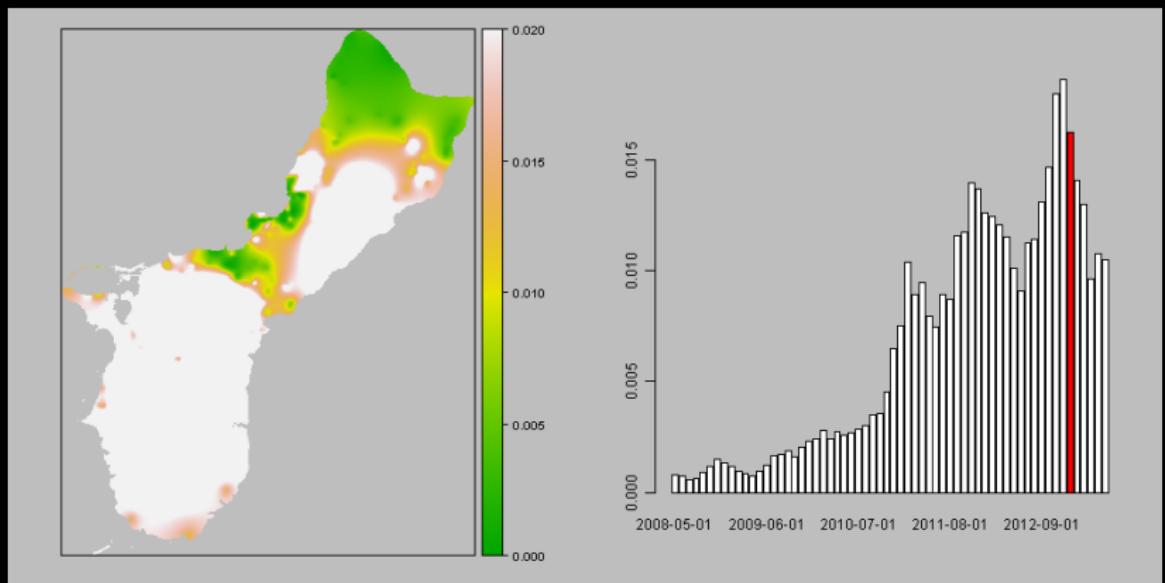
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2012



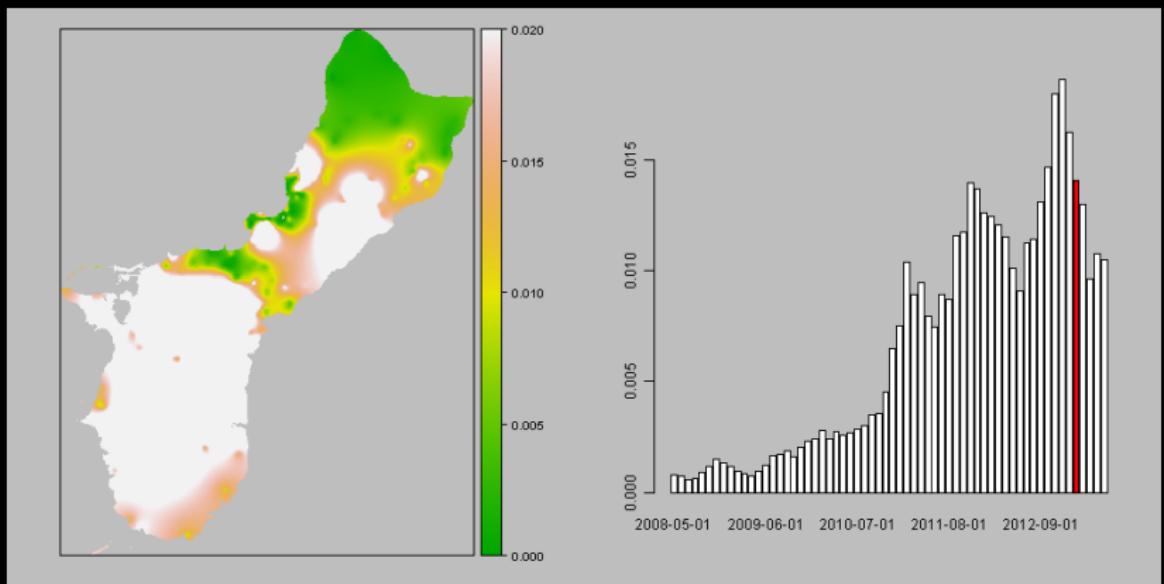
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2013



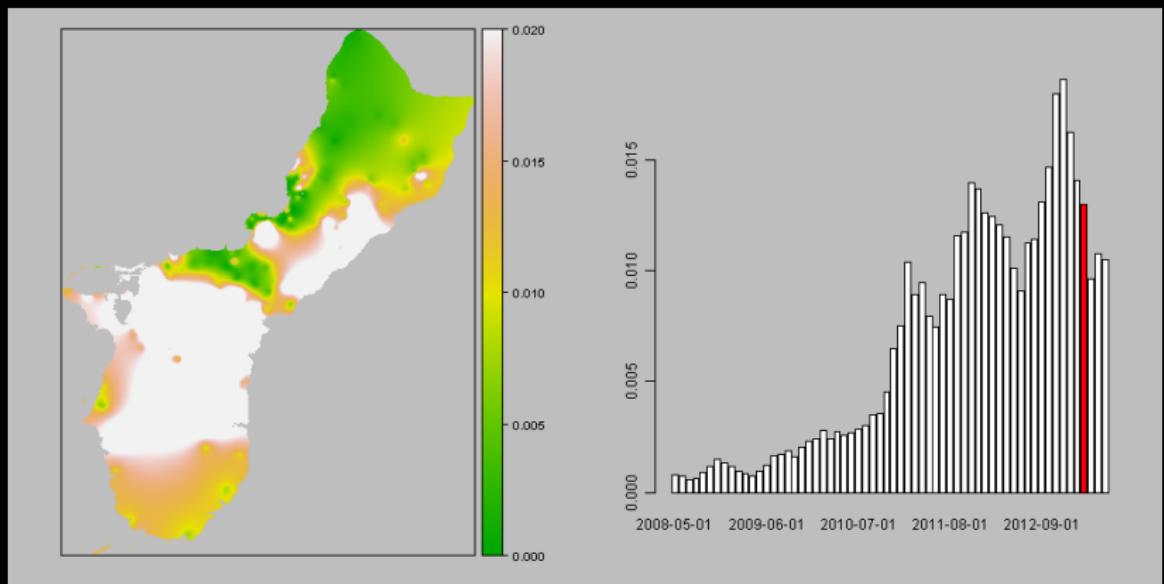
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2013



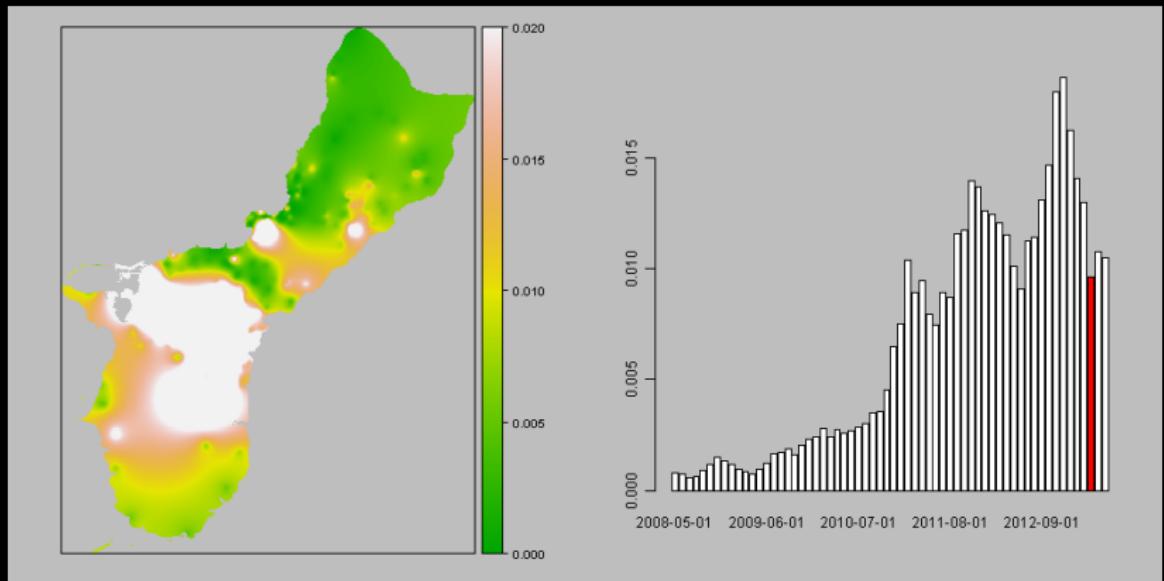
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2013



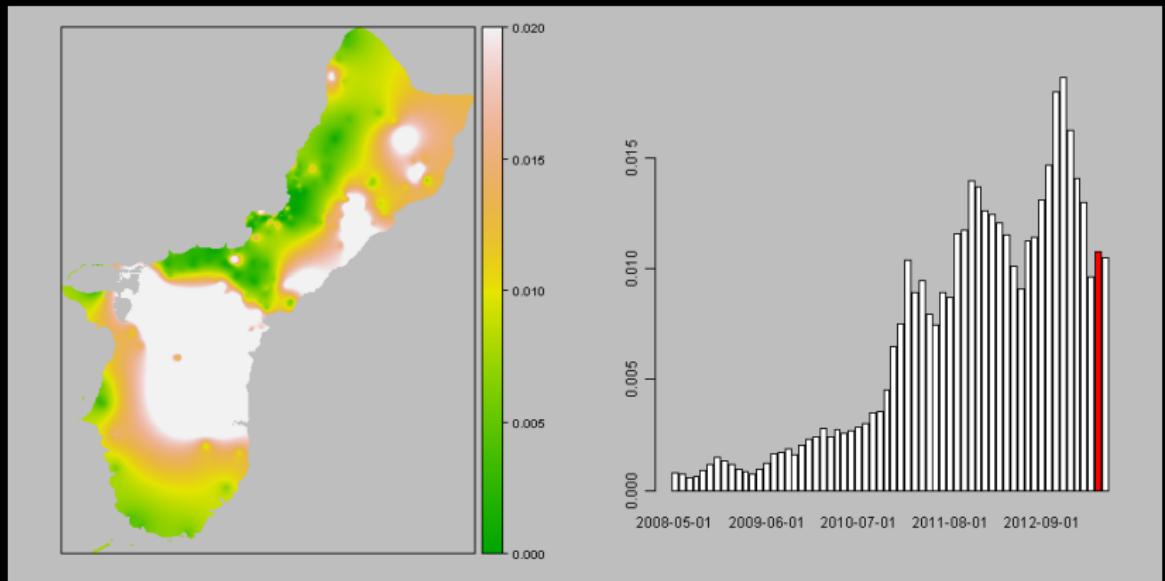
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2013



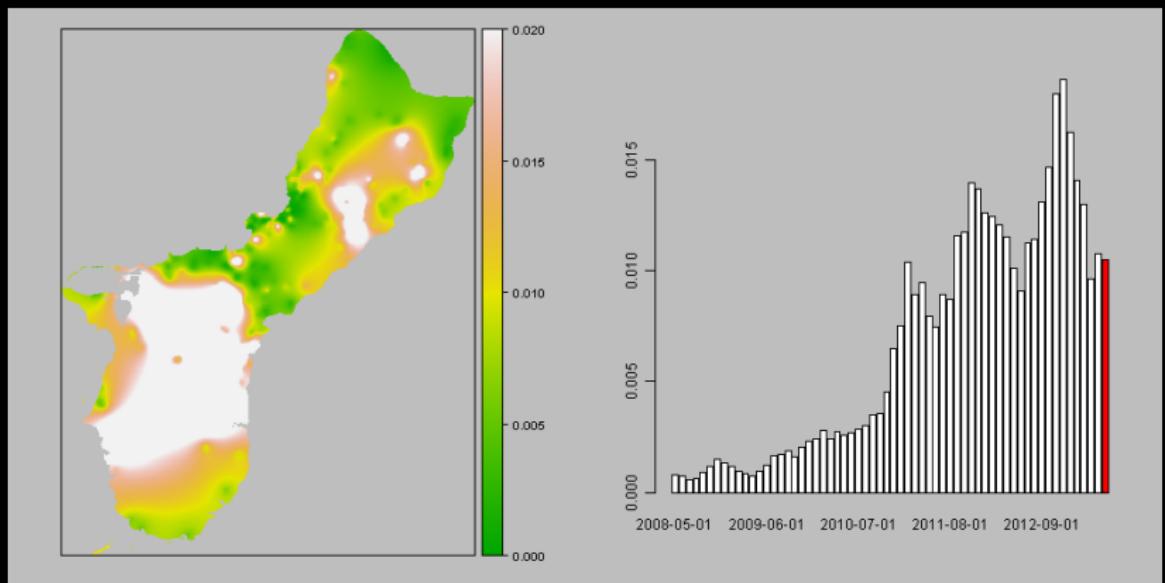
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2013



Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2013



Mean number of beetles caught per trap-day

Sanitation









GRUBS – 296
PUPAE – 41
ADULTS - 15

DANGER
**RESTRICTED
AREA**

2007/12/09





2007/12/11

DETECTOR DOGS



CHEMICAL CONTROL



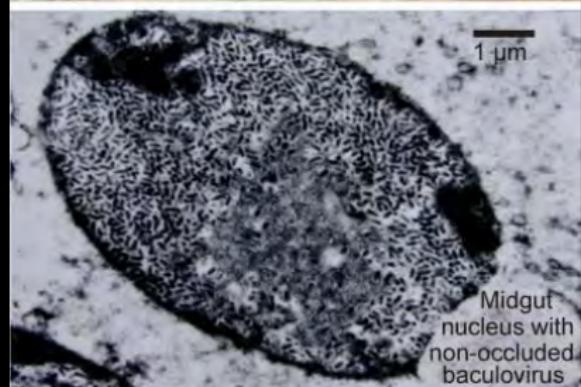
Insecticides Being Evaluated

- ▶ CYPERMETHRIN: quick knockdown of all stages; not persistent
- ▶ PYRIPROXIFEN (NYGARD®): insect growth regulator; prevents production of adults
- ▶ SPLAT RB® + CYPERMETHRIN: experimental attracticide; adults only

BIOCONTROL



Palm rhinoceros beetle









Metarhizium for Biological Control

- ▶ a USDA import and release permit was obtained for *Metarhizium* which is being produced for biocontrol of CRB by the Philippines Coconut Authority
- ▶ 15 kg of spores were imported on September 10, 2011 and December 10, 2011
- ▶ following lab bioassays, field releases were started by incorporation into breeding sites and autodissemination by adult males
- ▶ *Metarhizium* appears to be working well: we are finding dead grubs with fungus even in areas where we did not apply spores

Biological Control of the Coconut Rhinoceros Beetle









Invasive species aren't all bad.
They provide job security for biologists.



Acknowledgments

Thanks to the following for providing information and images for this talk:

- Diane Vice & Brent Tibbatts, Div. of Aquatic & Wildlife Resources, Guam Dept. of Agriculture
- Dan Vice, USDA Wildlife Services
- Anne Brook, Navy
- A Host of Others