Failure Analysis of the Guam Coconut Rhinoceros Beetle Eradication Project

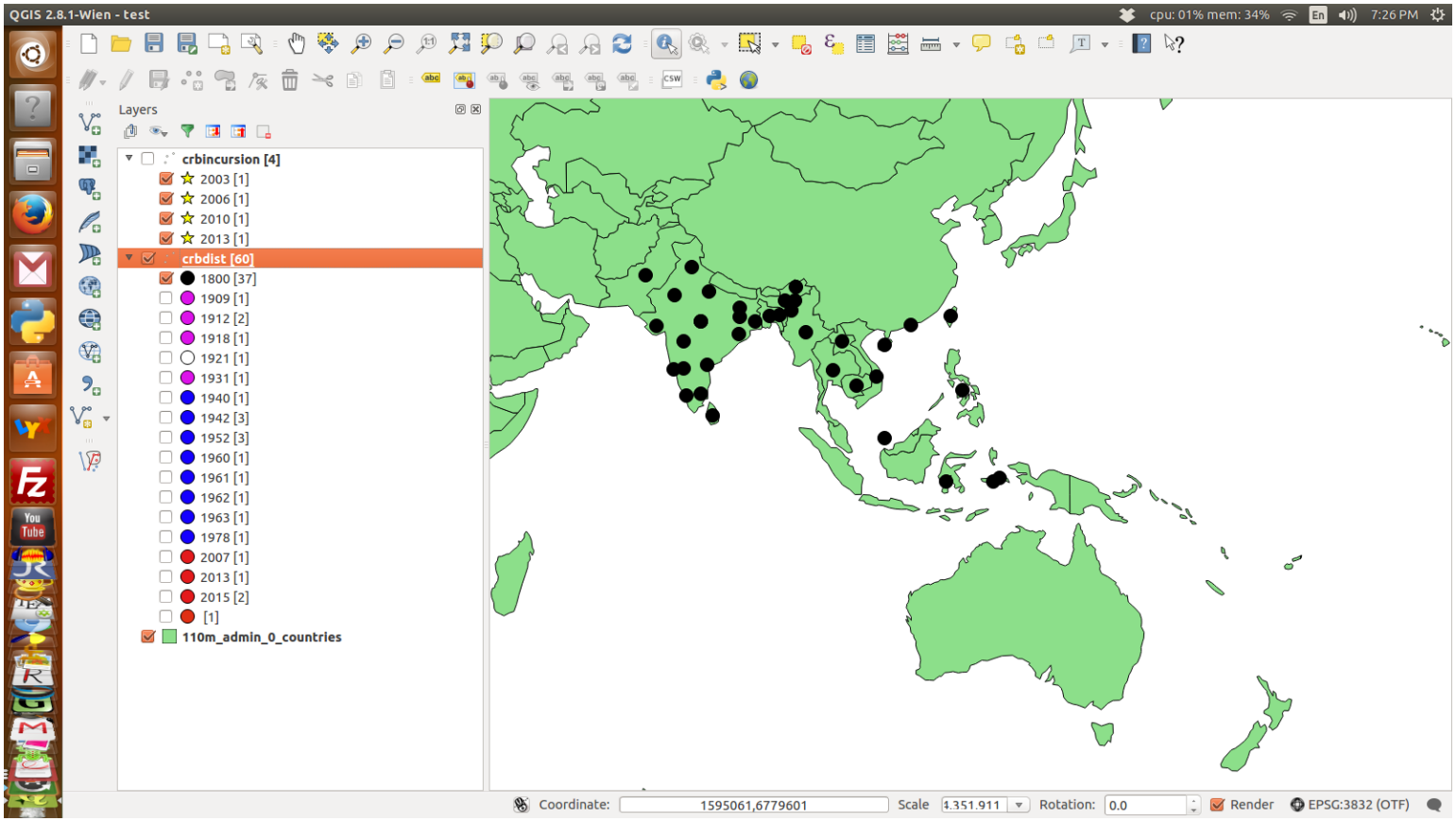
Aubrey Moore
Western Pacific Tropical Research Center
University of Guam

Pacific Entomology Conference, Honolulu, HI, April 2015

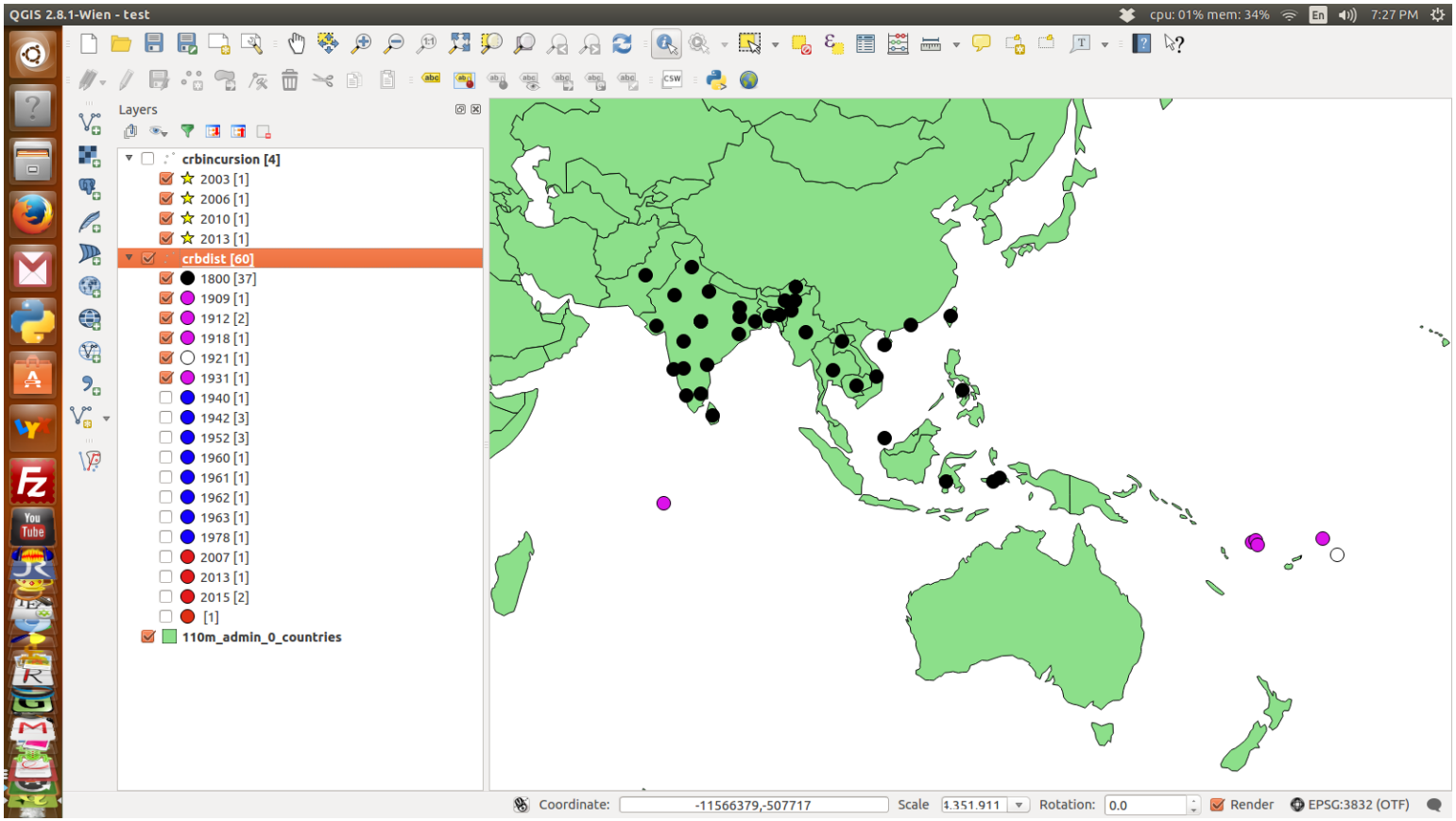
Overview

Coconut rhinoceros beetle, *Oryctes rhinoceros*

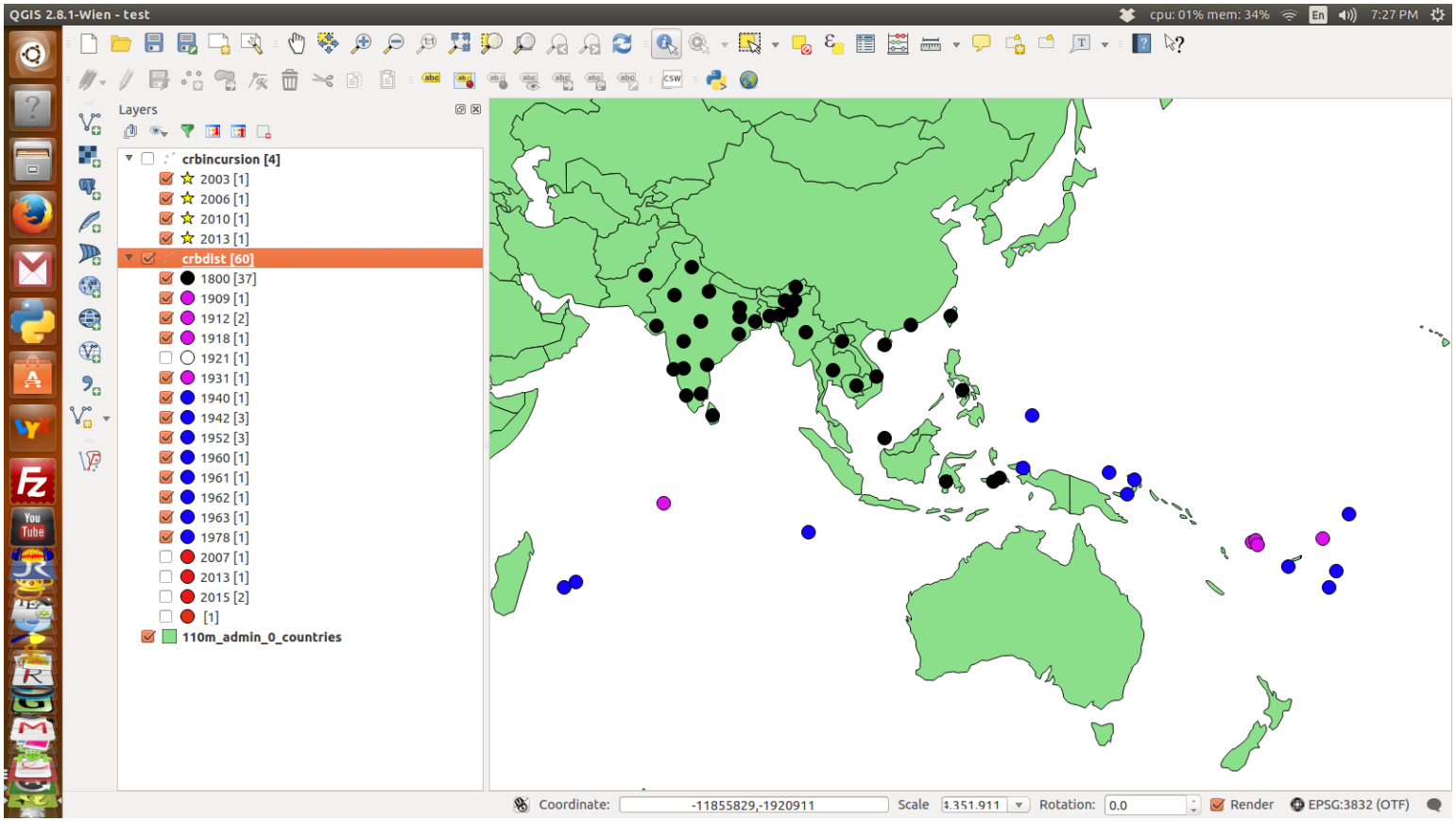
Geographic Distribution



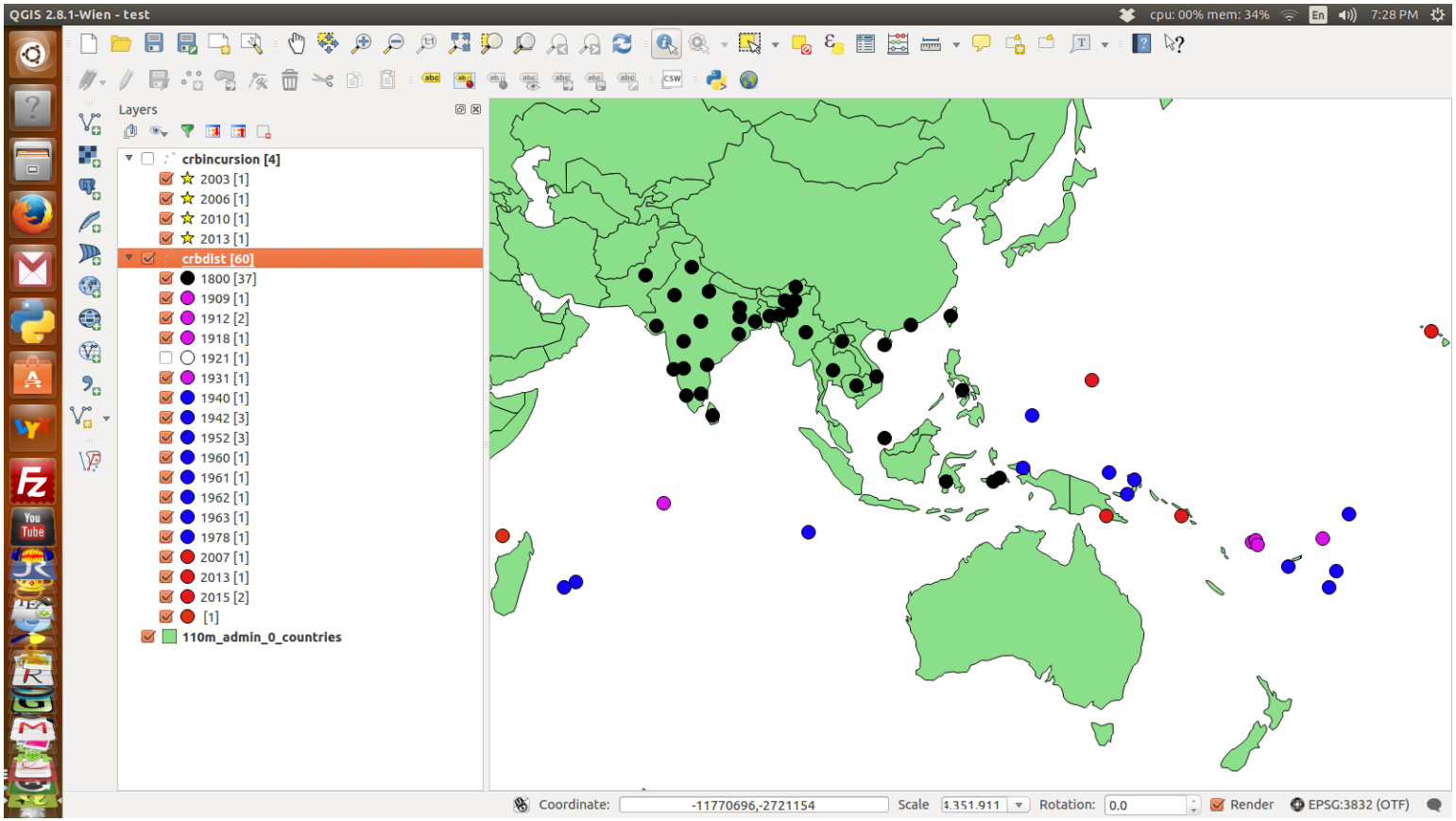
Geographic Distribution



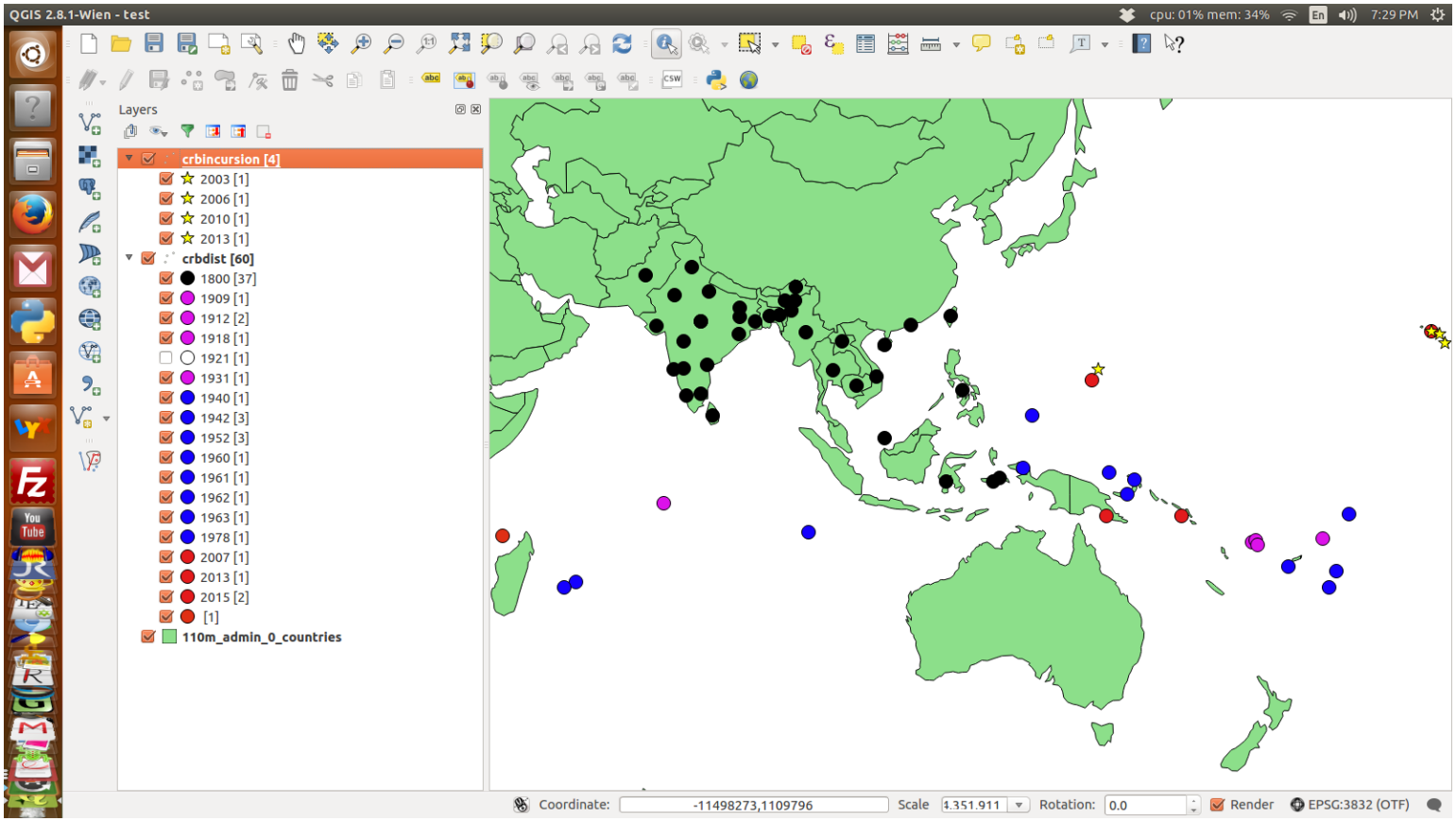
Geographic Distribution



Geographic Distribution



Geographic Distribution



Coconut rhinoceros beetle damage

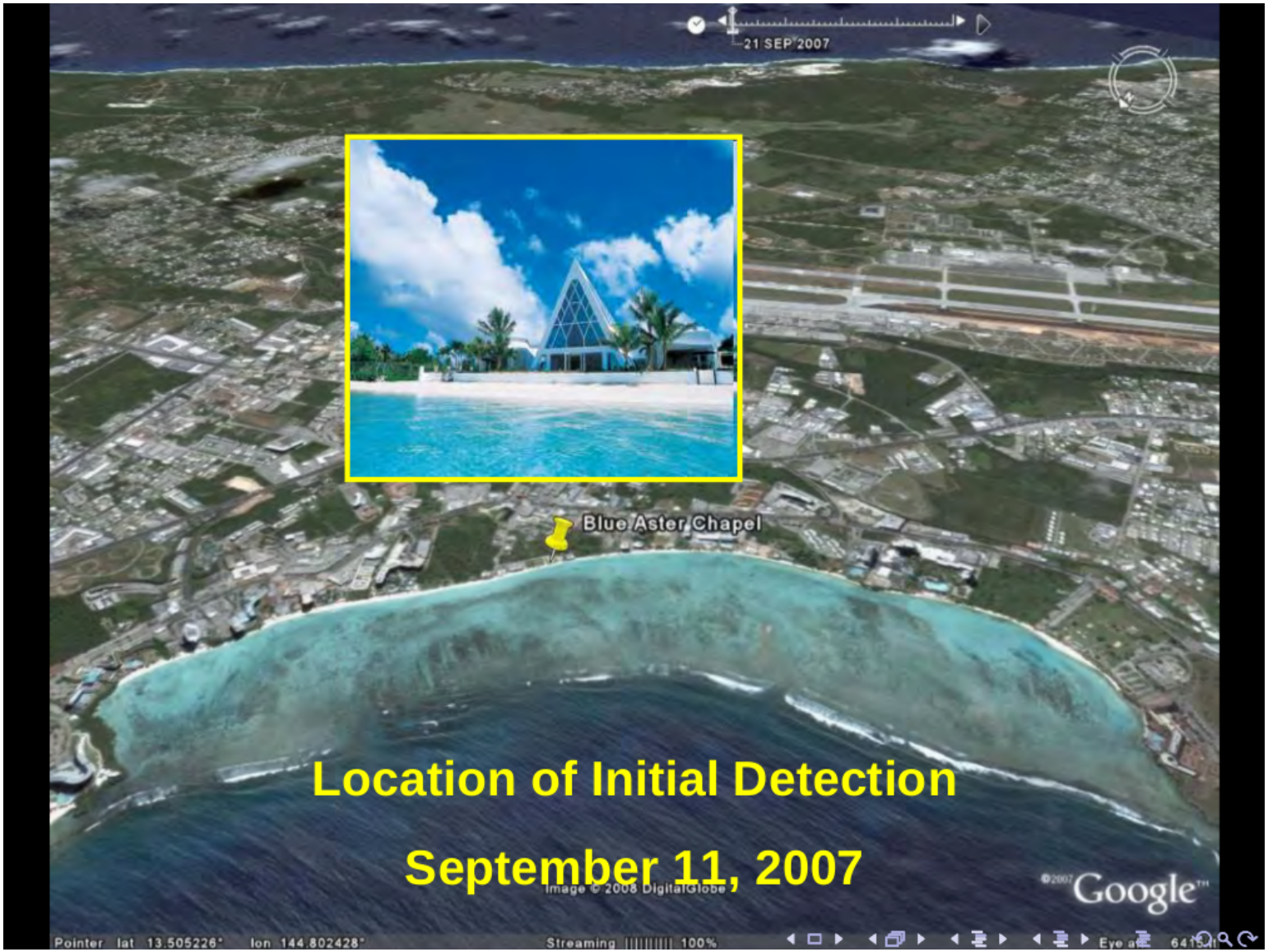
Coconut rhinoceros beetle grubs

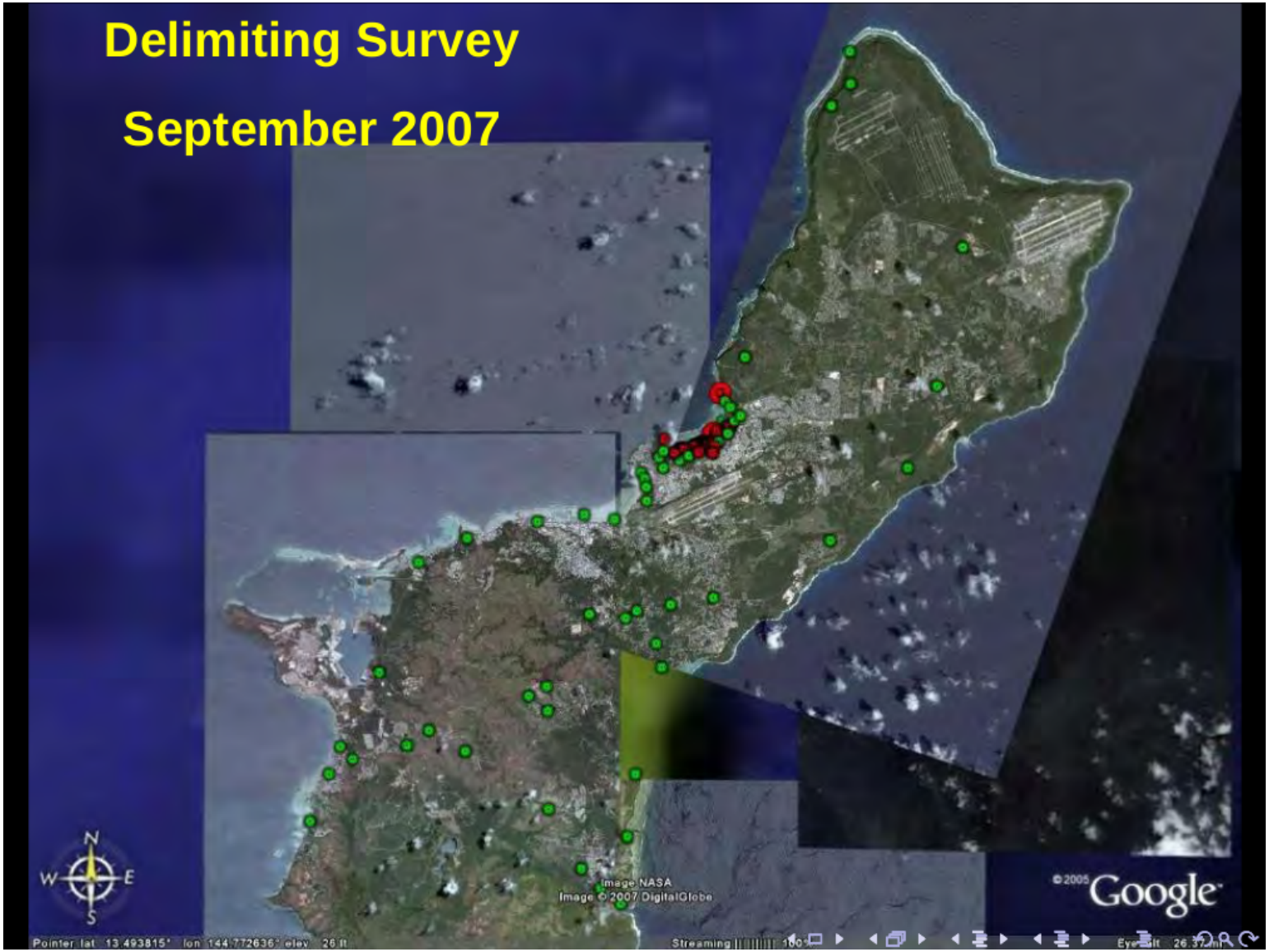
98% of the CRB population (all life stages) are found in breeding sites

Feedback loop

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

History of the Guam CRB Eradication Project





Guam Coconut Rhinoceros Eradication Project
ORGANIZATION

Partners:	**Funding:**
USDA-APHIS	USDA-APHIS
Guam Dept. of Agriculture	US Forest Service
University of Guam	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

Quarantine


Initial Quarantine Area
September 2007
501
503
502
508
509
506
507
504
499
A1
G1
453
497
476
488
486
469
505
475
470
464
465
458
460
457
463
455
456
G3
G2
588
589
591
590
592
593
Image © 2007 DigitalGlobe
©2007 Google
Pointer lat 13.509068° lon 144.803960° elev 44 ft
Streaming 100%

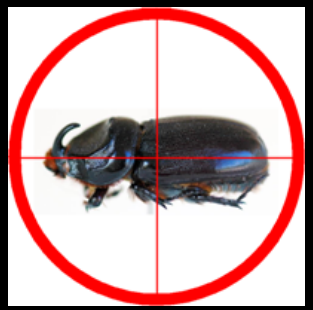
PHEROMONE TRAPS

- Mass trapping unsuccessful
- Traps useful for monitoring

Visualization of Trap Catch Data

Aubrey Moore

Guam Coconut Rhinoceros Beetle Eradication Project



Generated 2014-06-10 18:56:16
Path: C:/Documents and Settings/Administrator/My Documents/CRB monthly surveillance reports/map dev
R script: makeMaps.R
Brew file: makeBeamer.txt

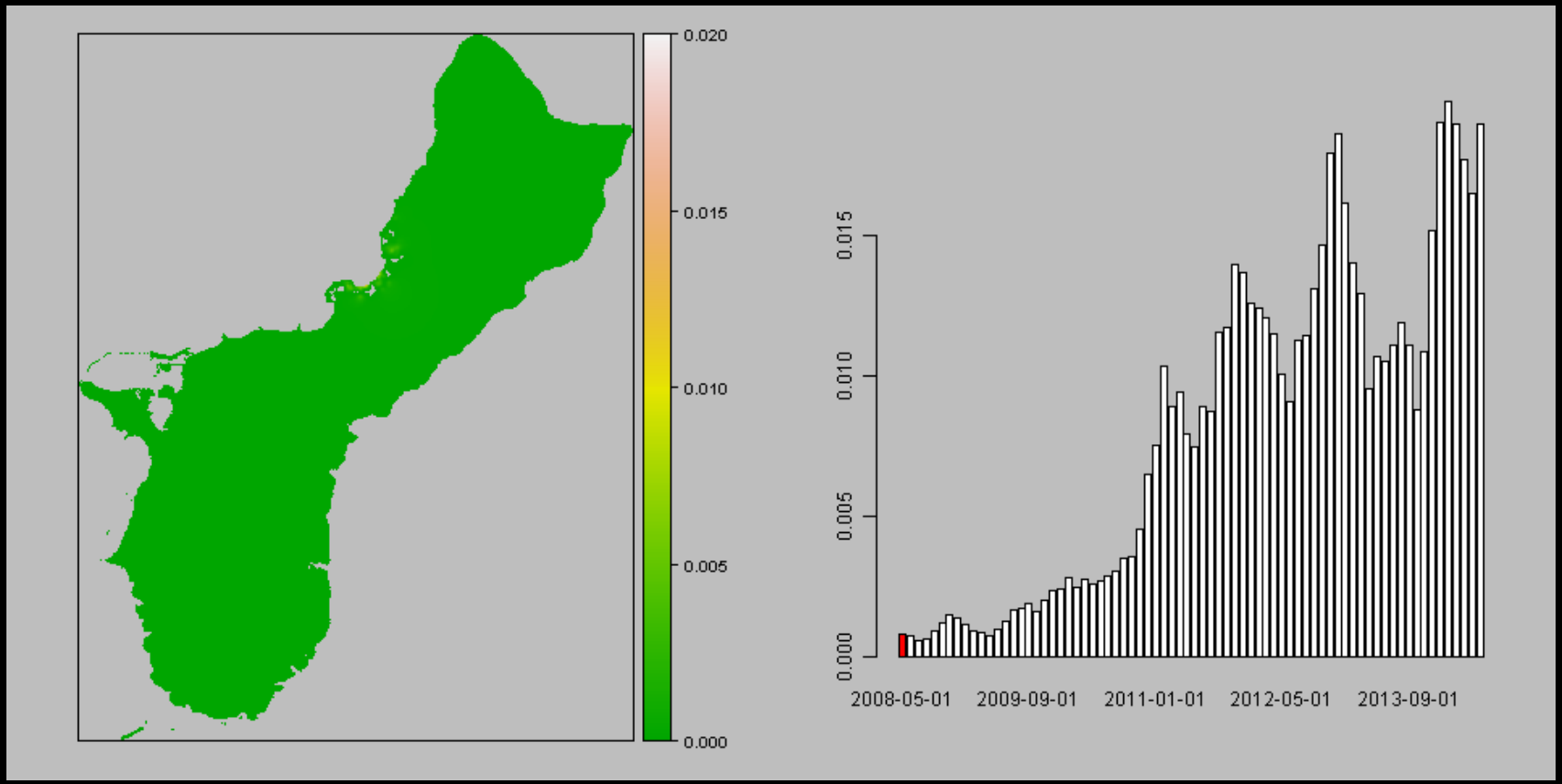
Introduction

- 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

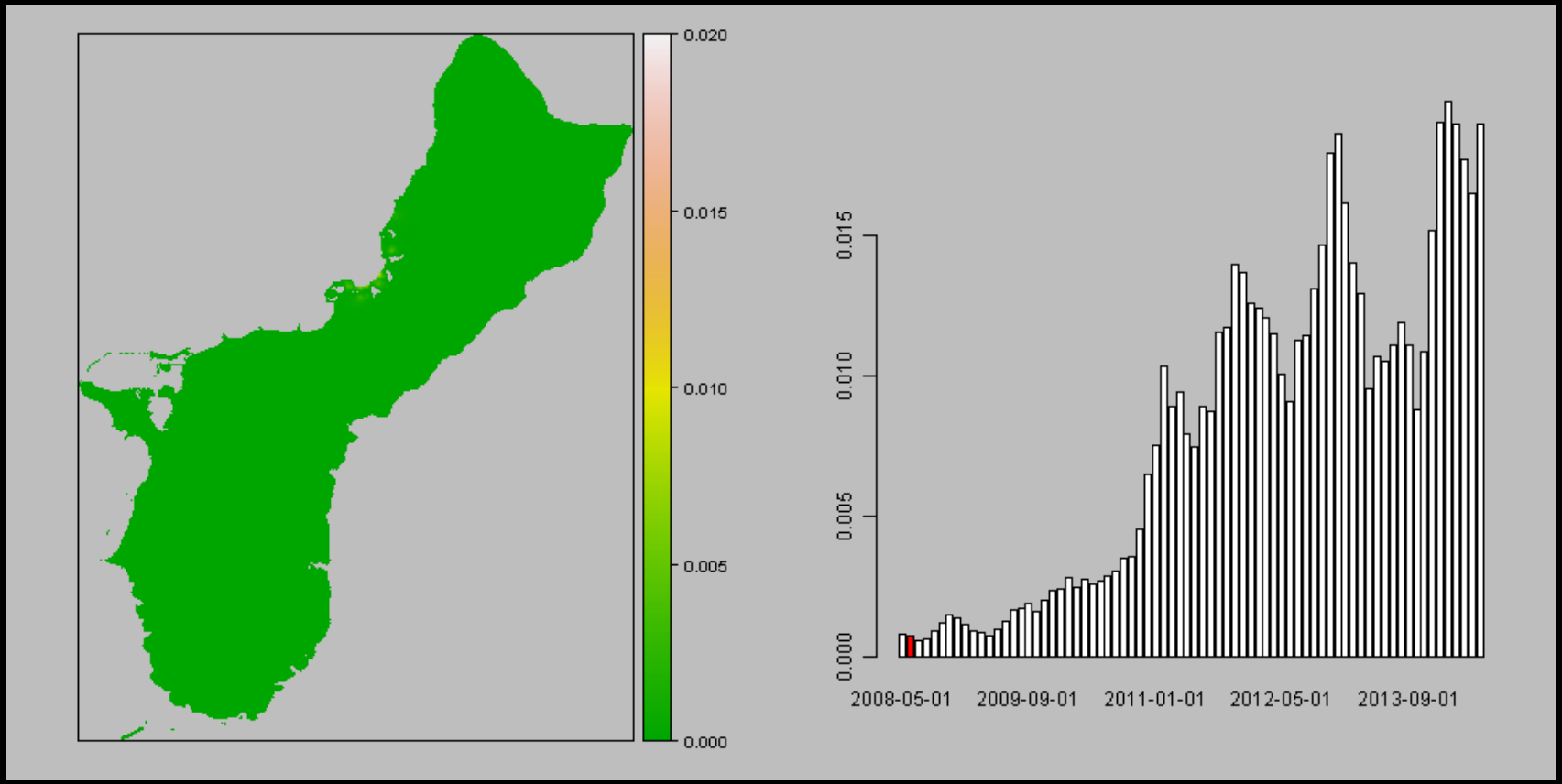
- Interpolated raster maps were made using an R script which:
  1. Accesses georeferenced data stored in the CRB project's online MySQL database.
  2. Processes the data using the GRASS6 GIS
  3. Writes the LaTeX code which generated this PDF document.

90 day trapping period ending on 01 May 2008



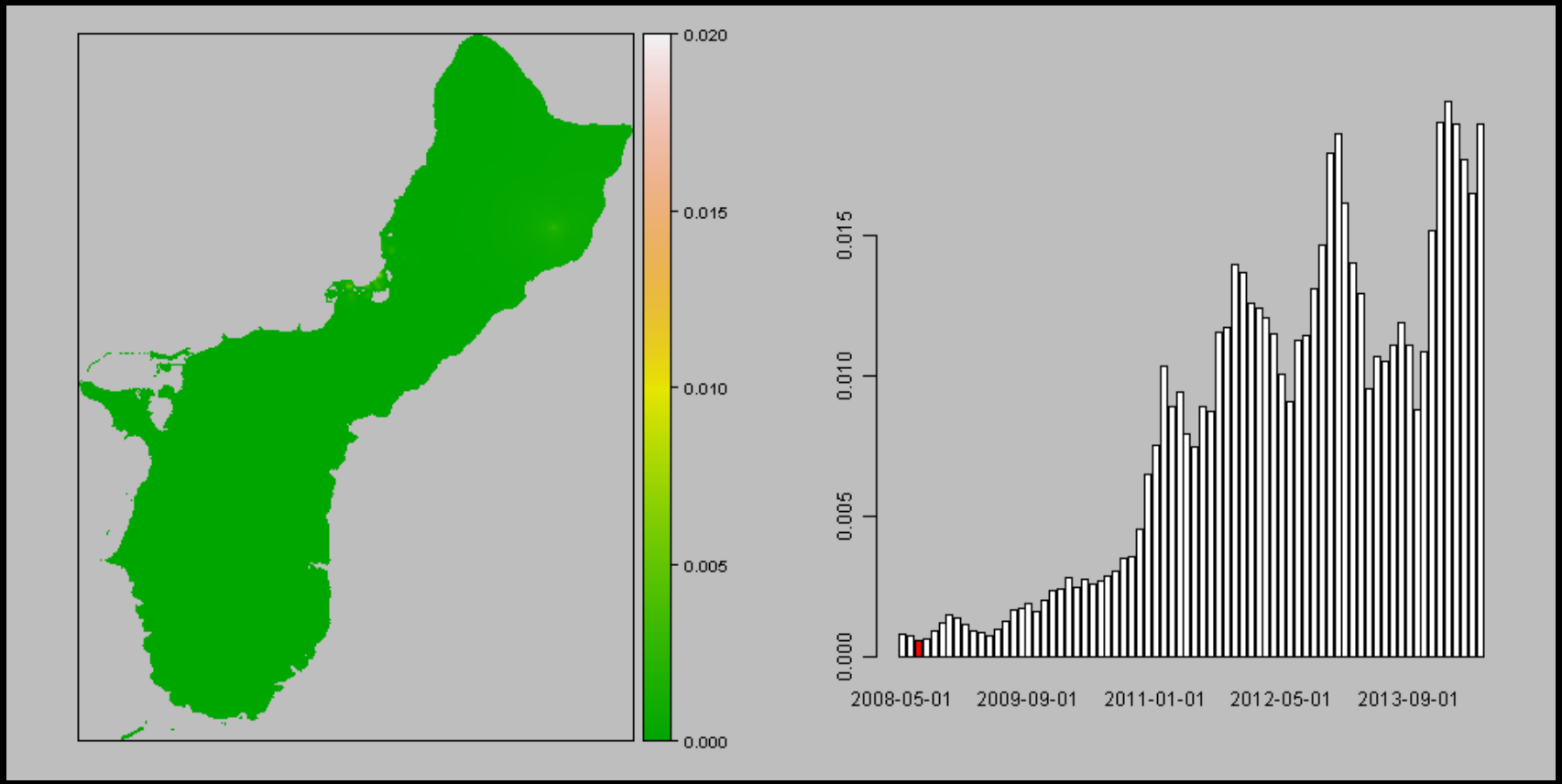
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2008



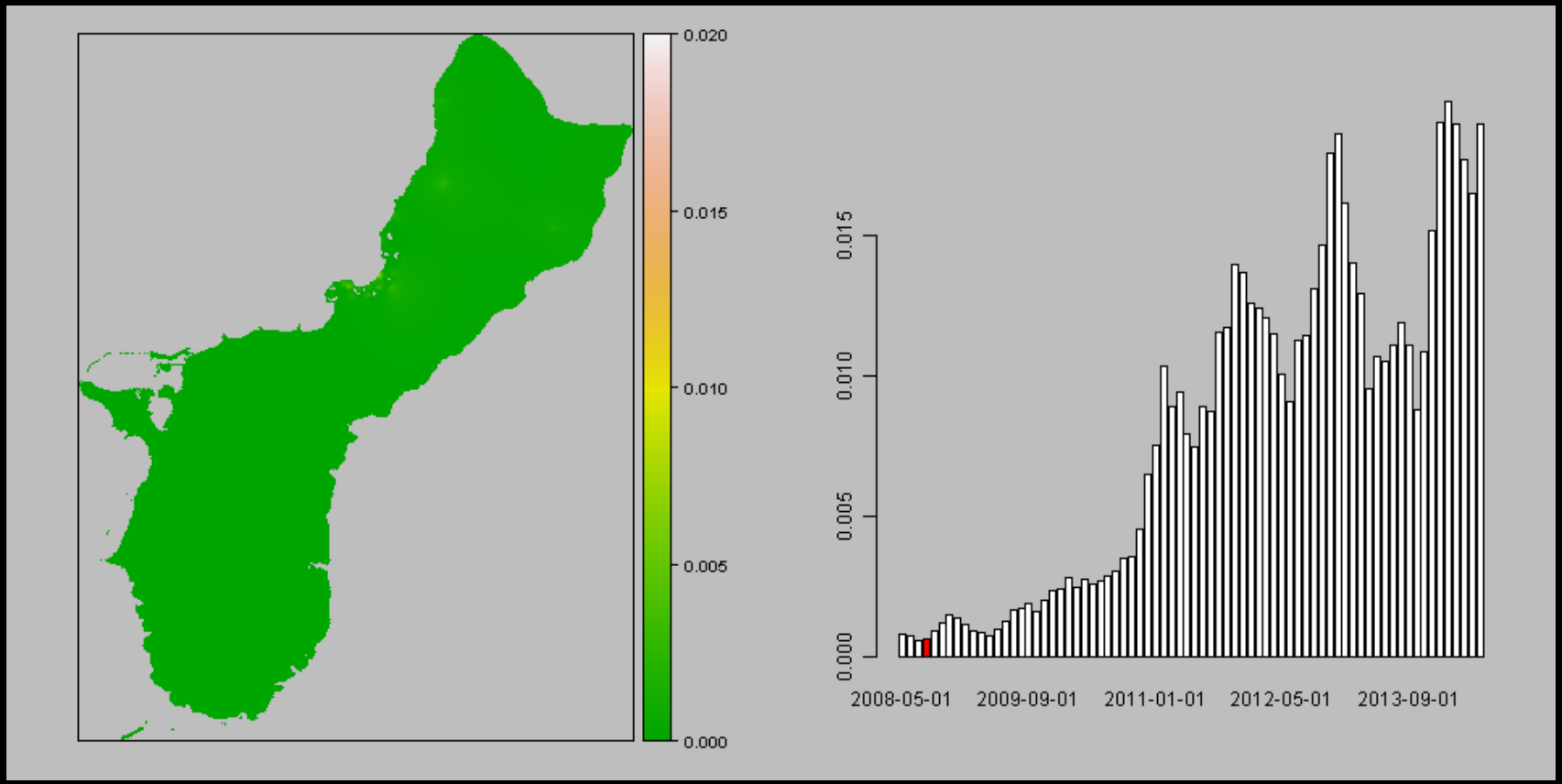
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2008



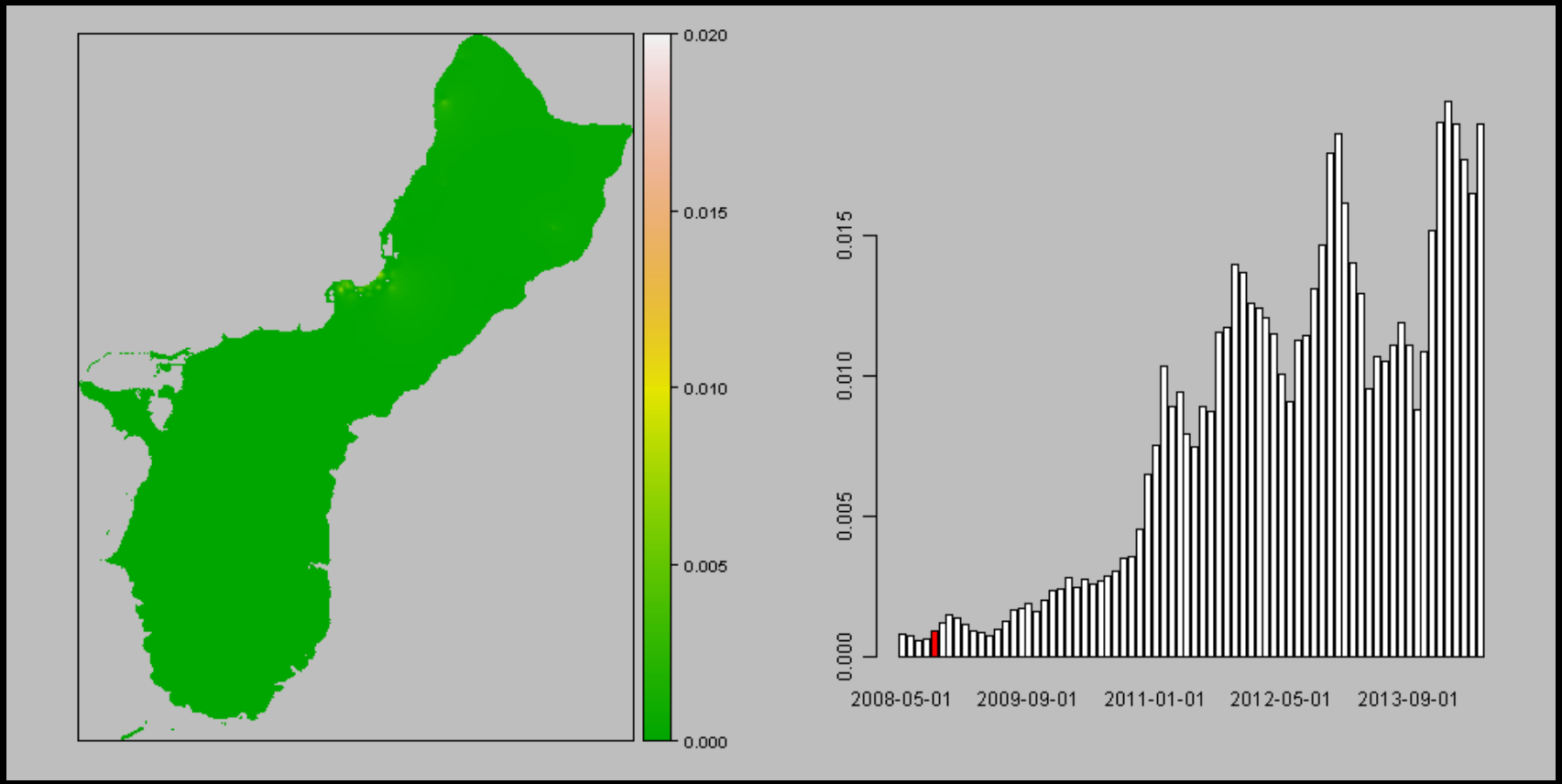
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2008



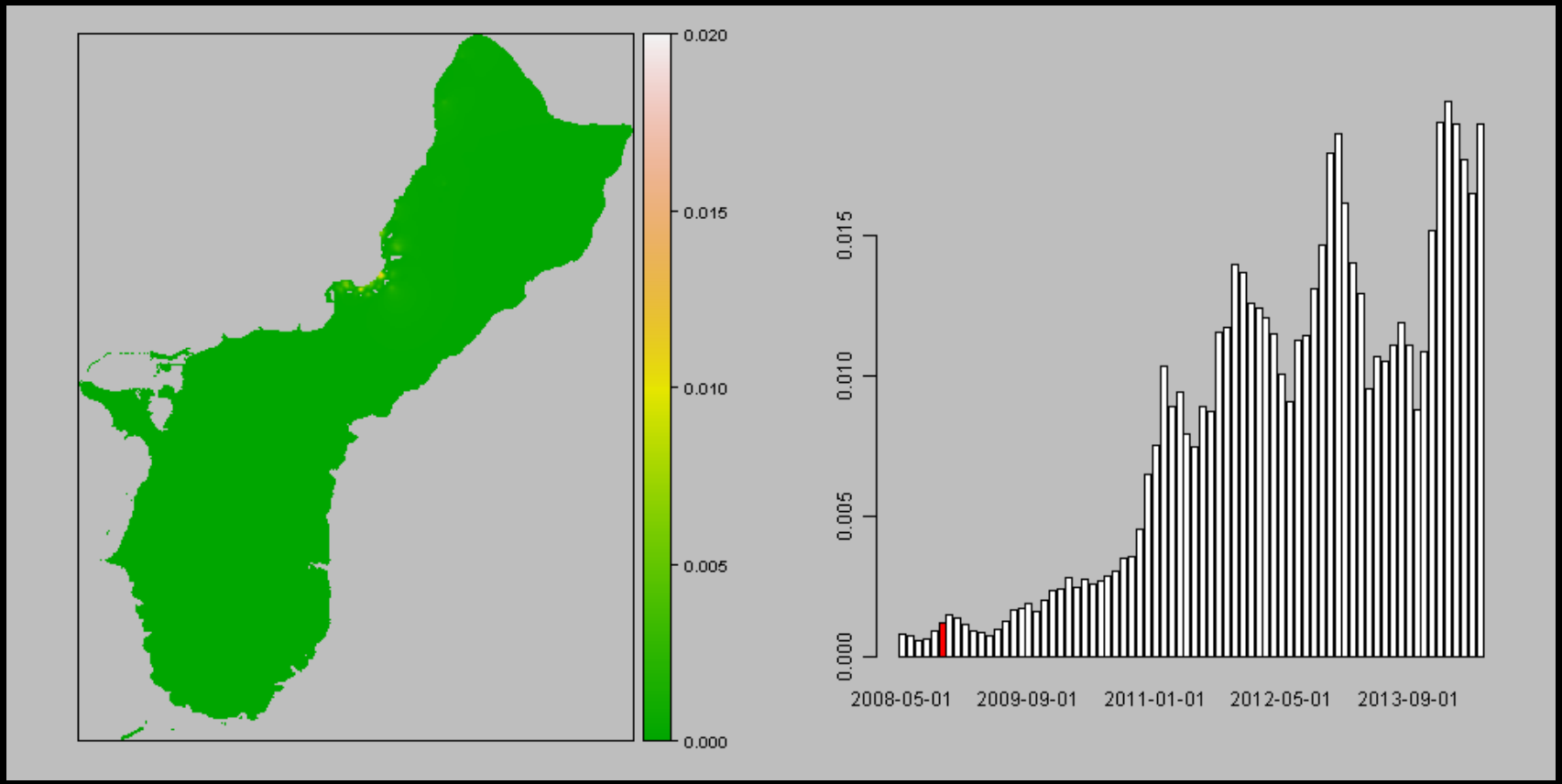
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2008



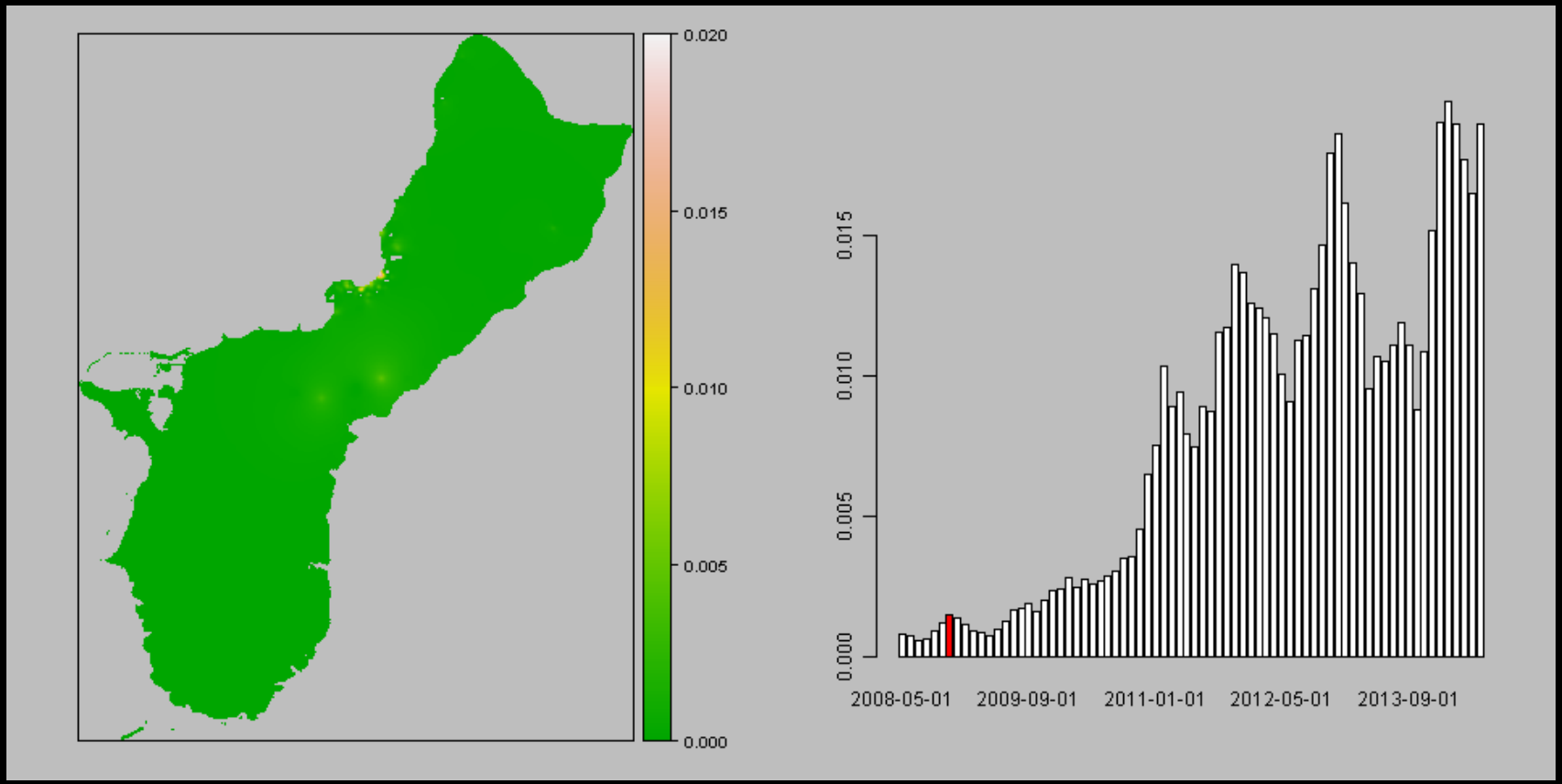
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2008



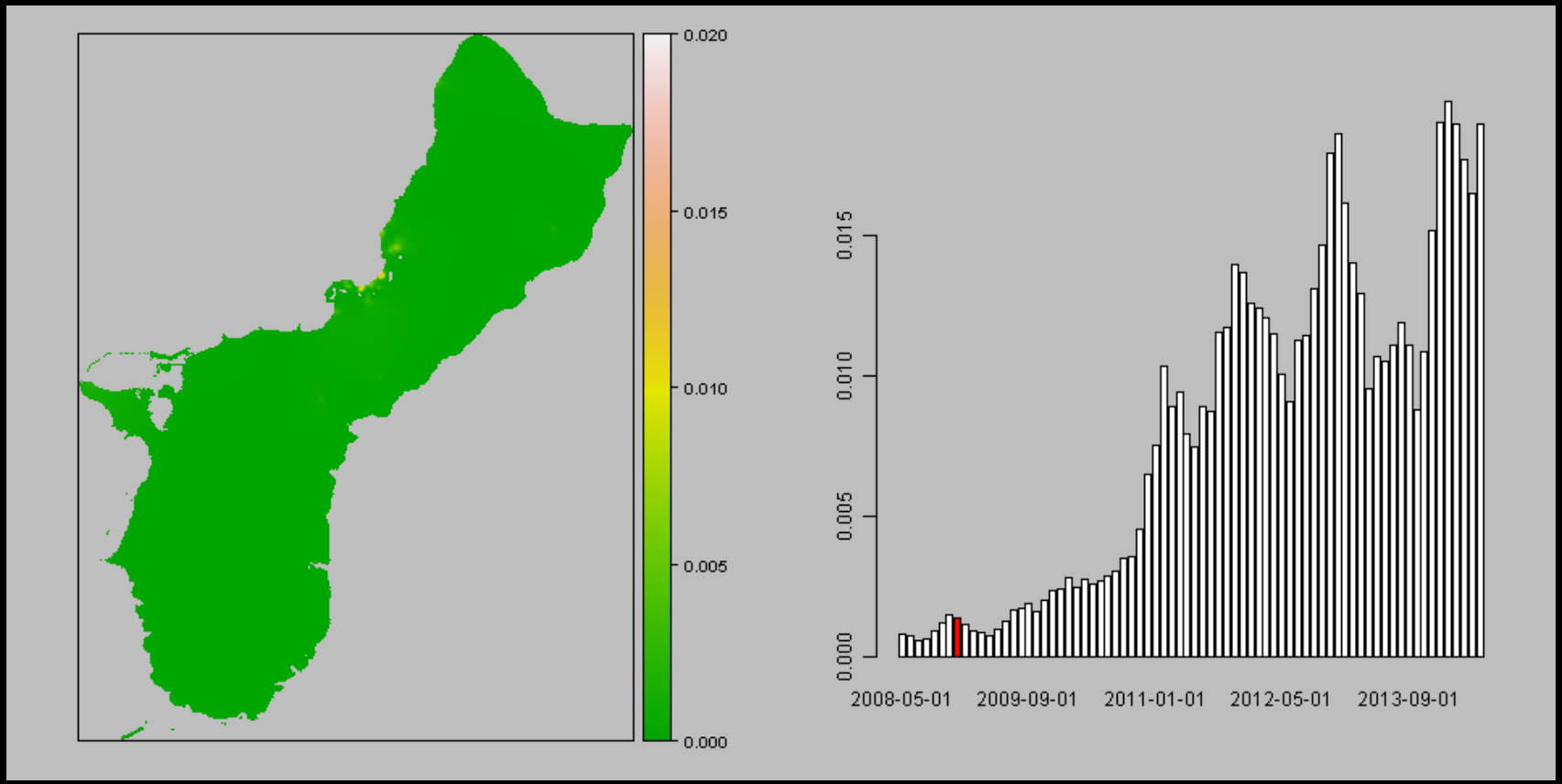
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2008



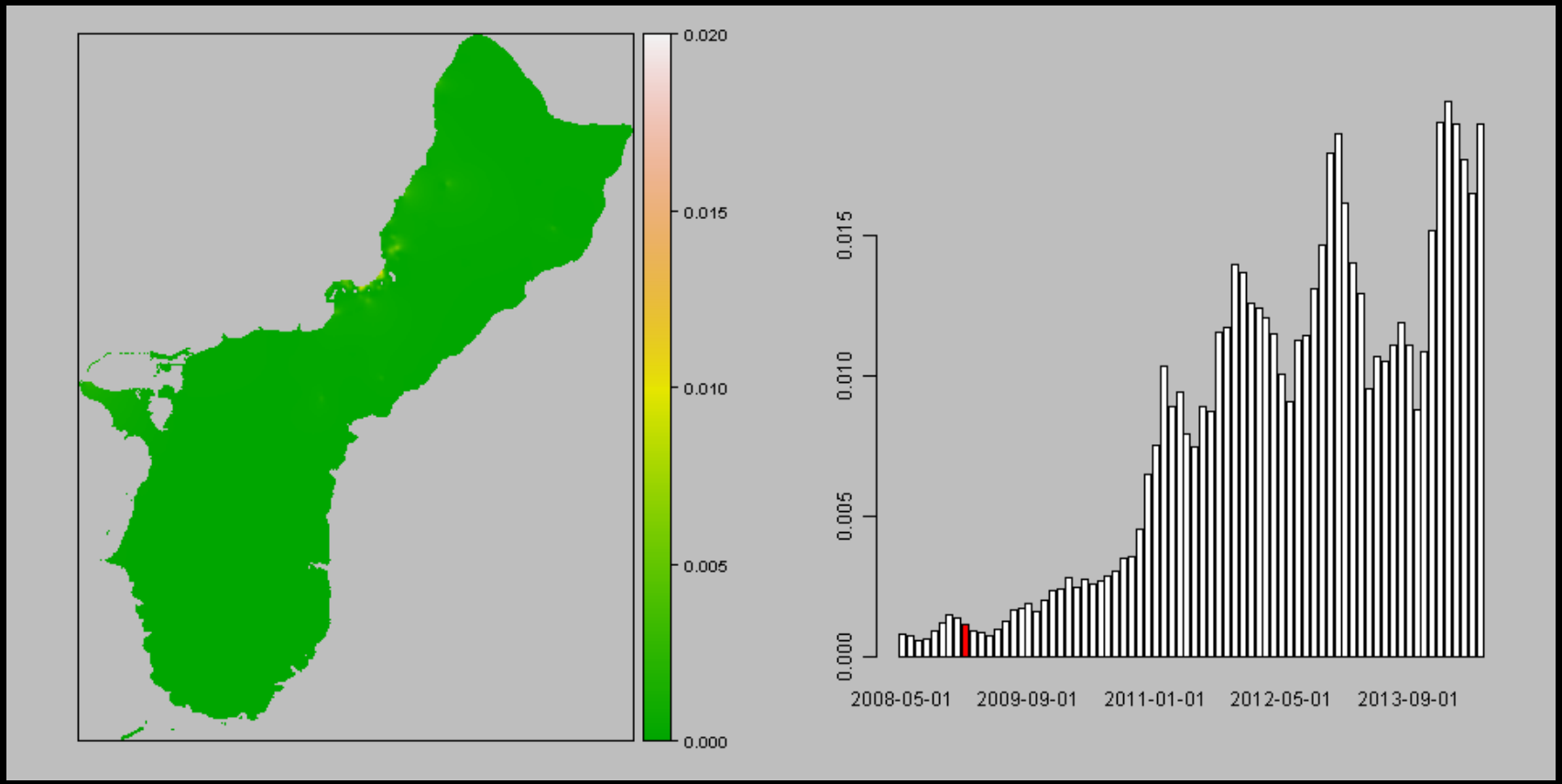
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2008



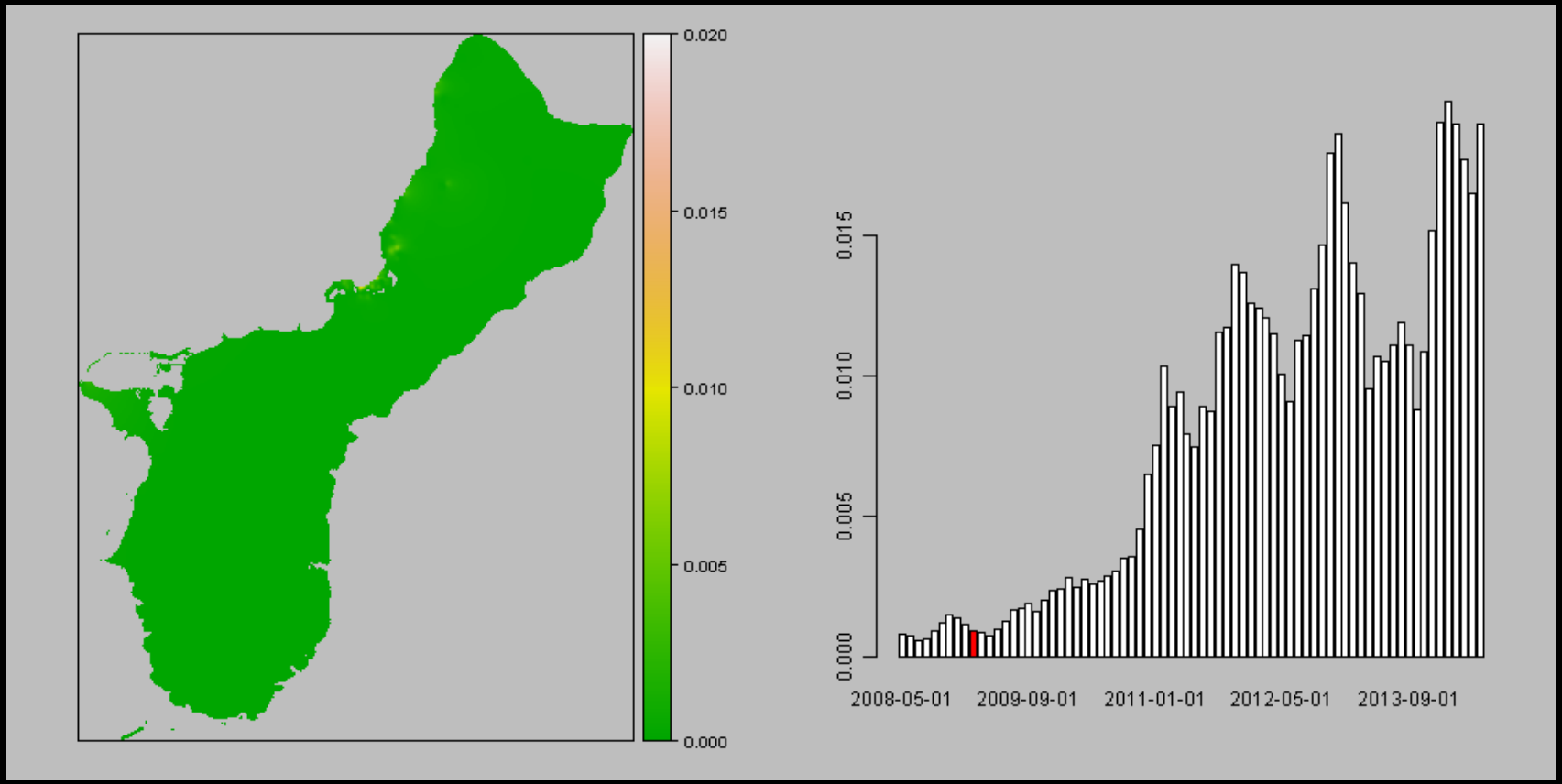
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2009



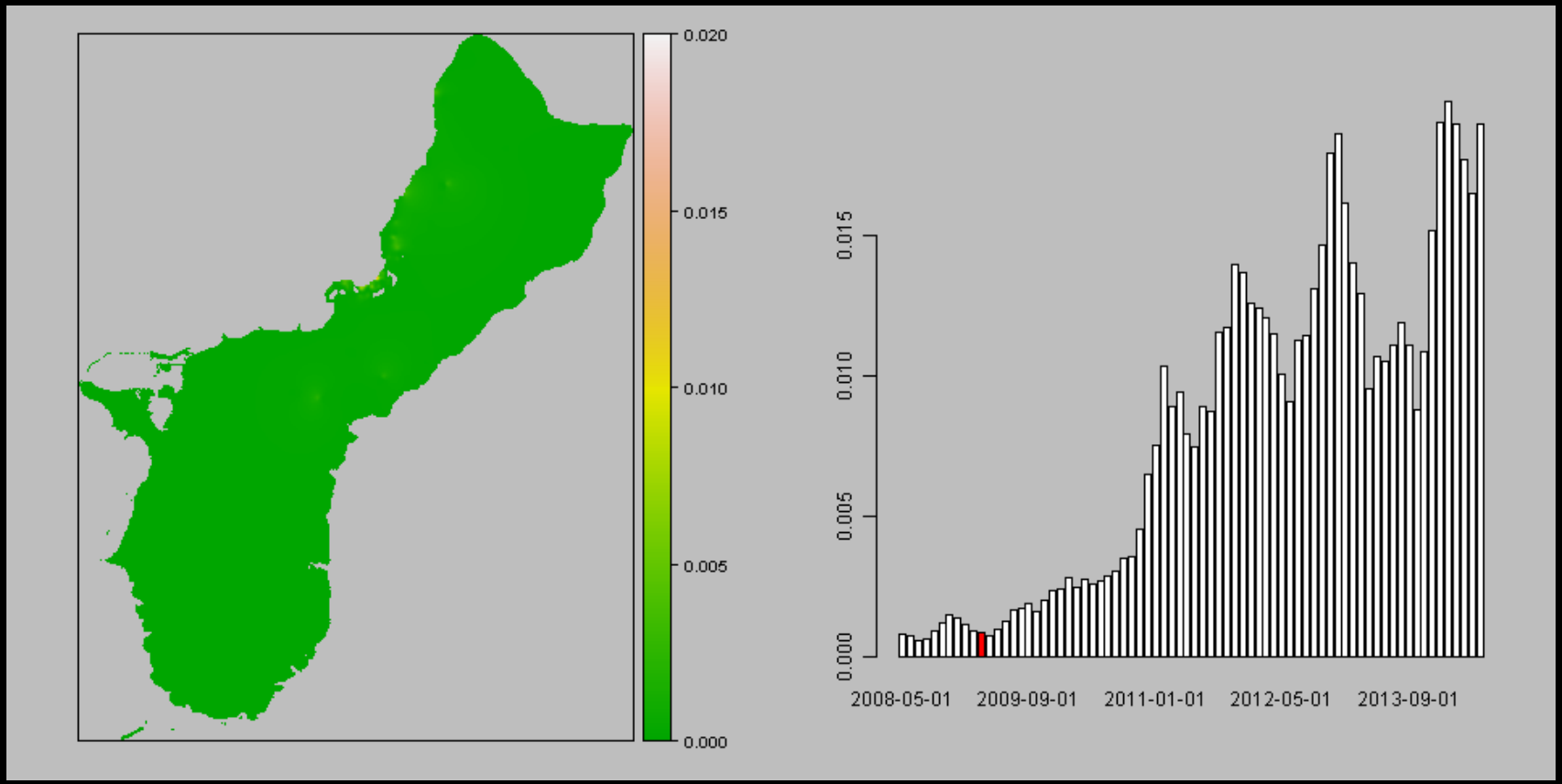
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2009



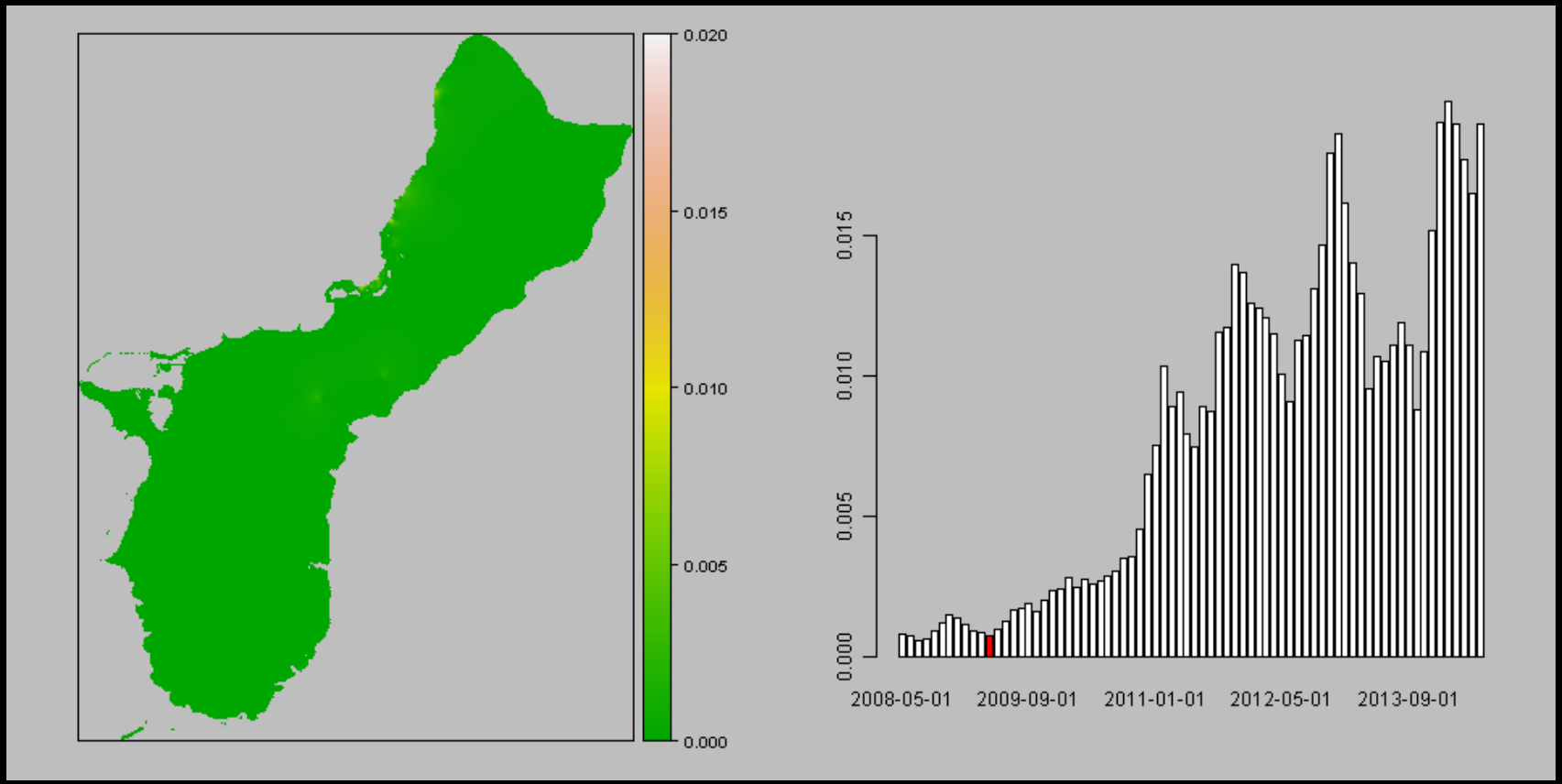
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2009



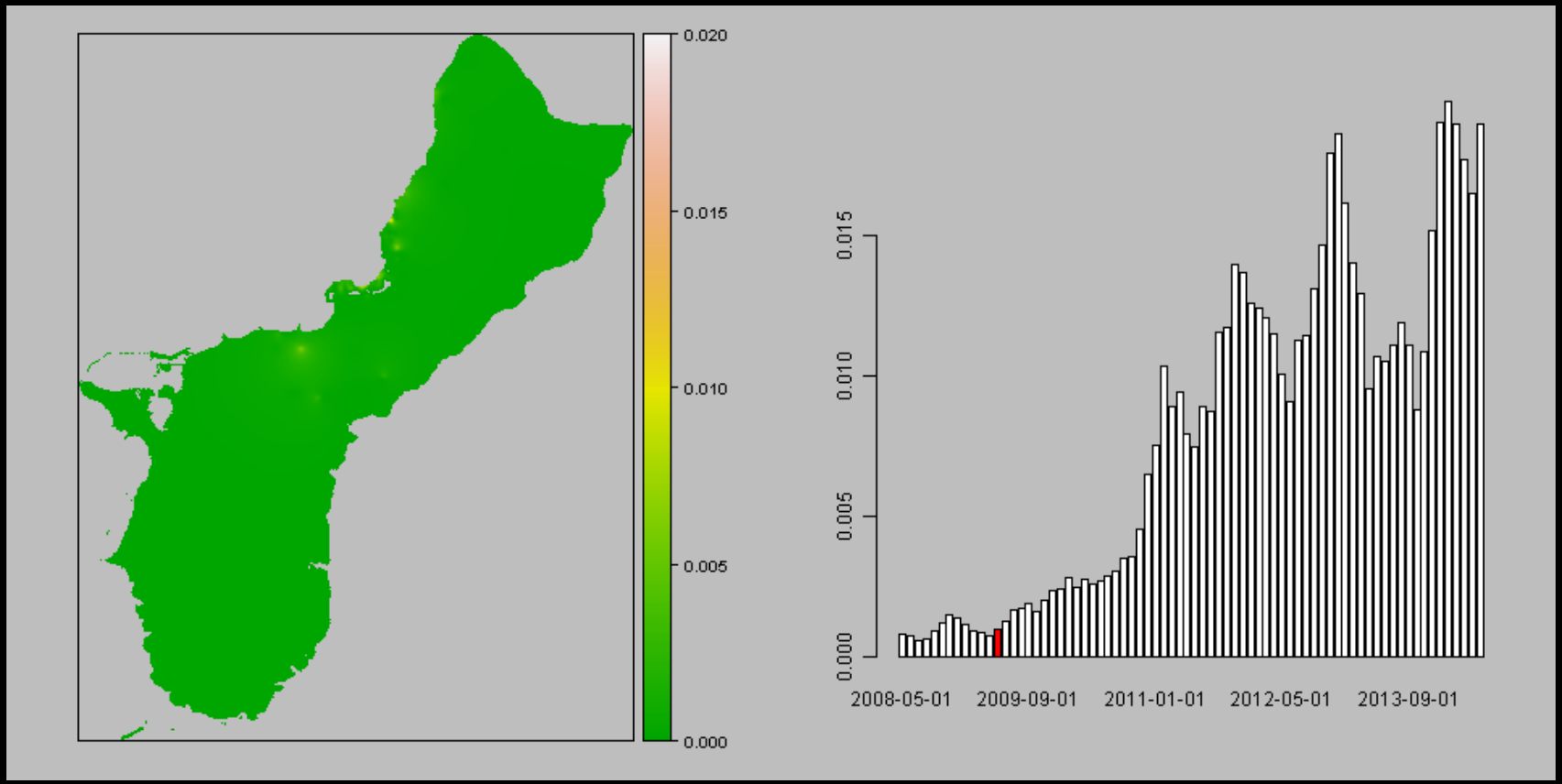
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2009



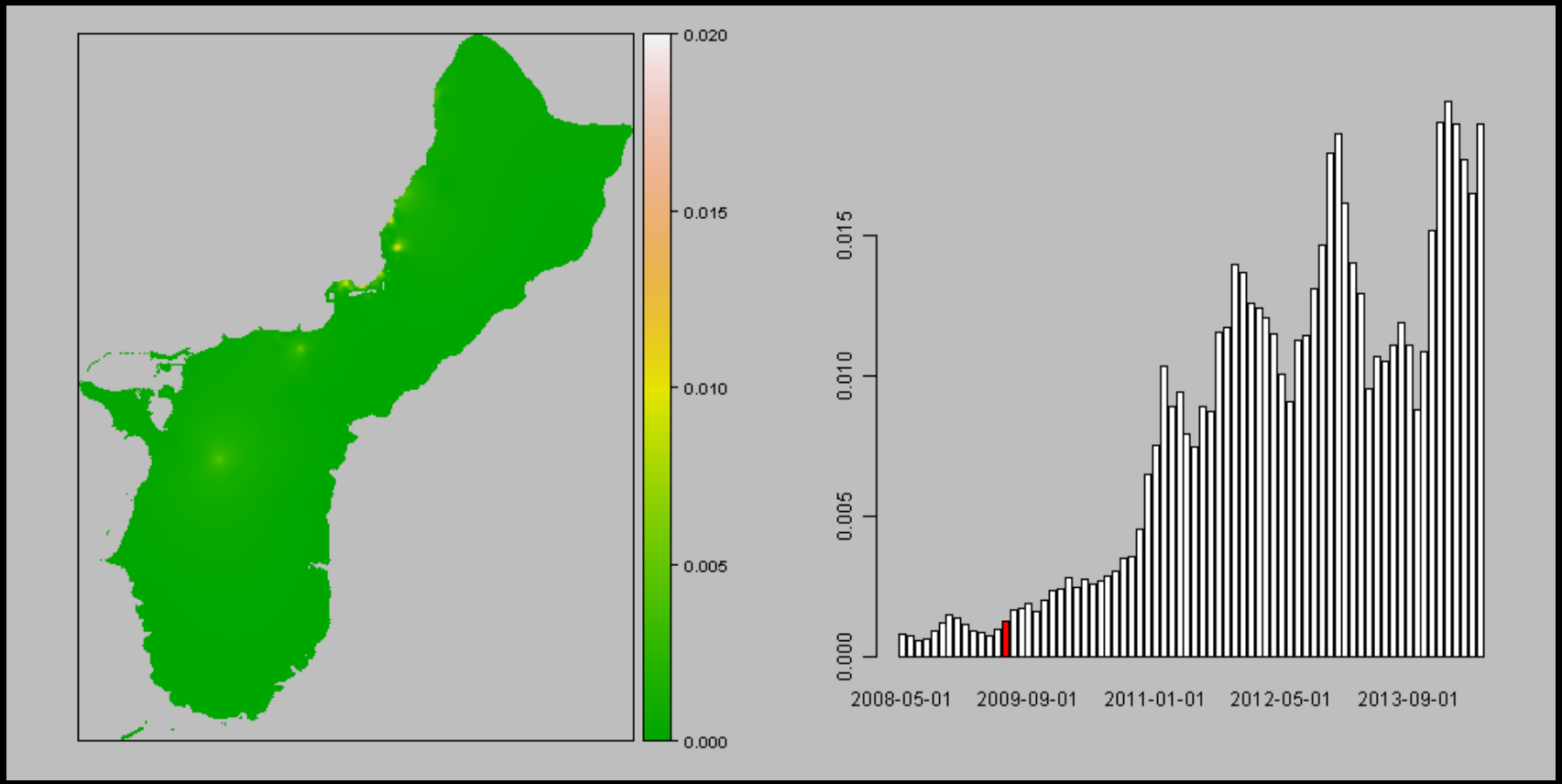
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2009



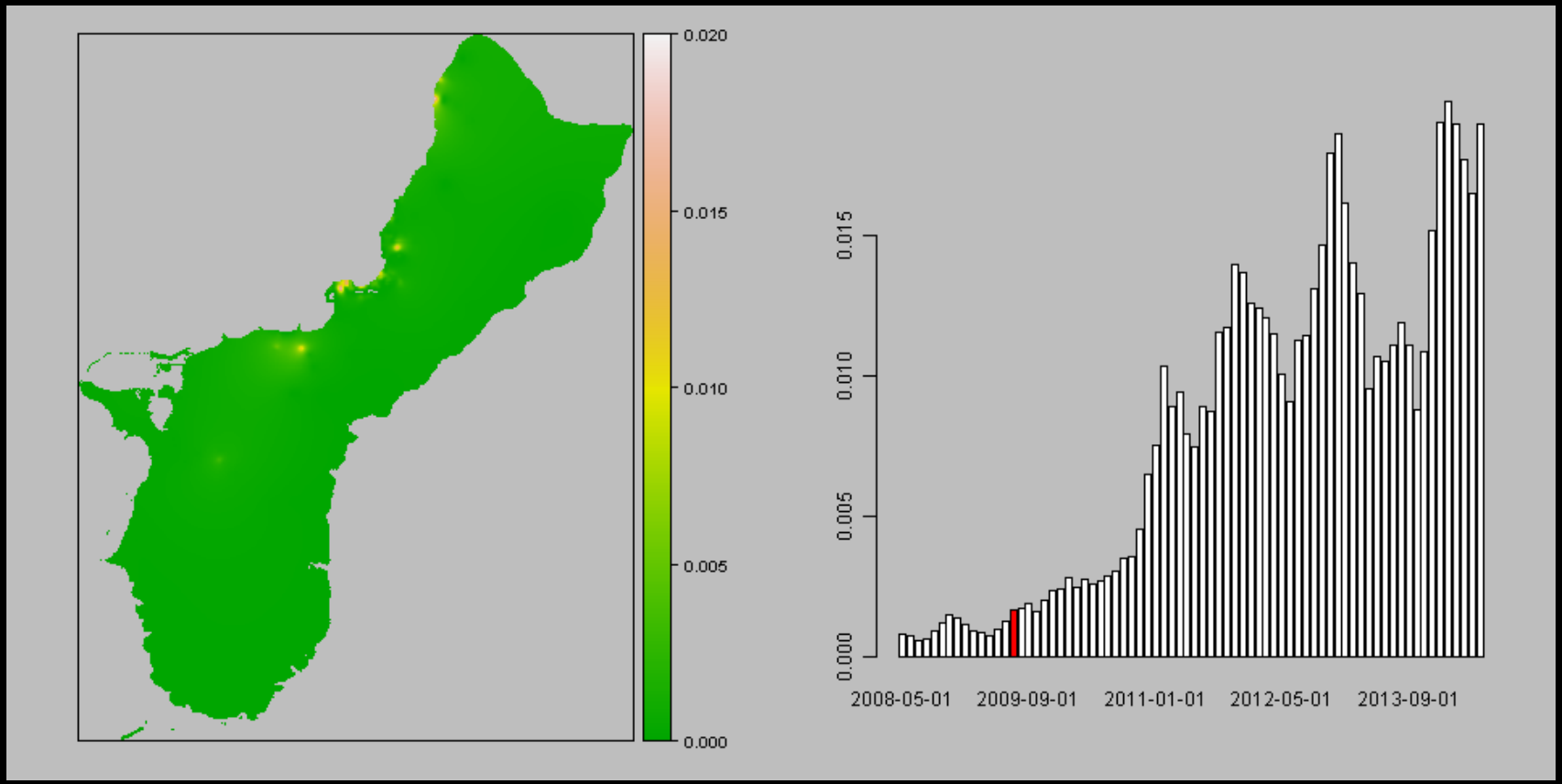
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2009



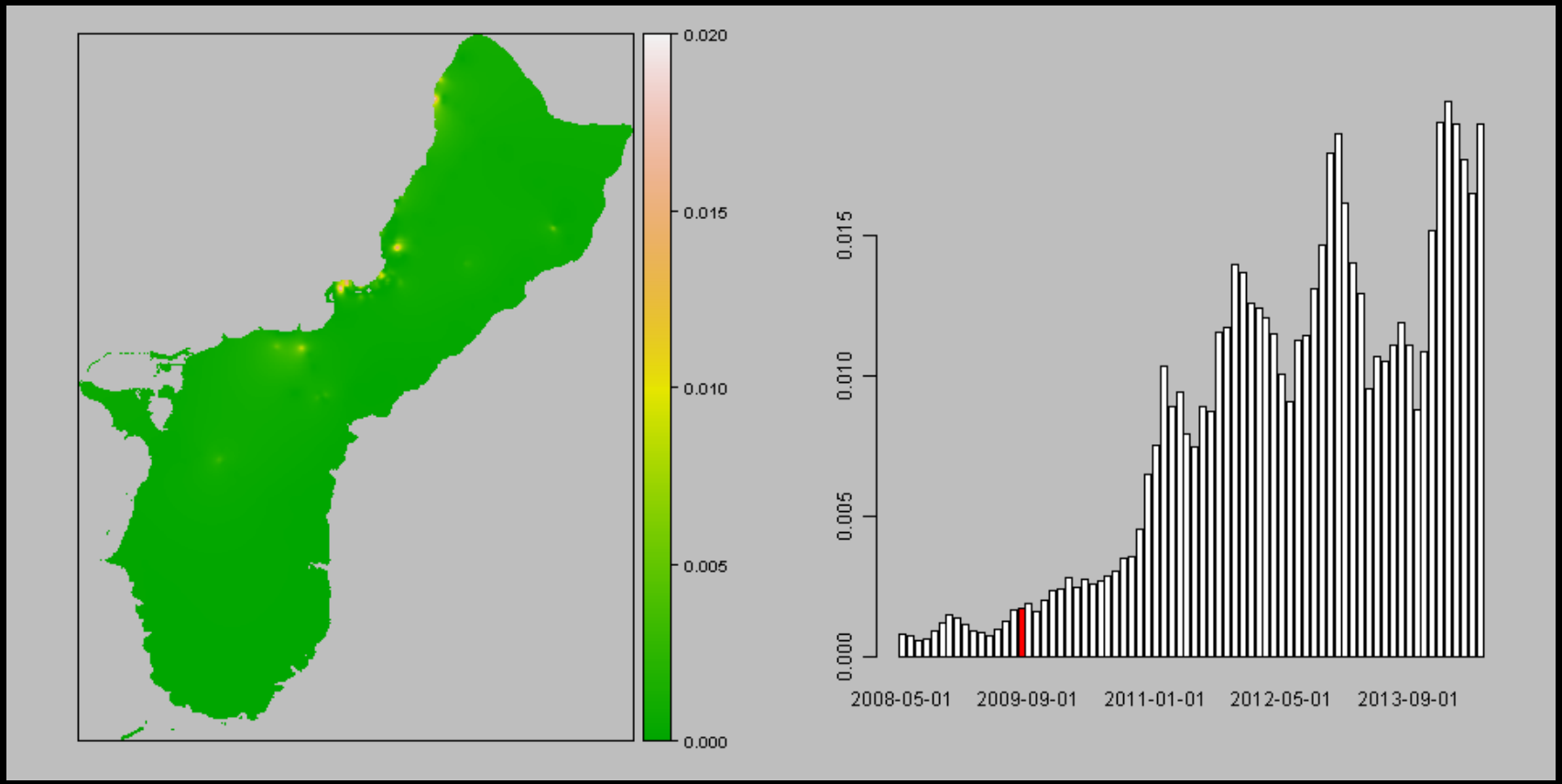
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2009



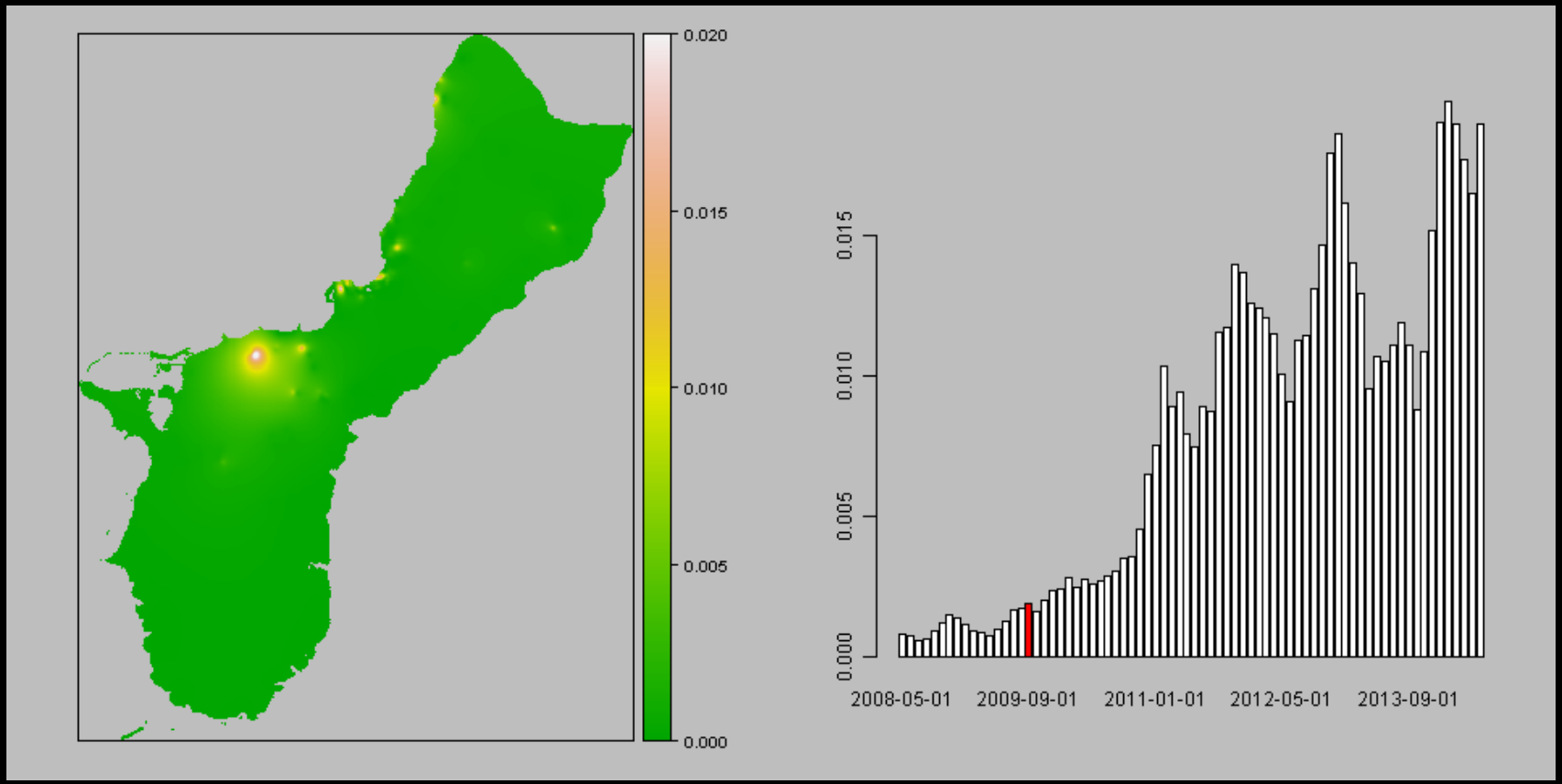
Mean number of beetles caught per trap-day

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



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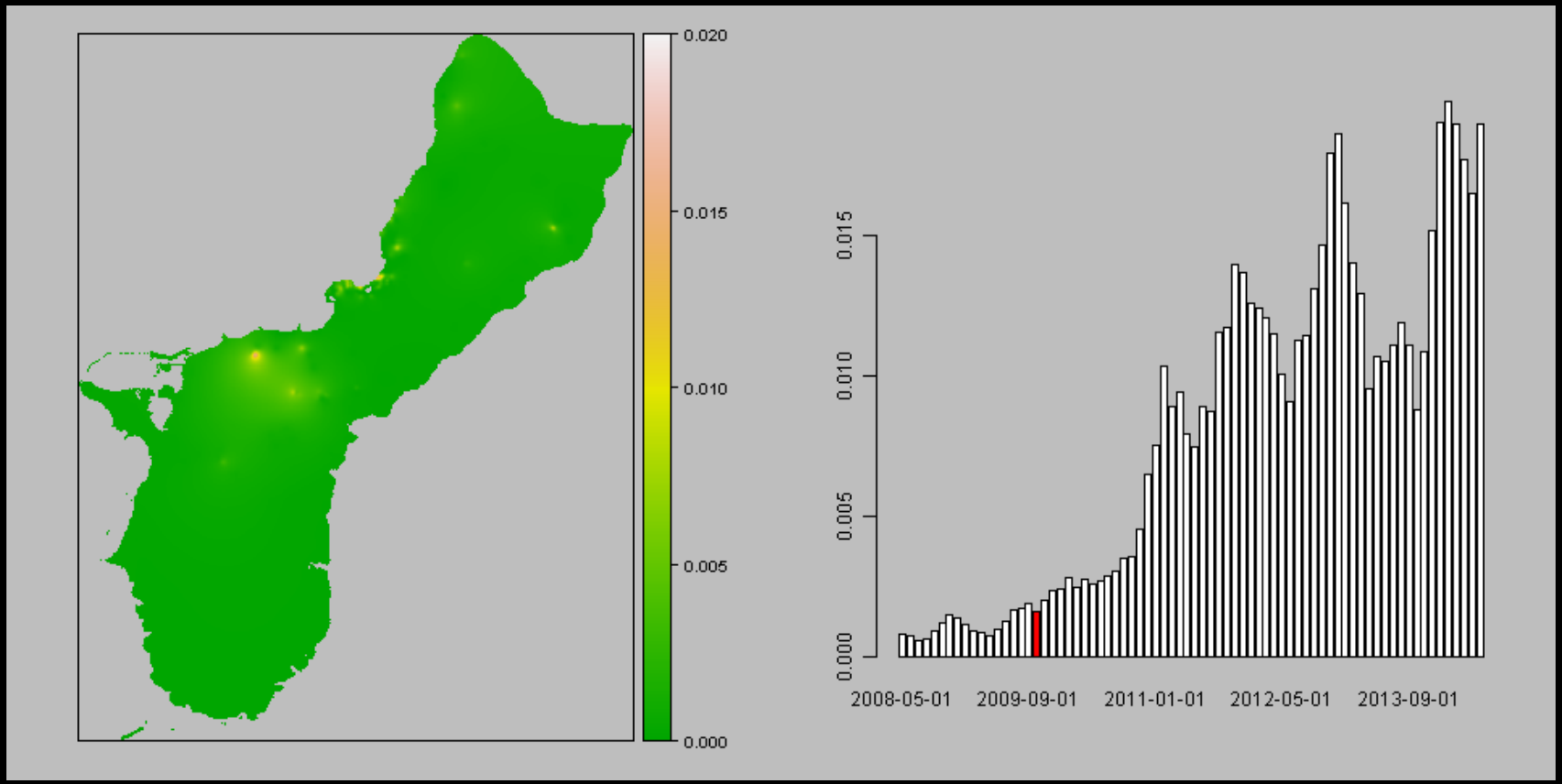

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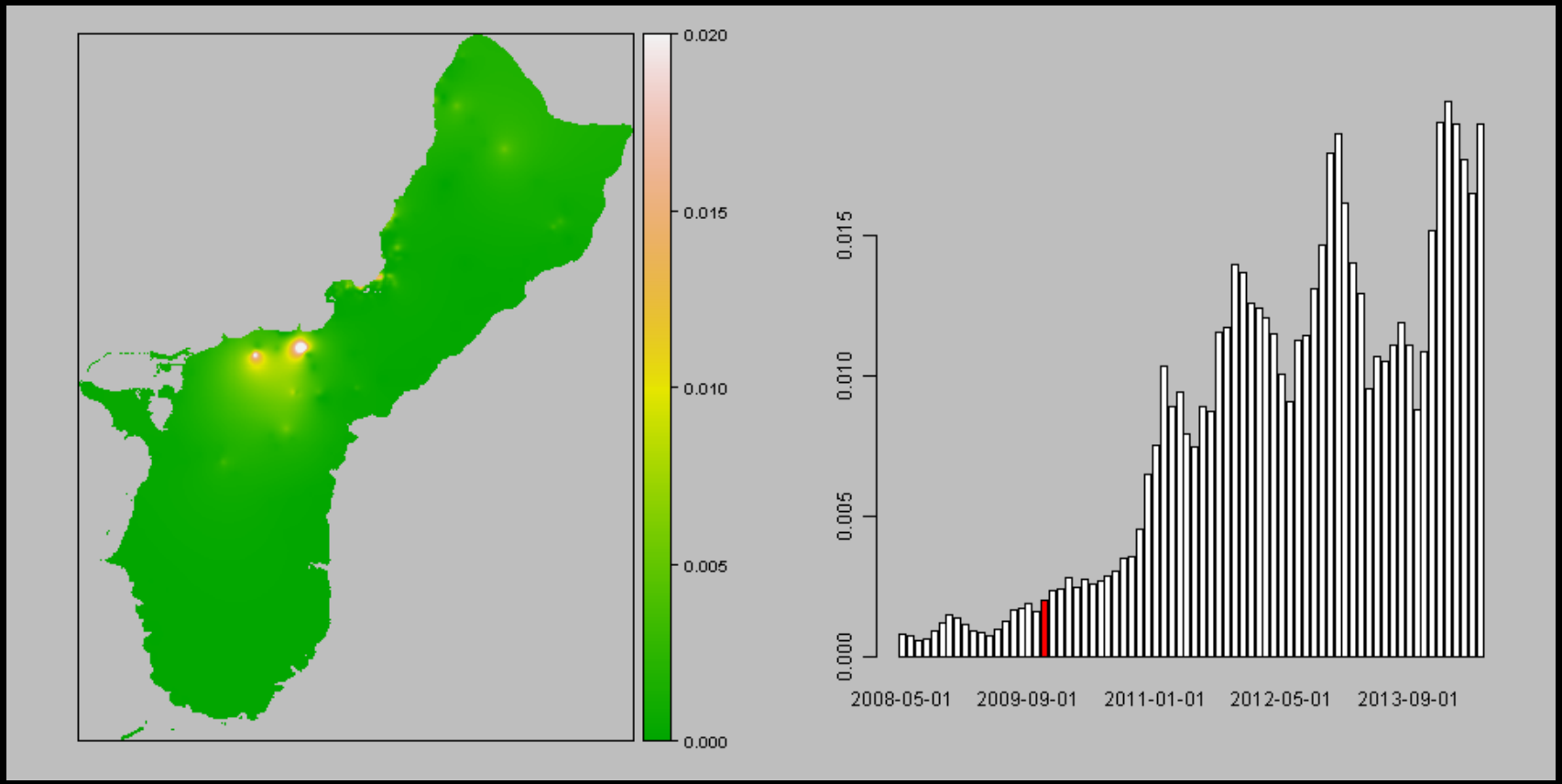

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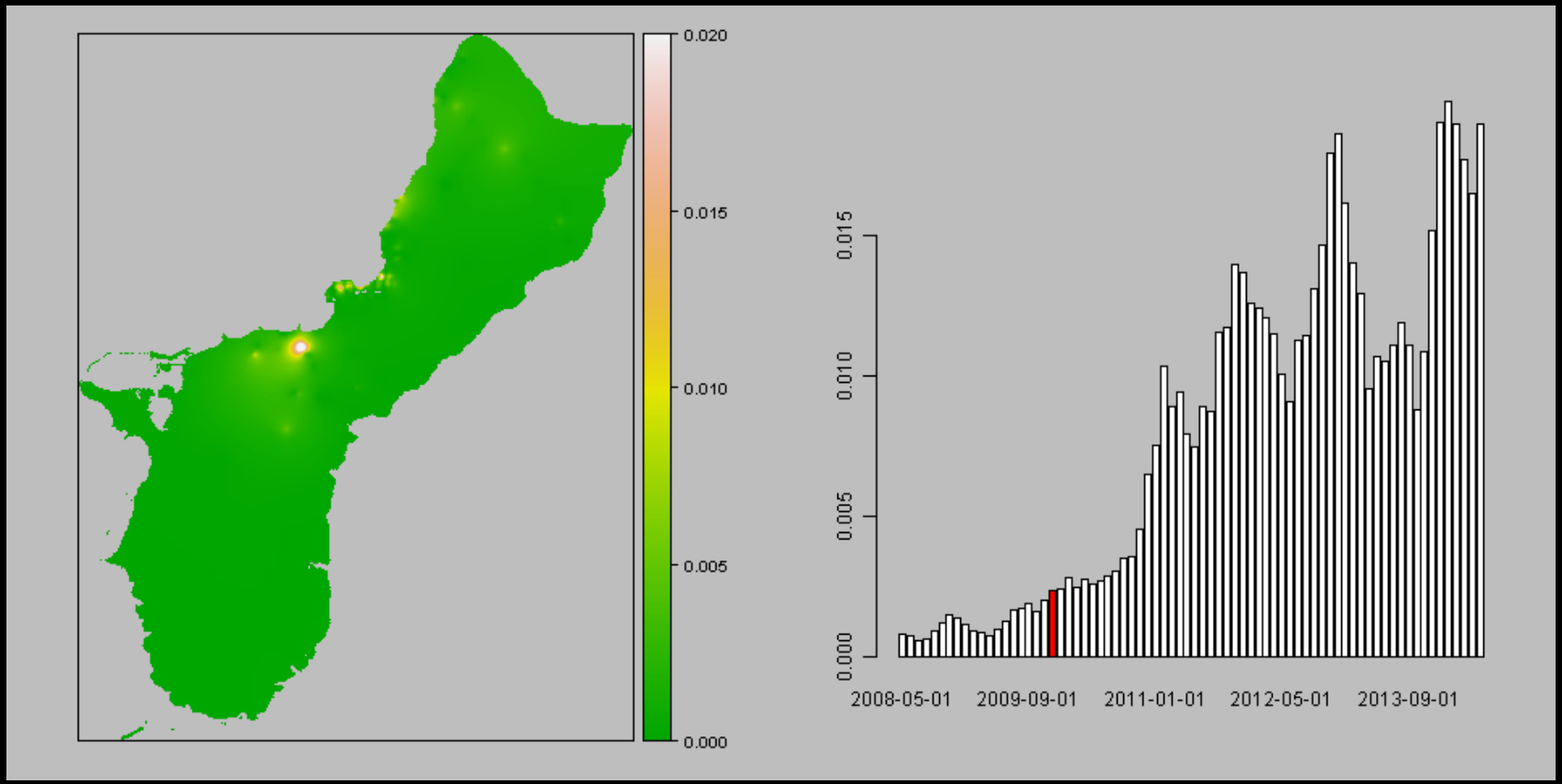

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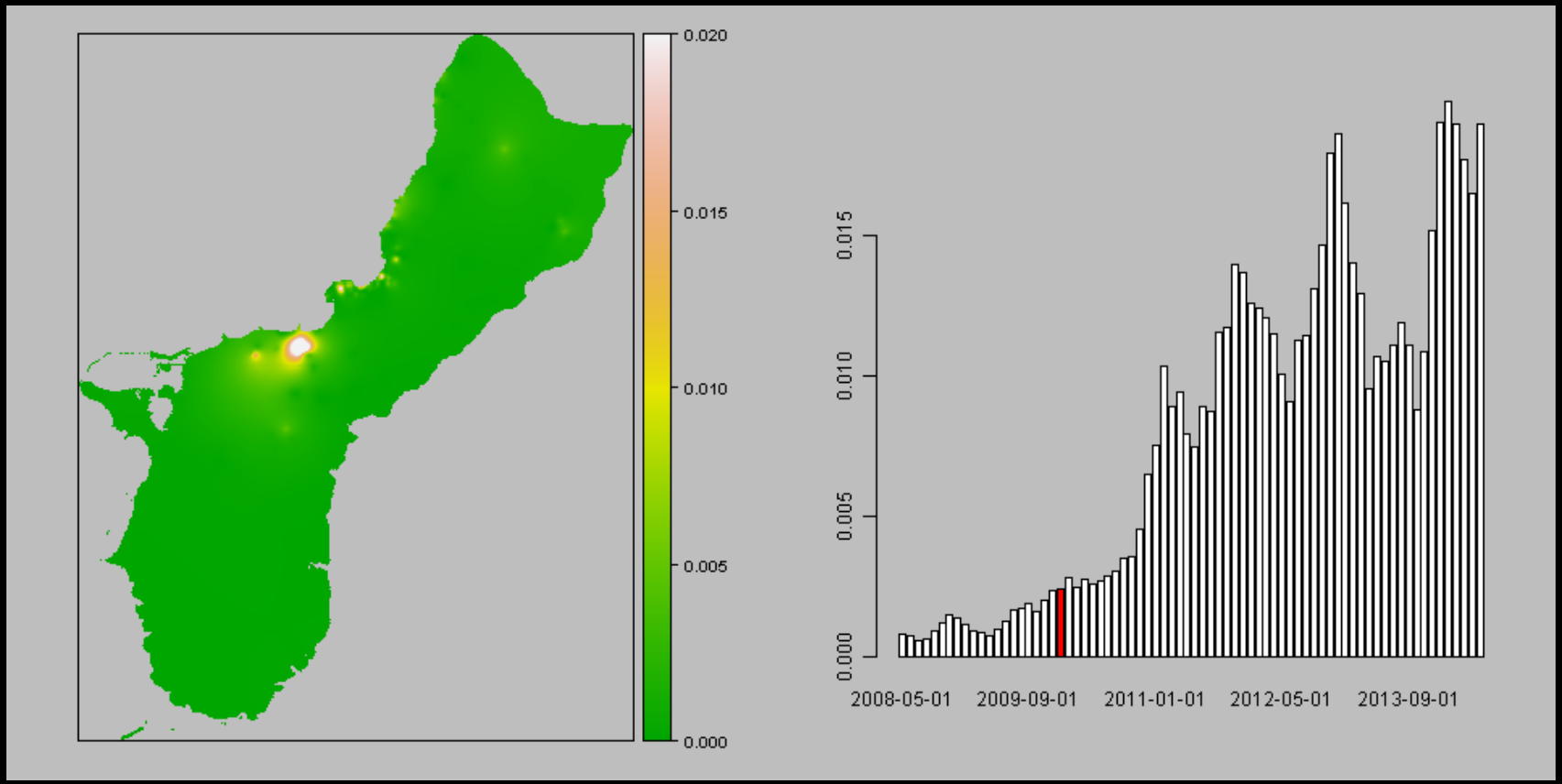

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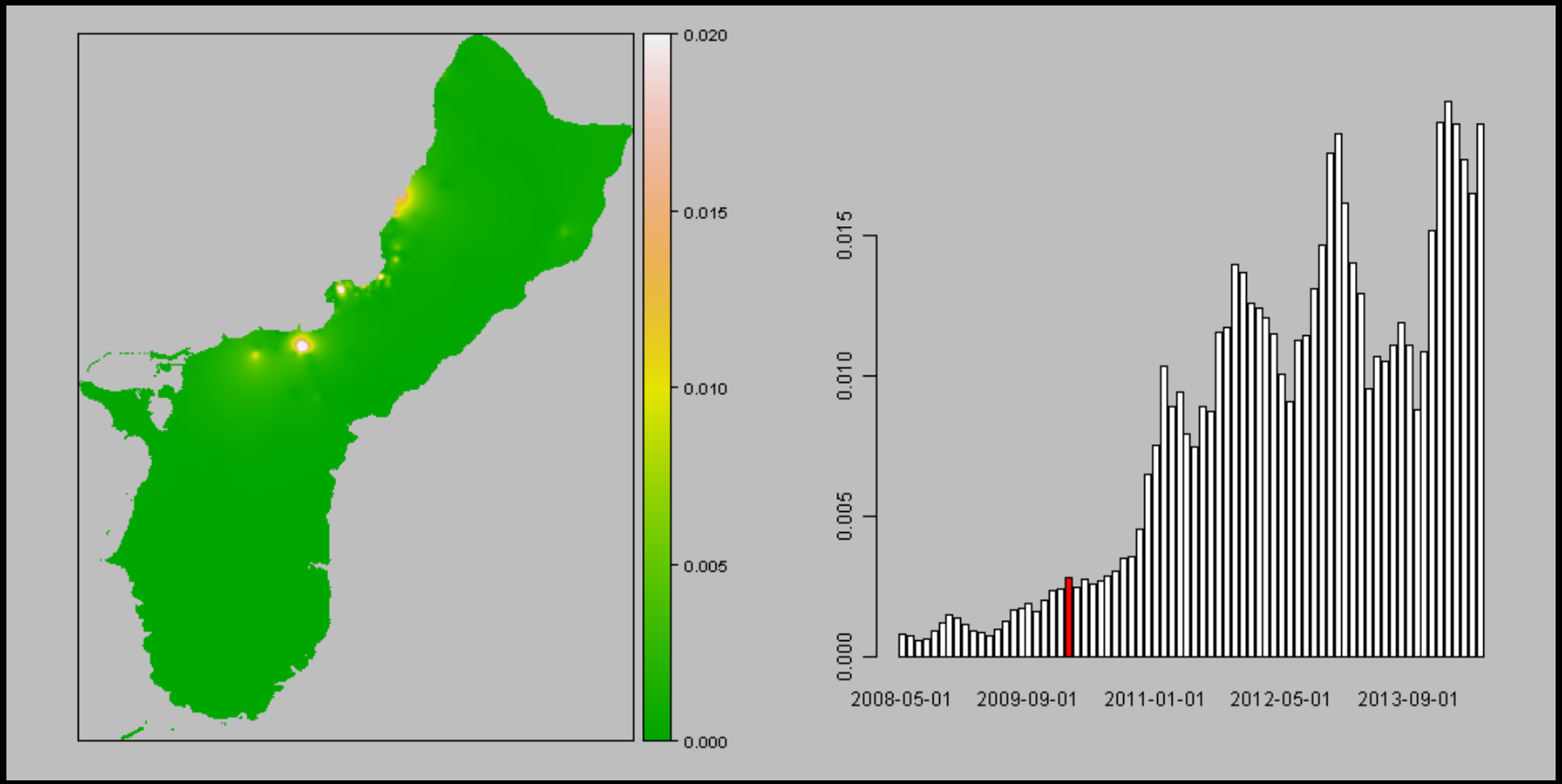
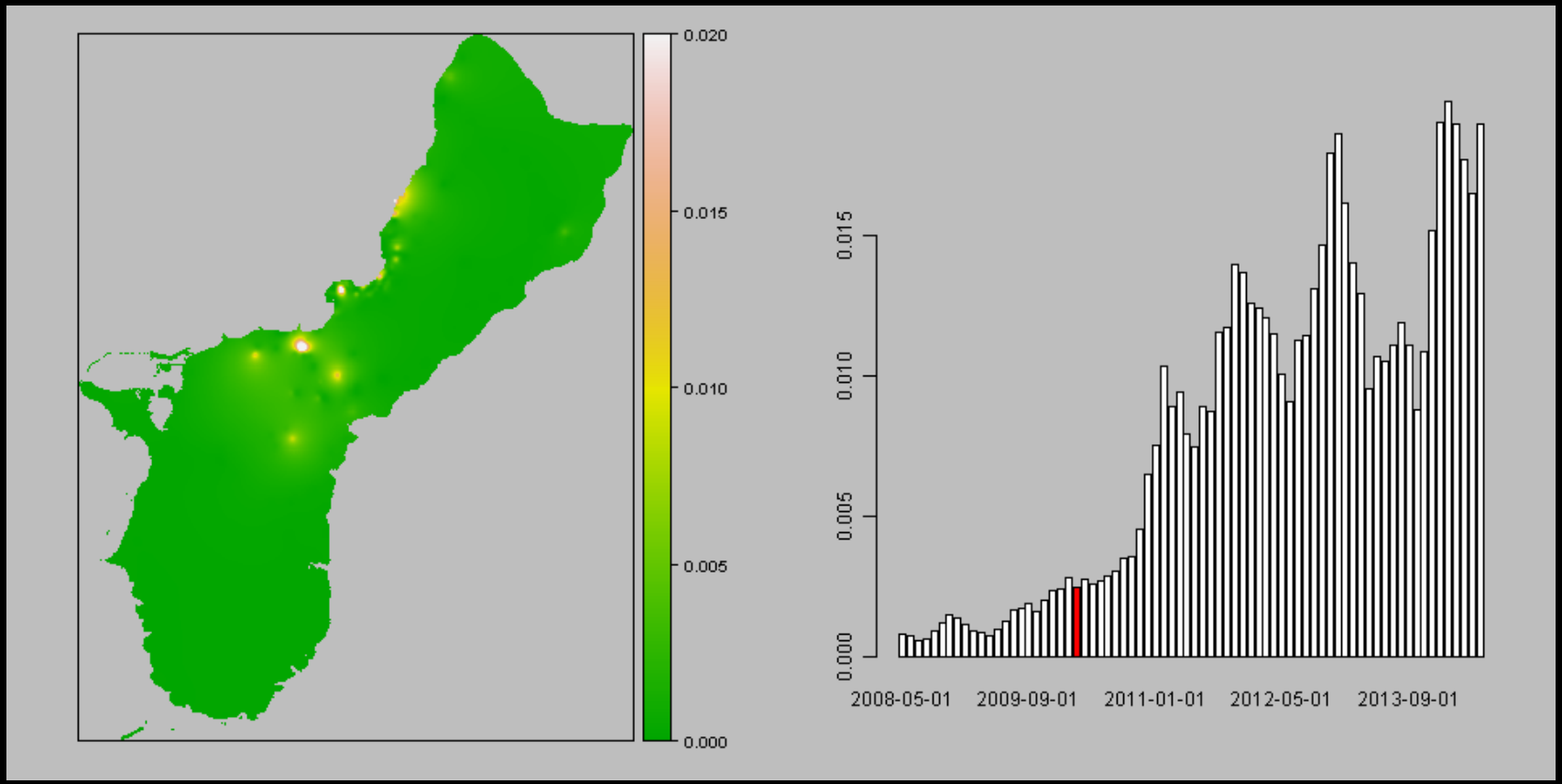


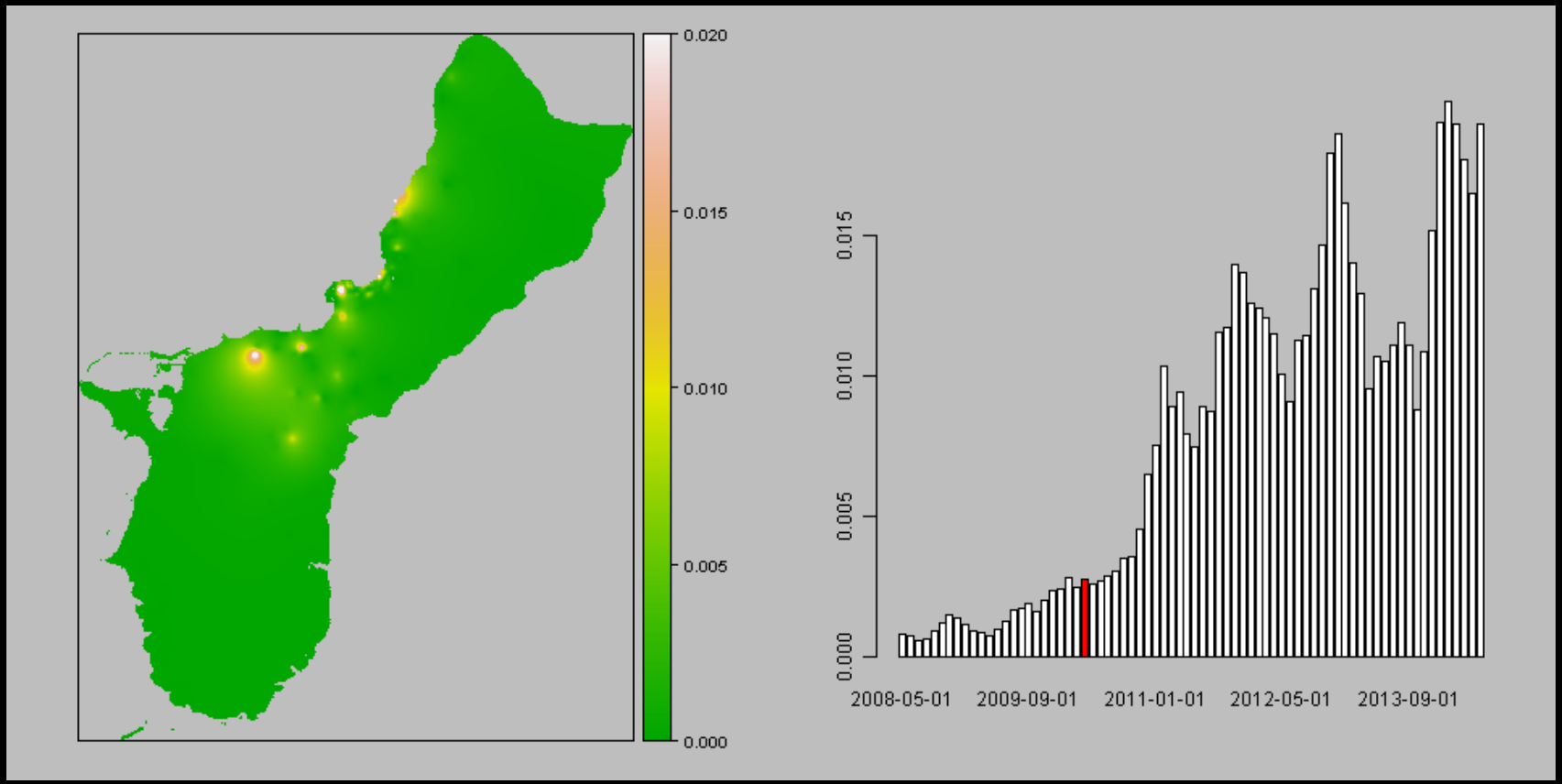
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2010



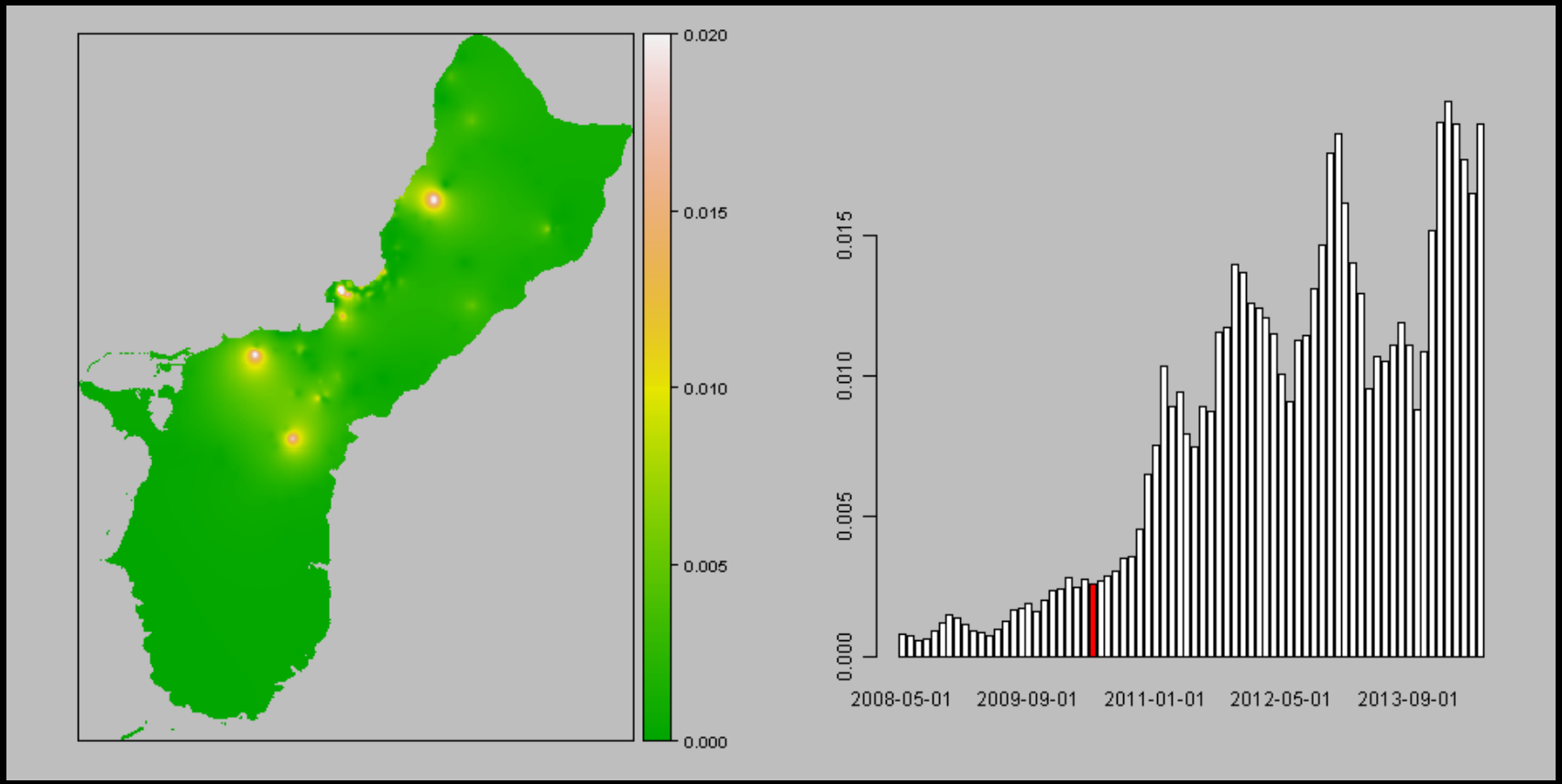
Mean number of beetles caught per trap-day

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

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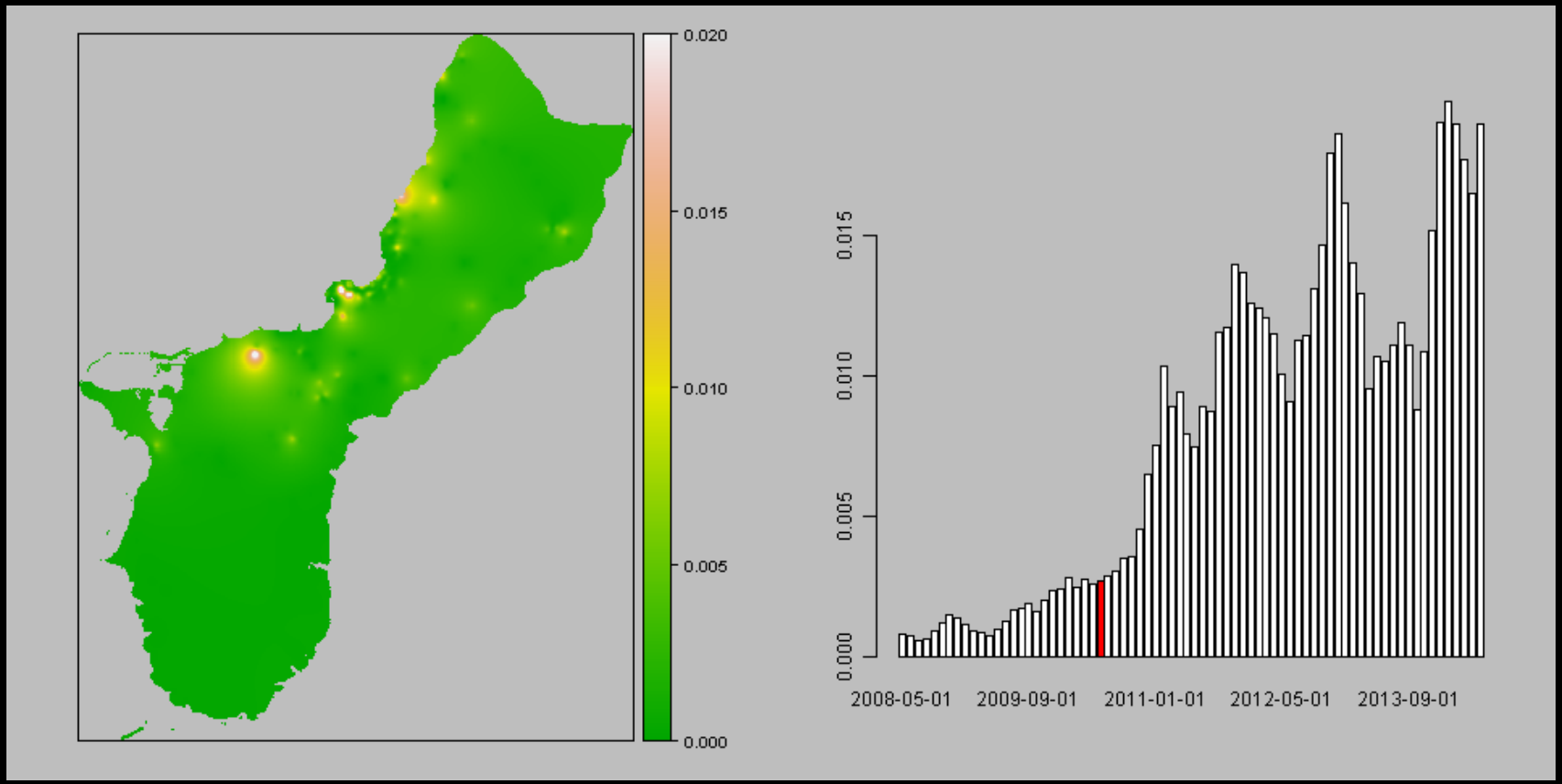
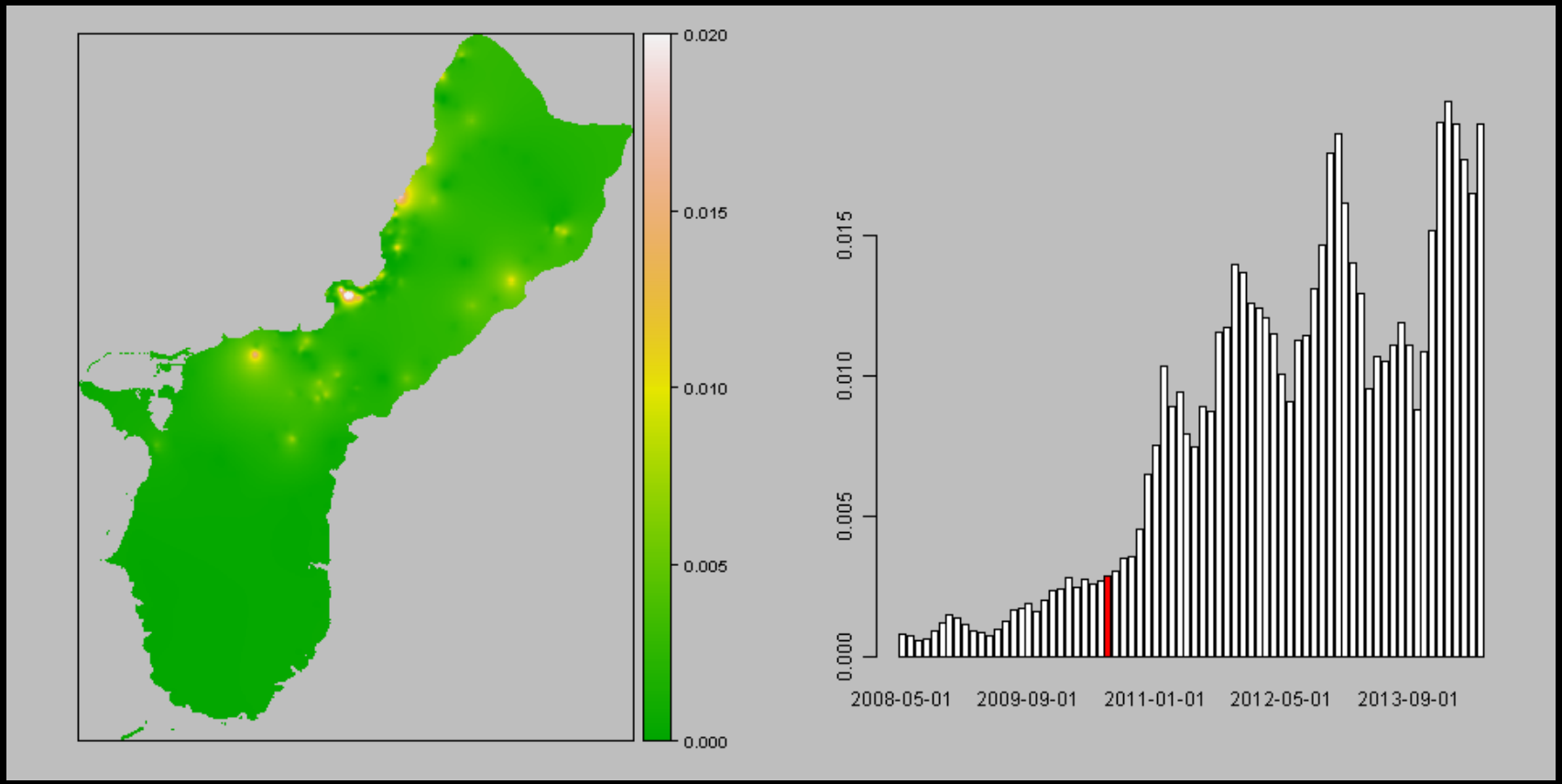


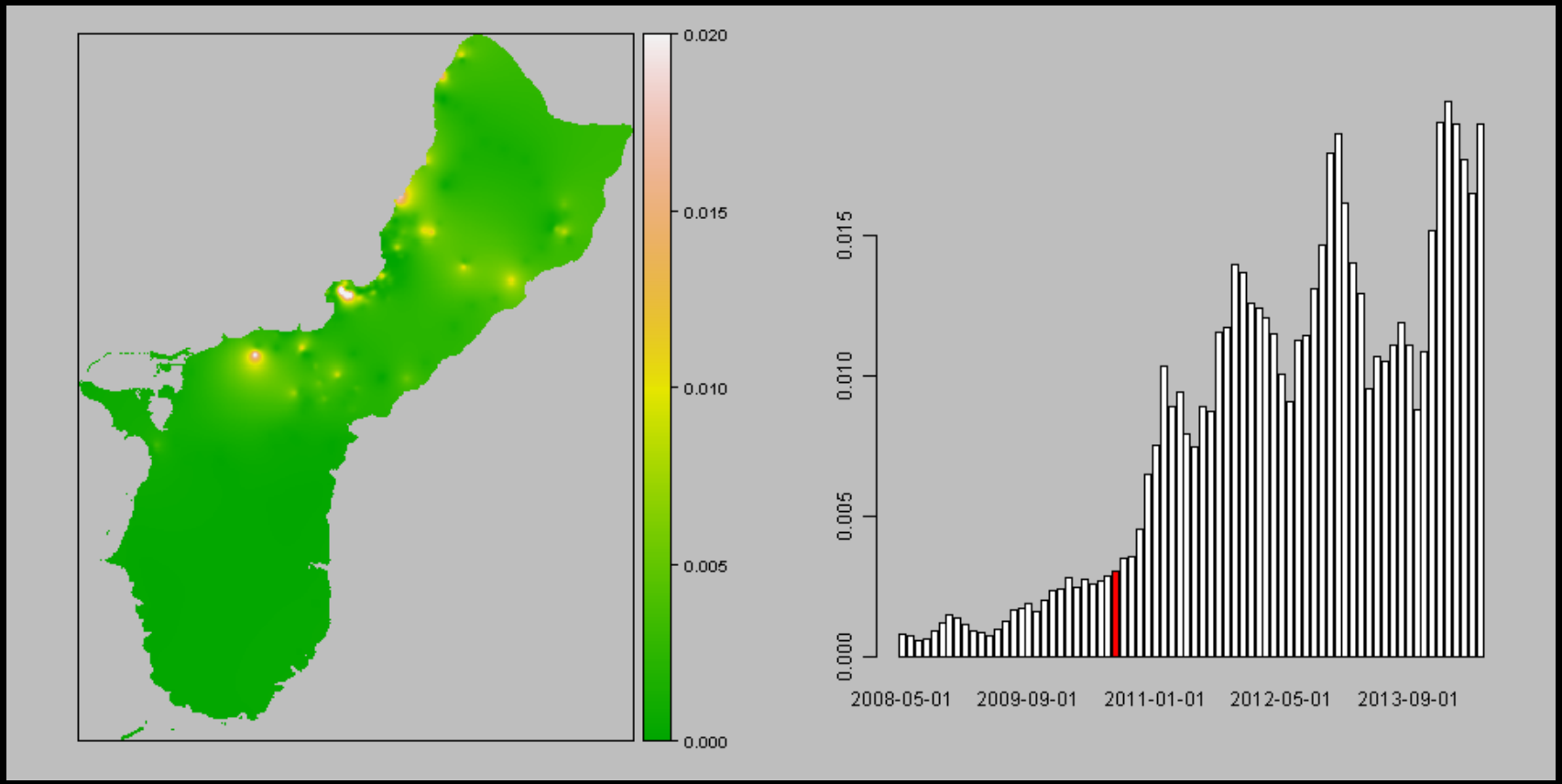
Mean number of beetles caught per trap-day

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

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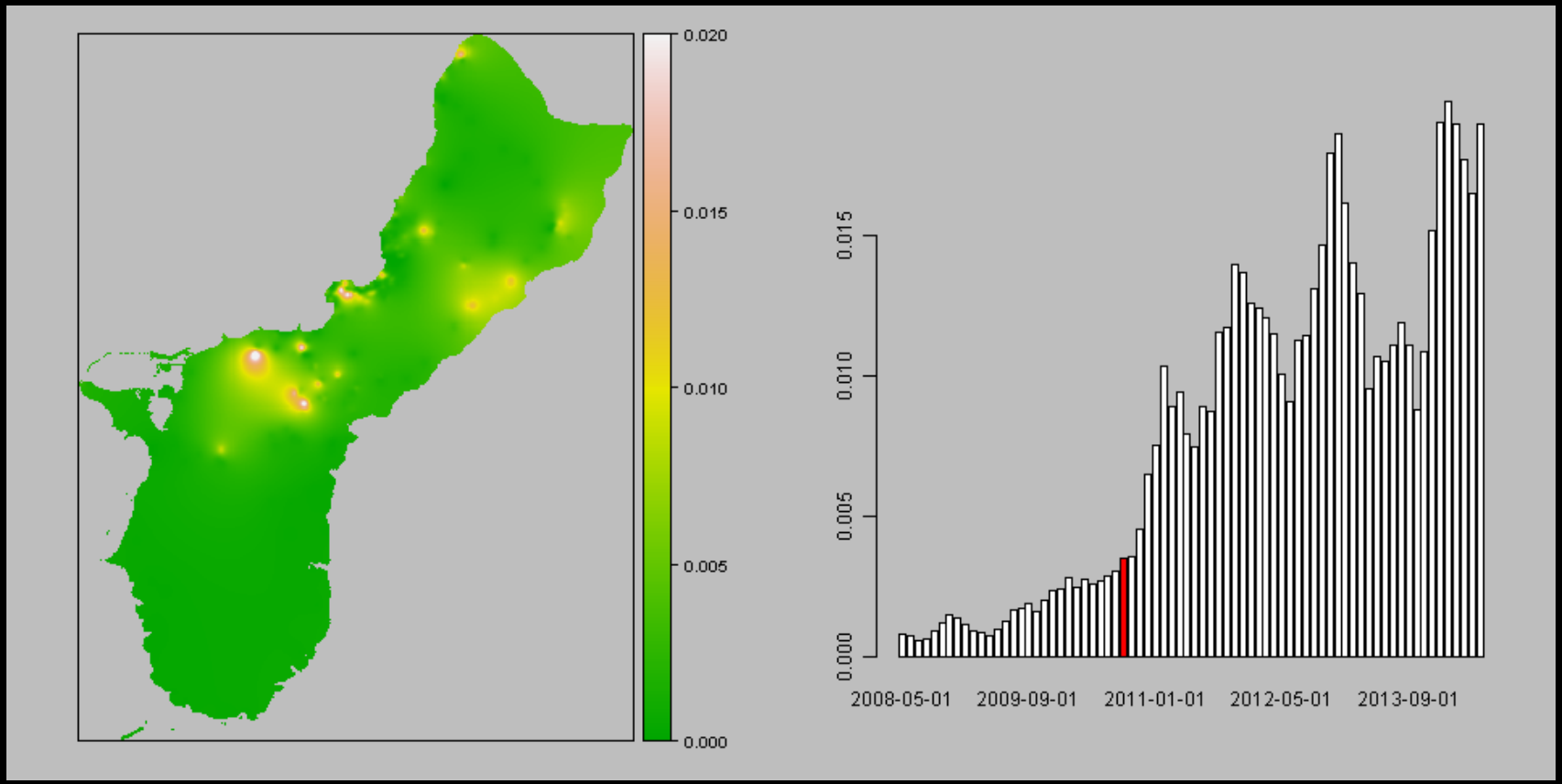
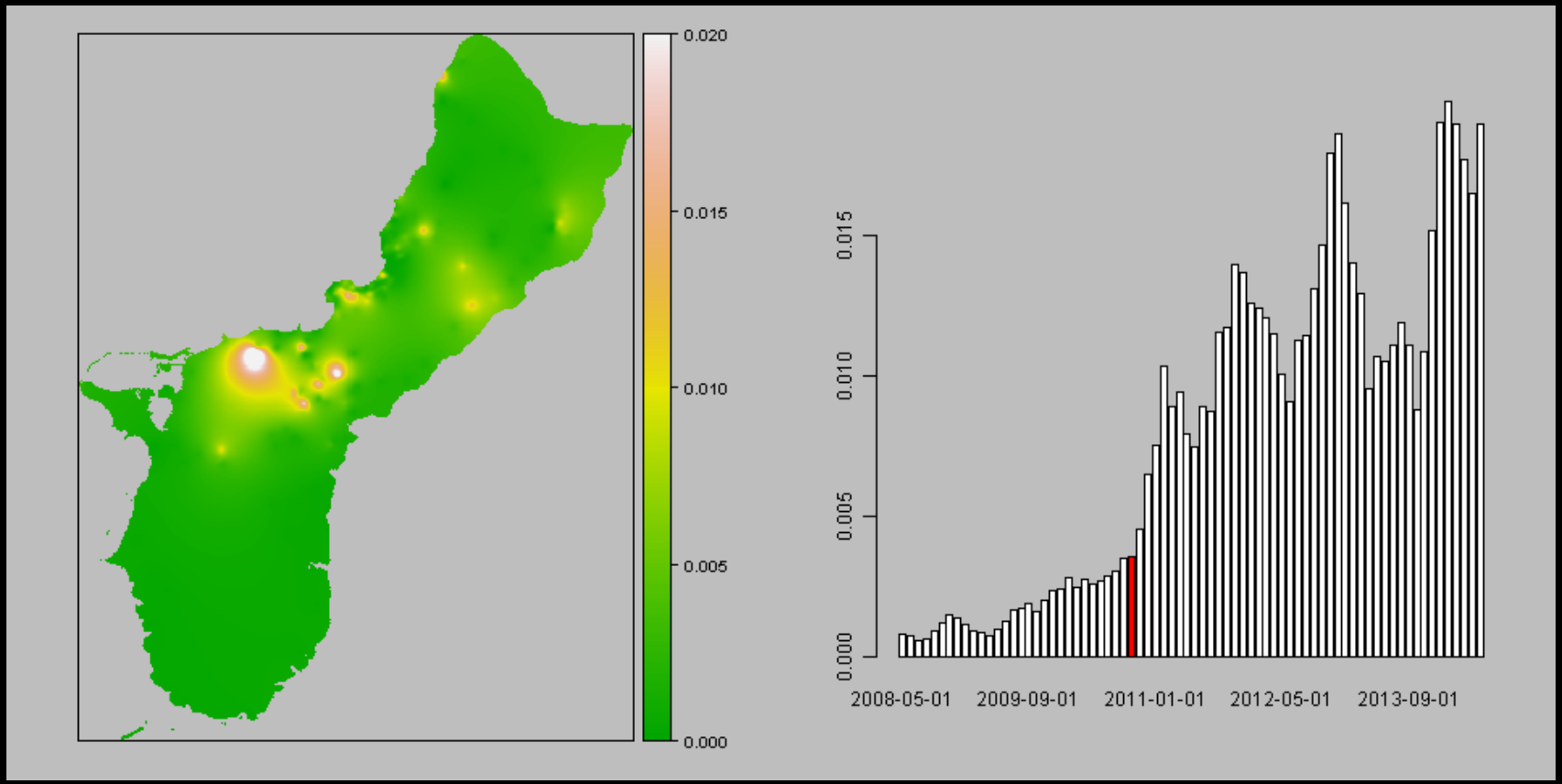


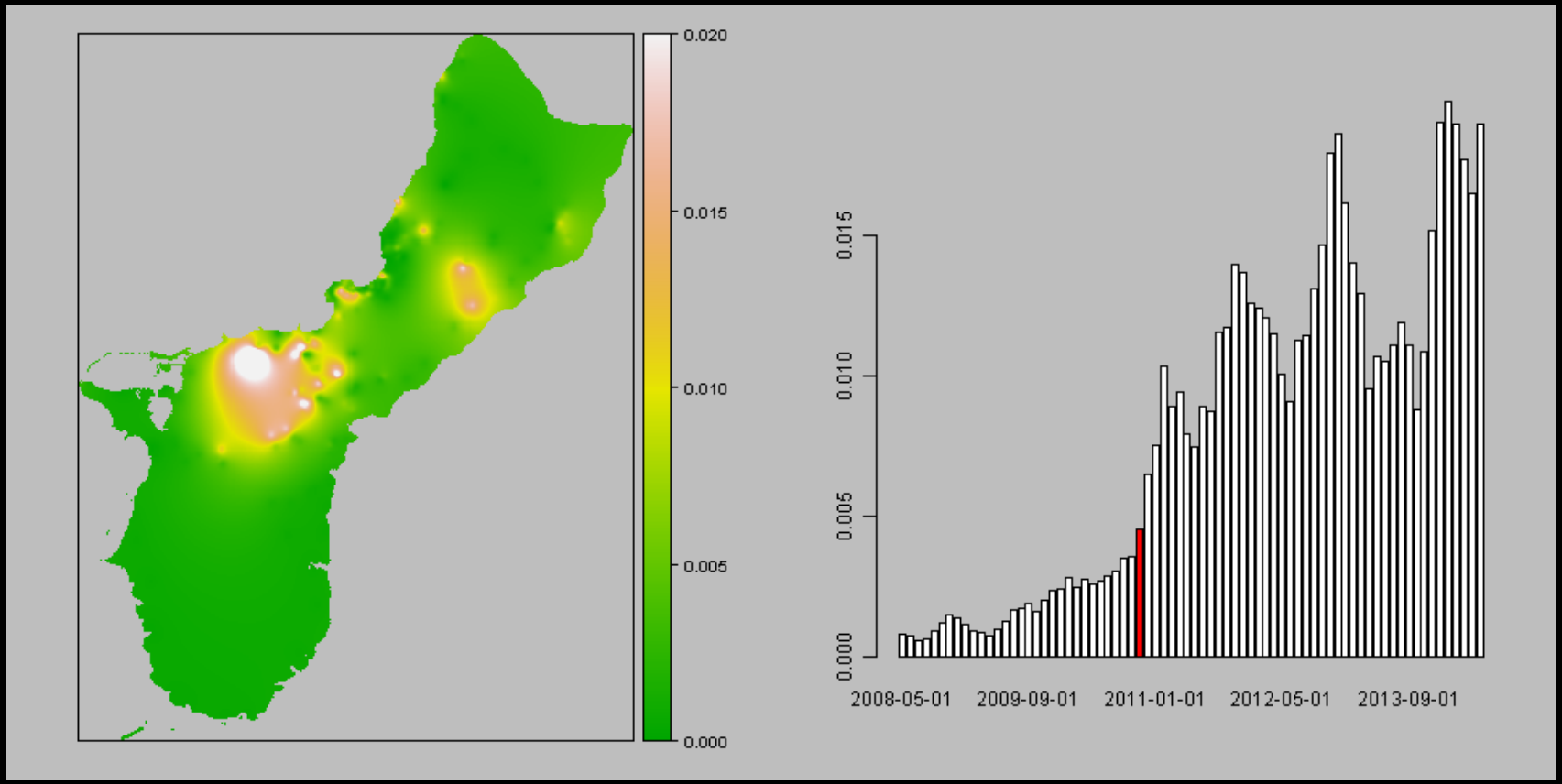
Mean number of beetles caught per trap-day

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



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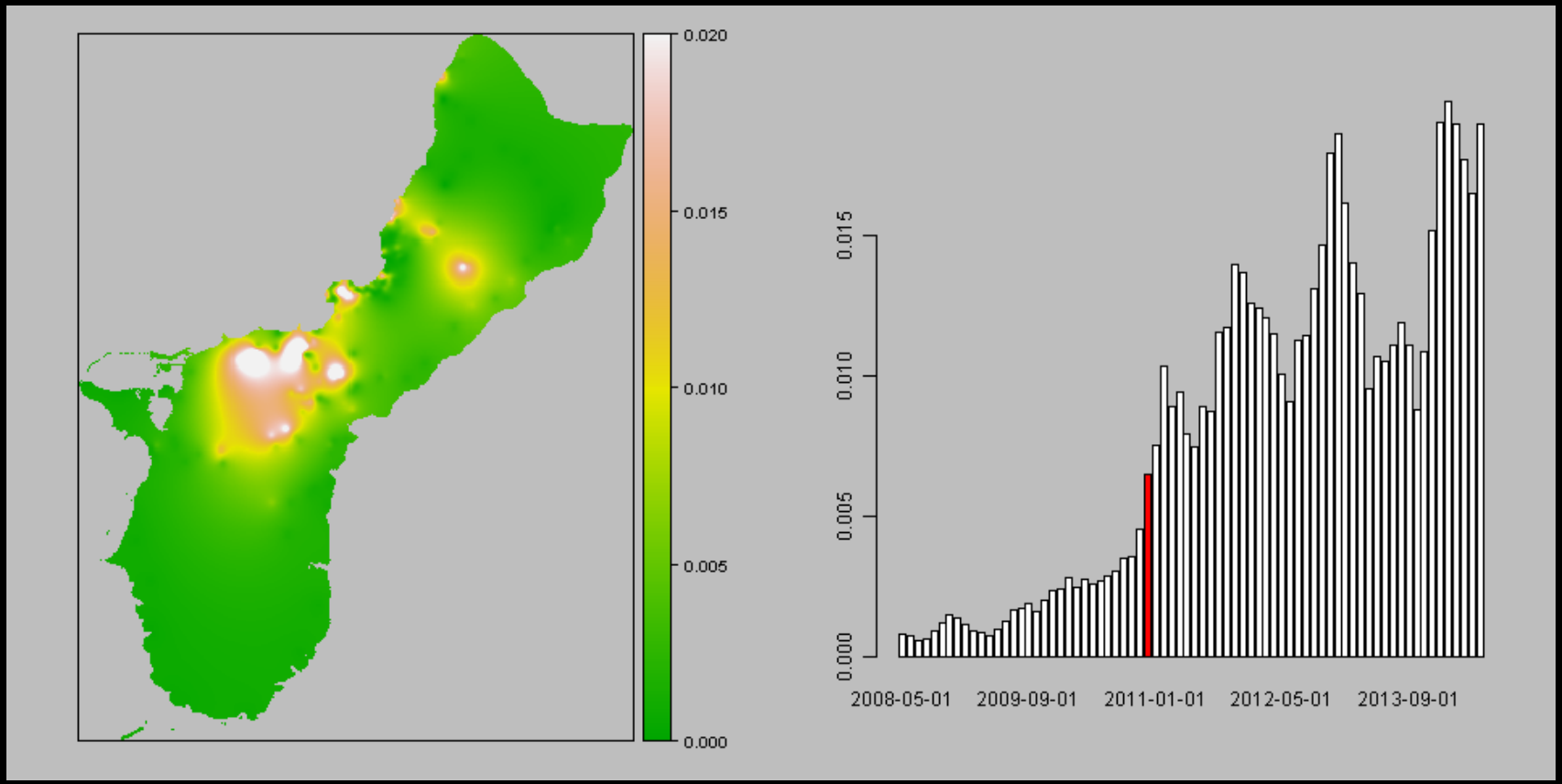
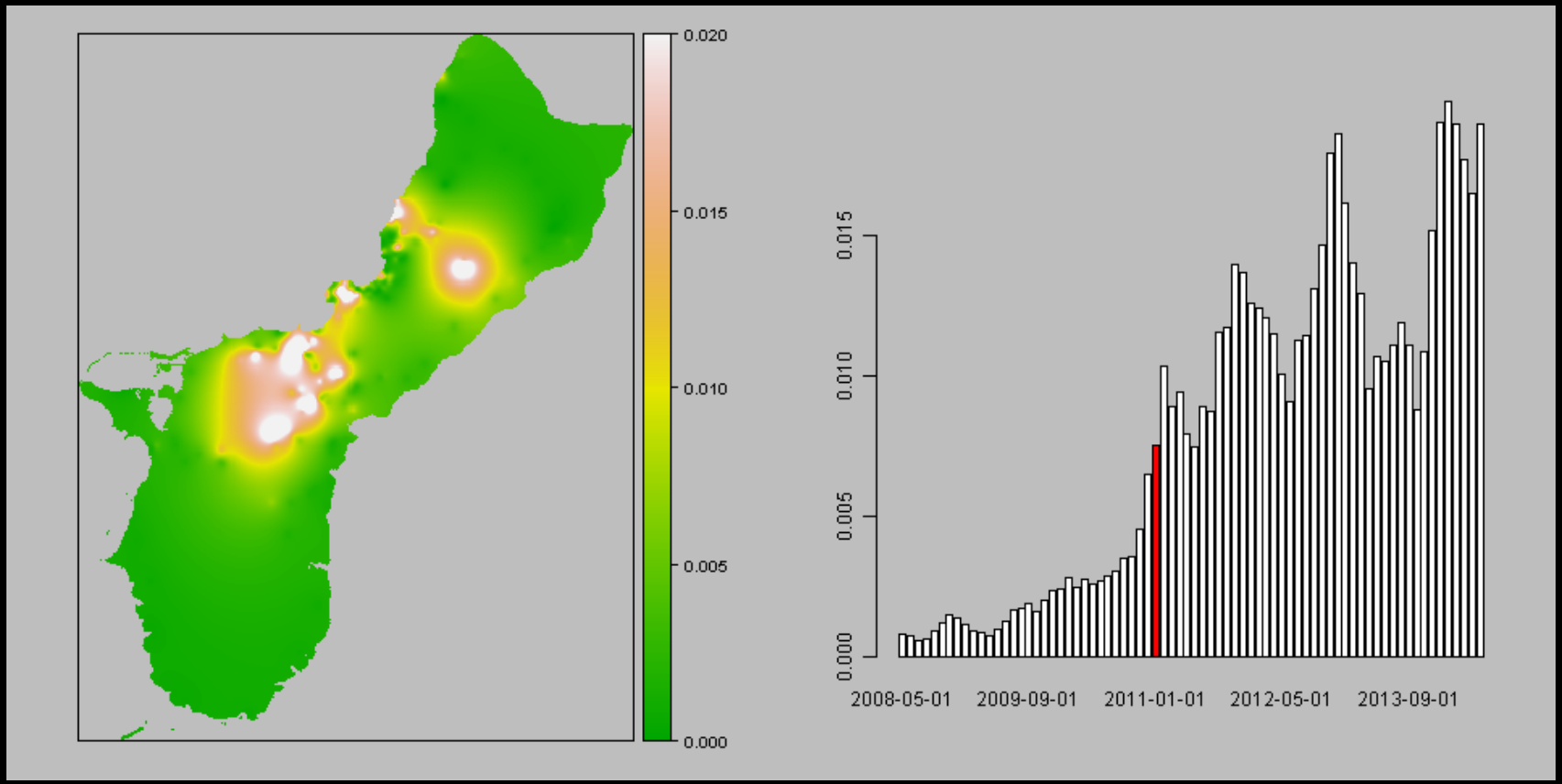


Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2011



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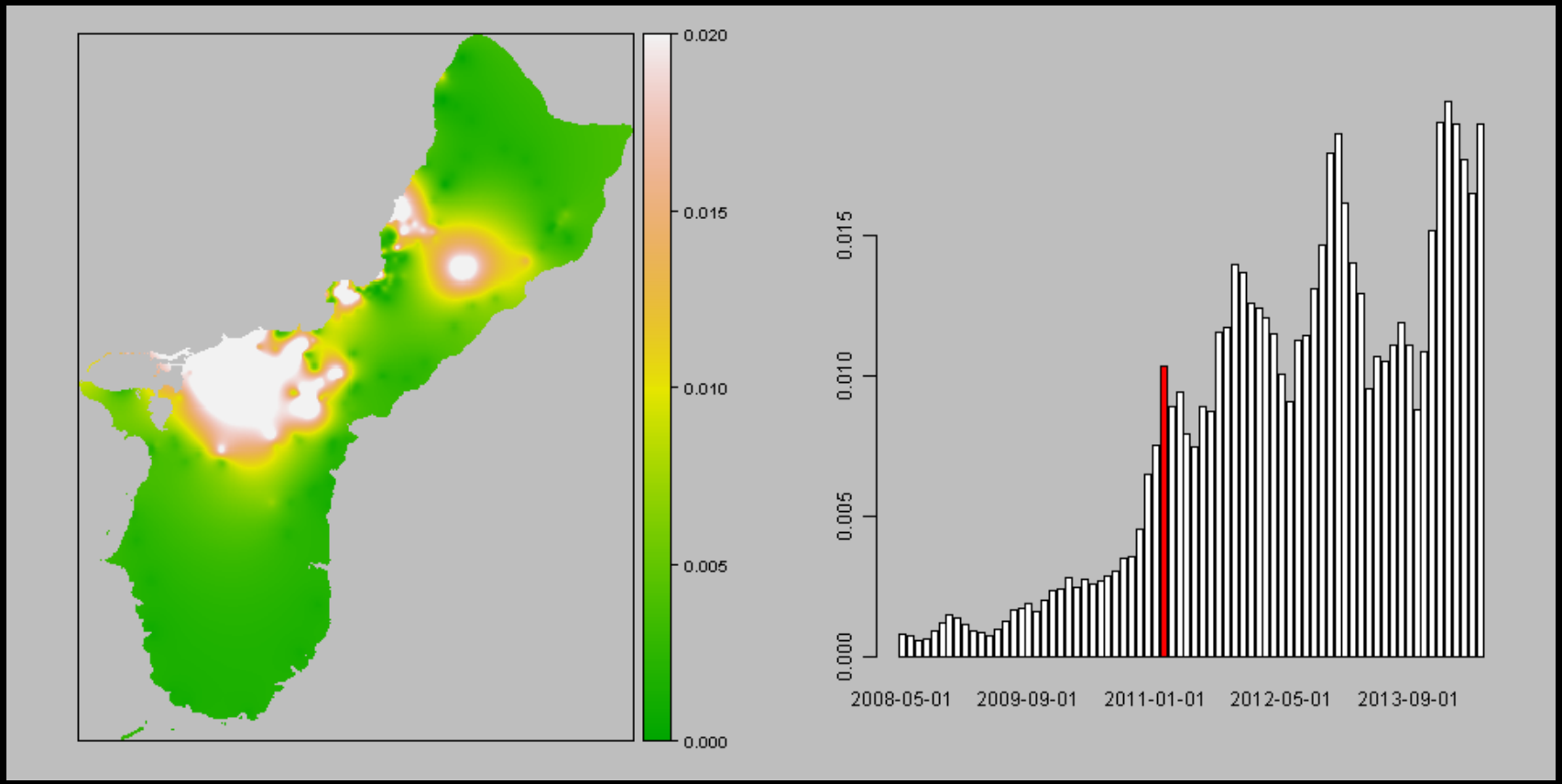
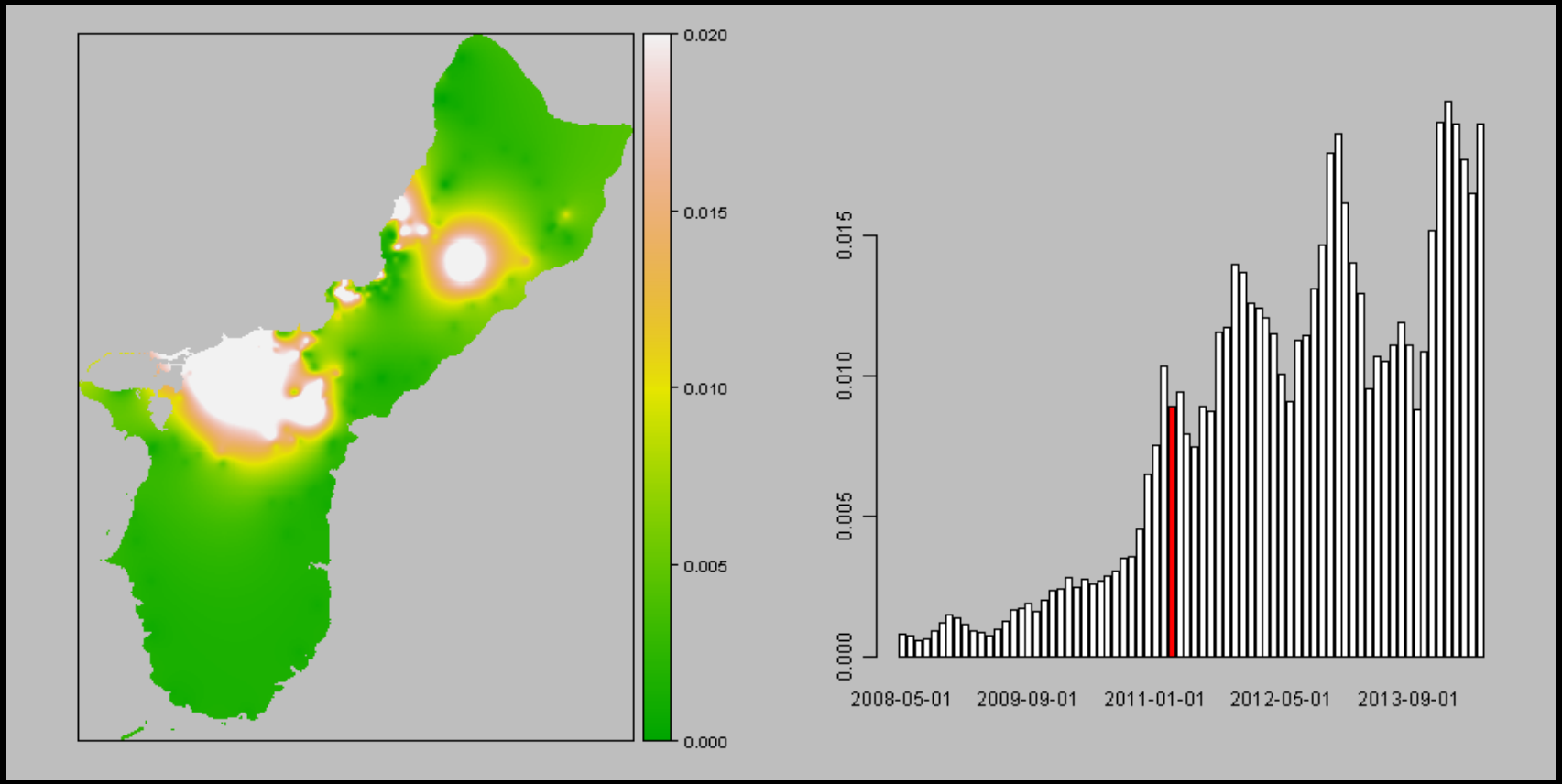


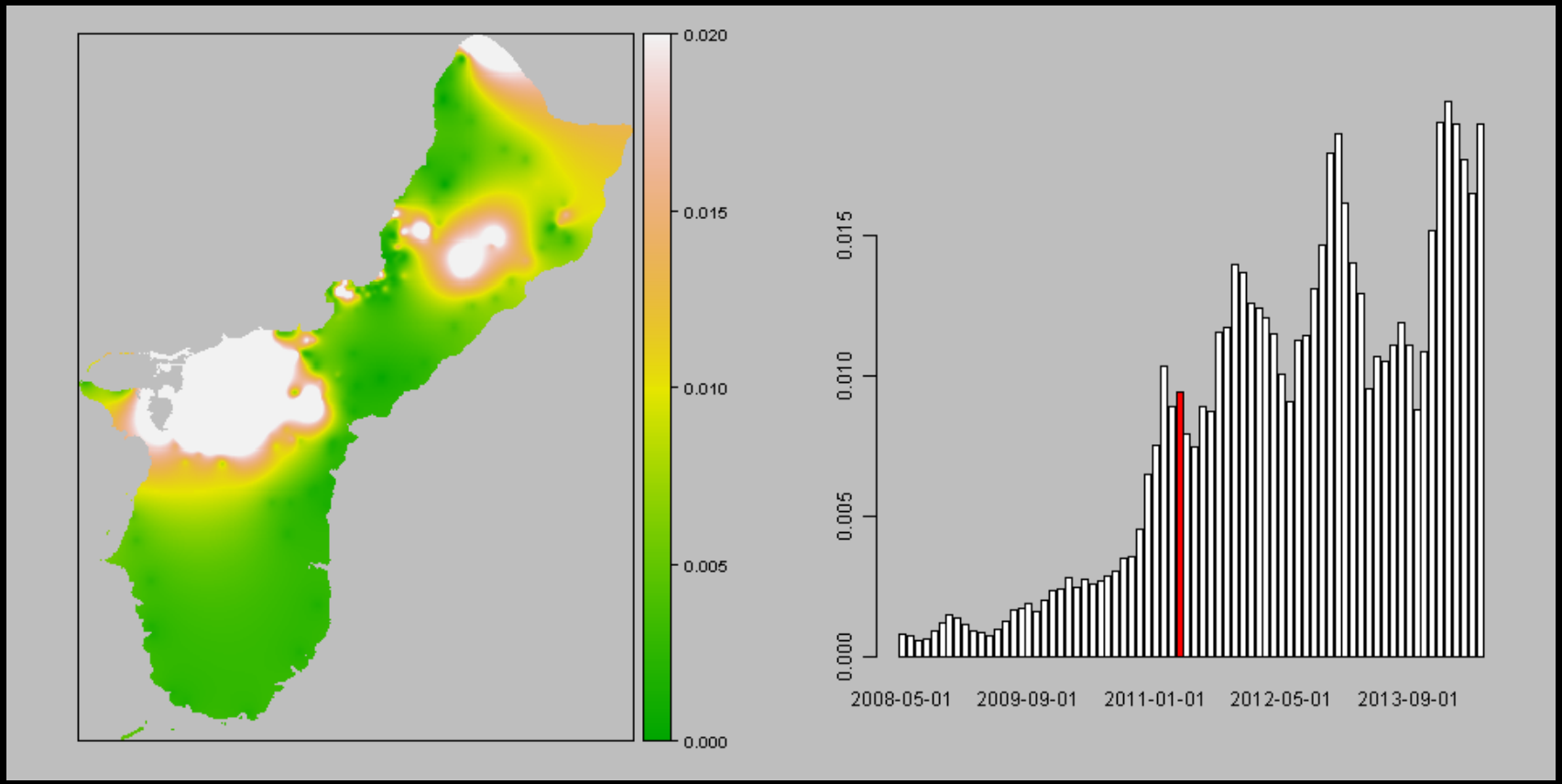
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2011



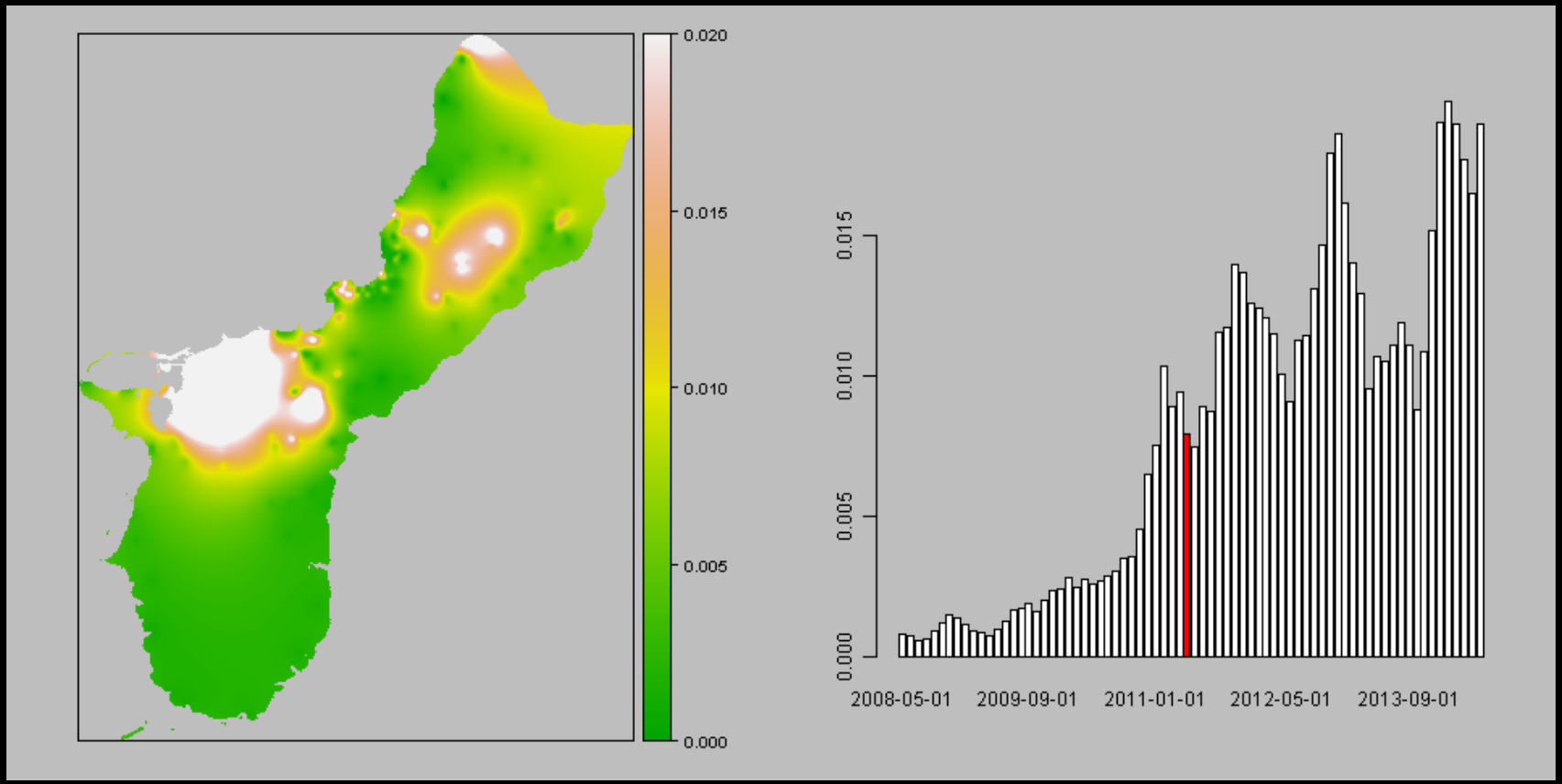
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2011



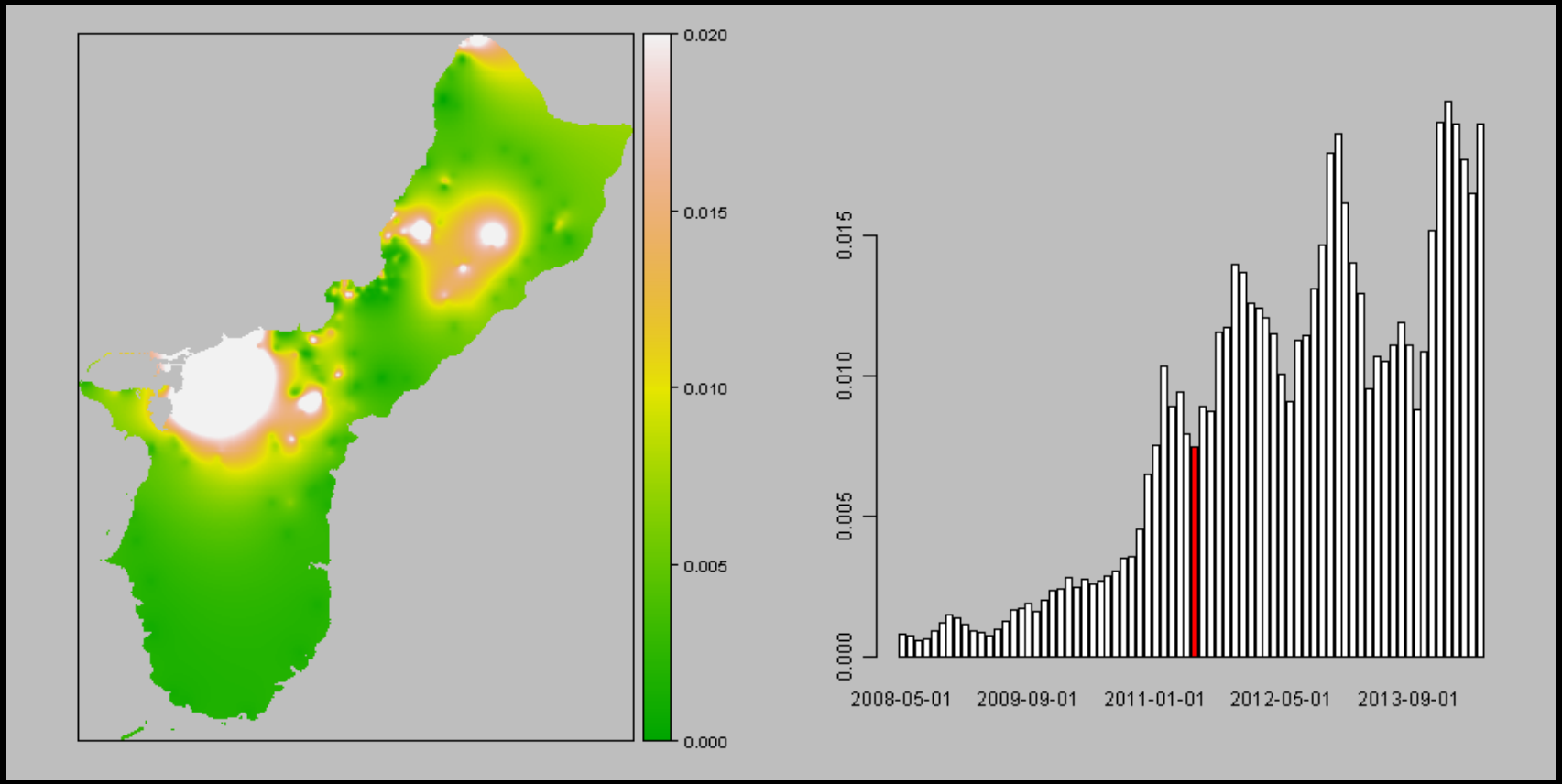
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2011



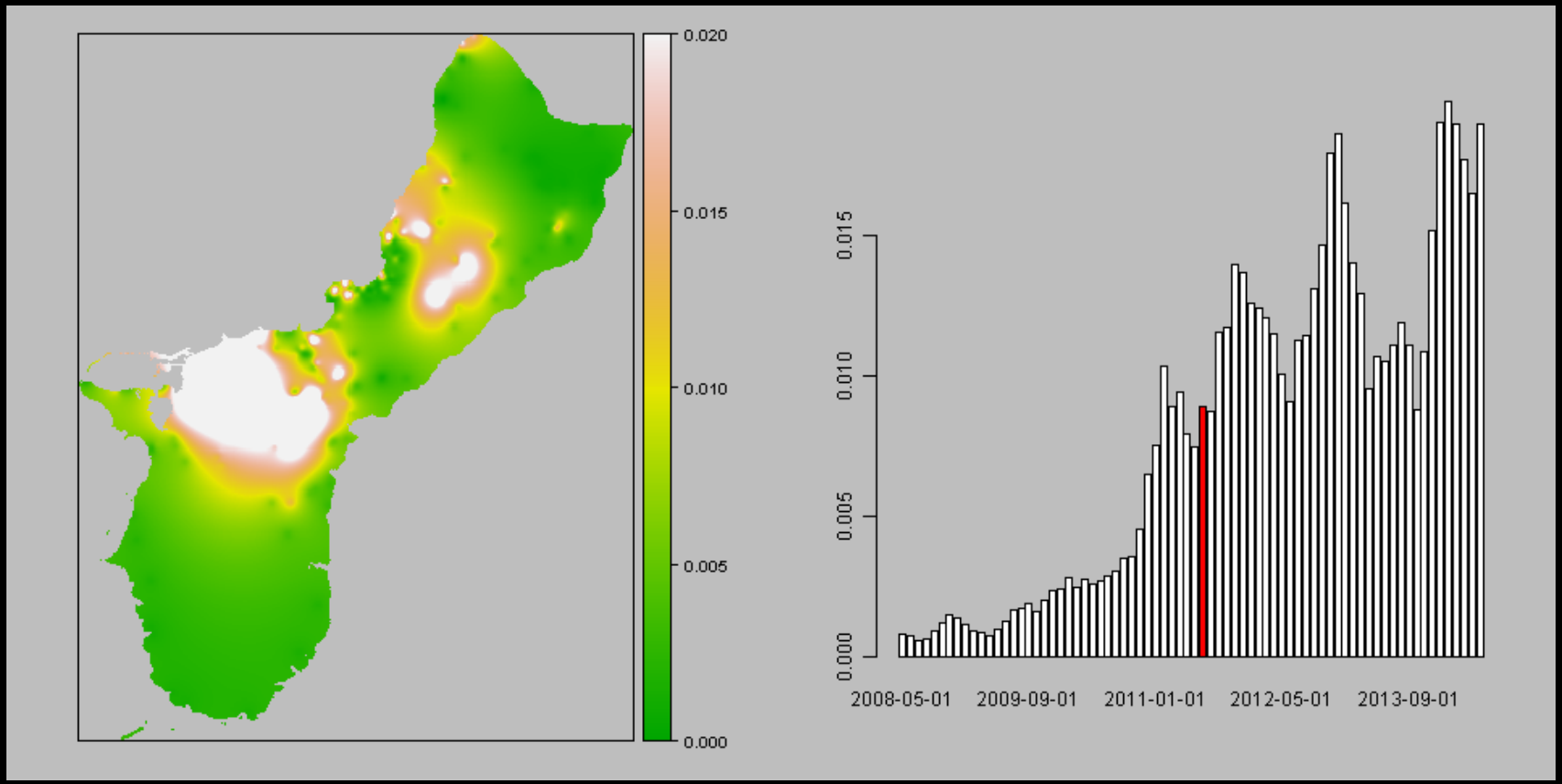
Mean number of beetles caught per trap-day

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



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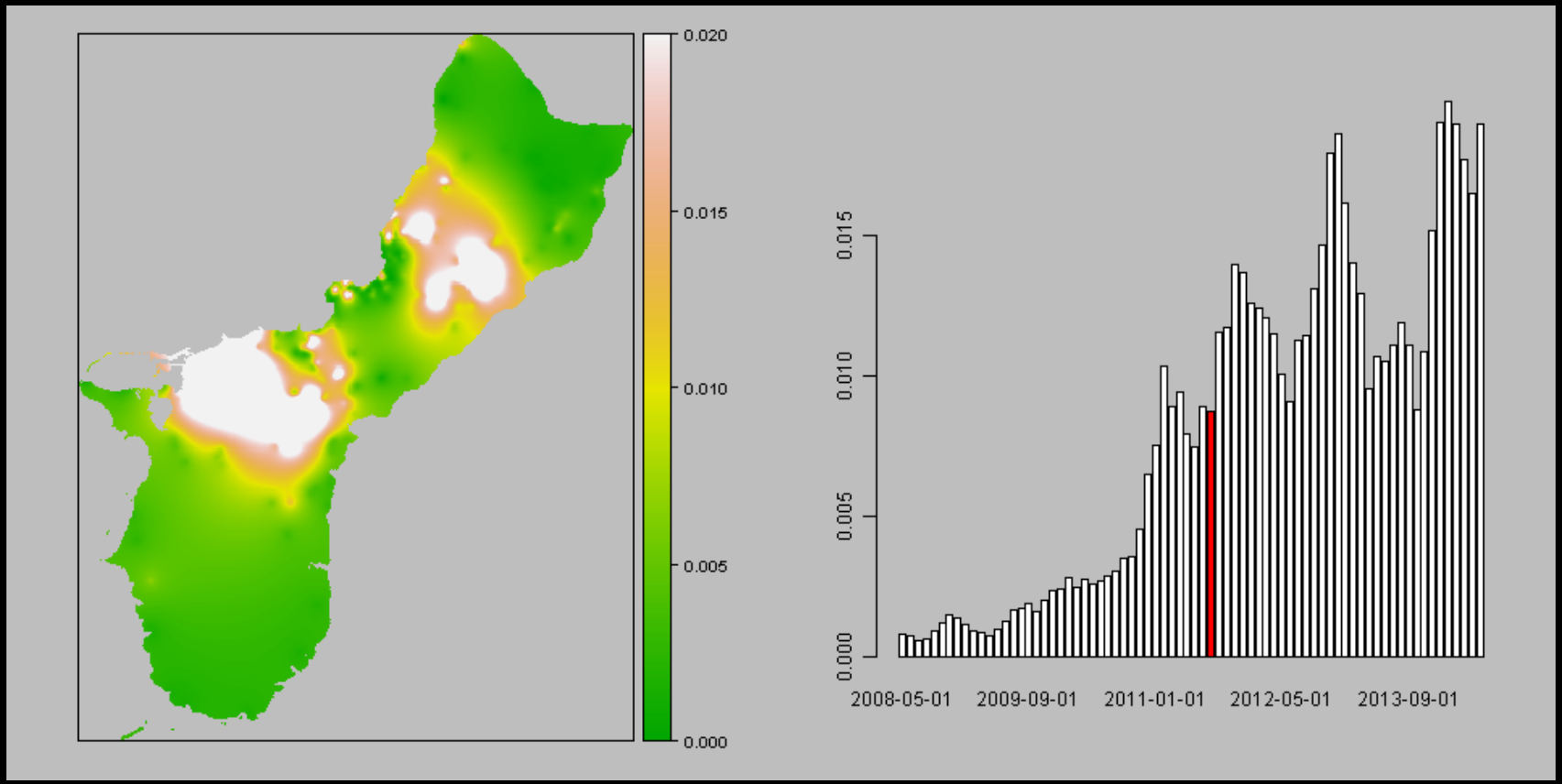

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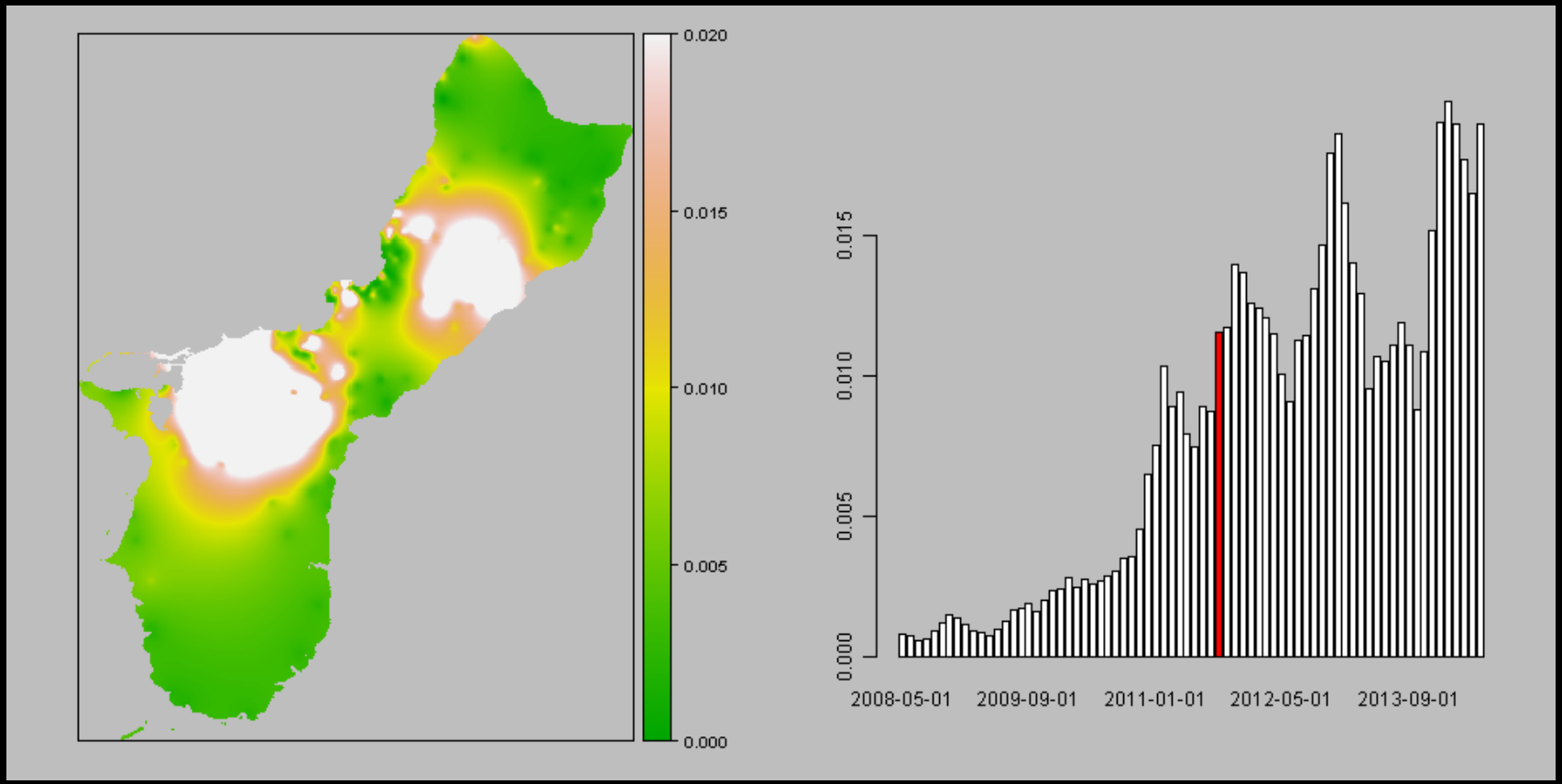
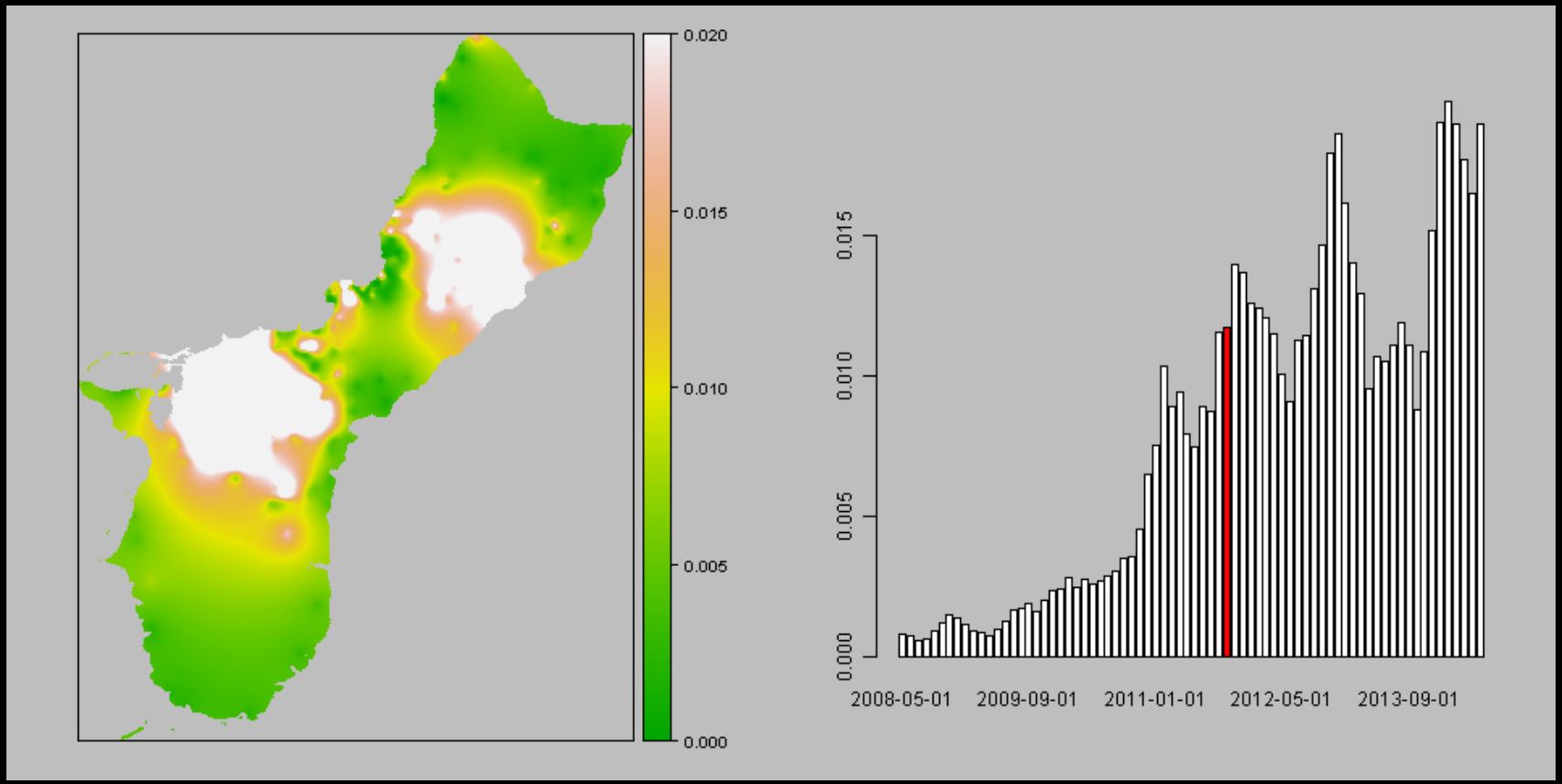


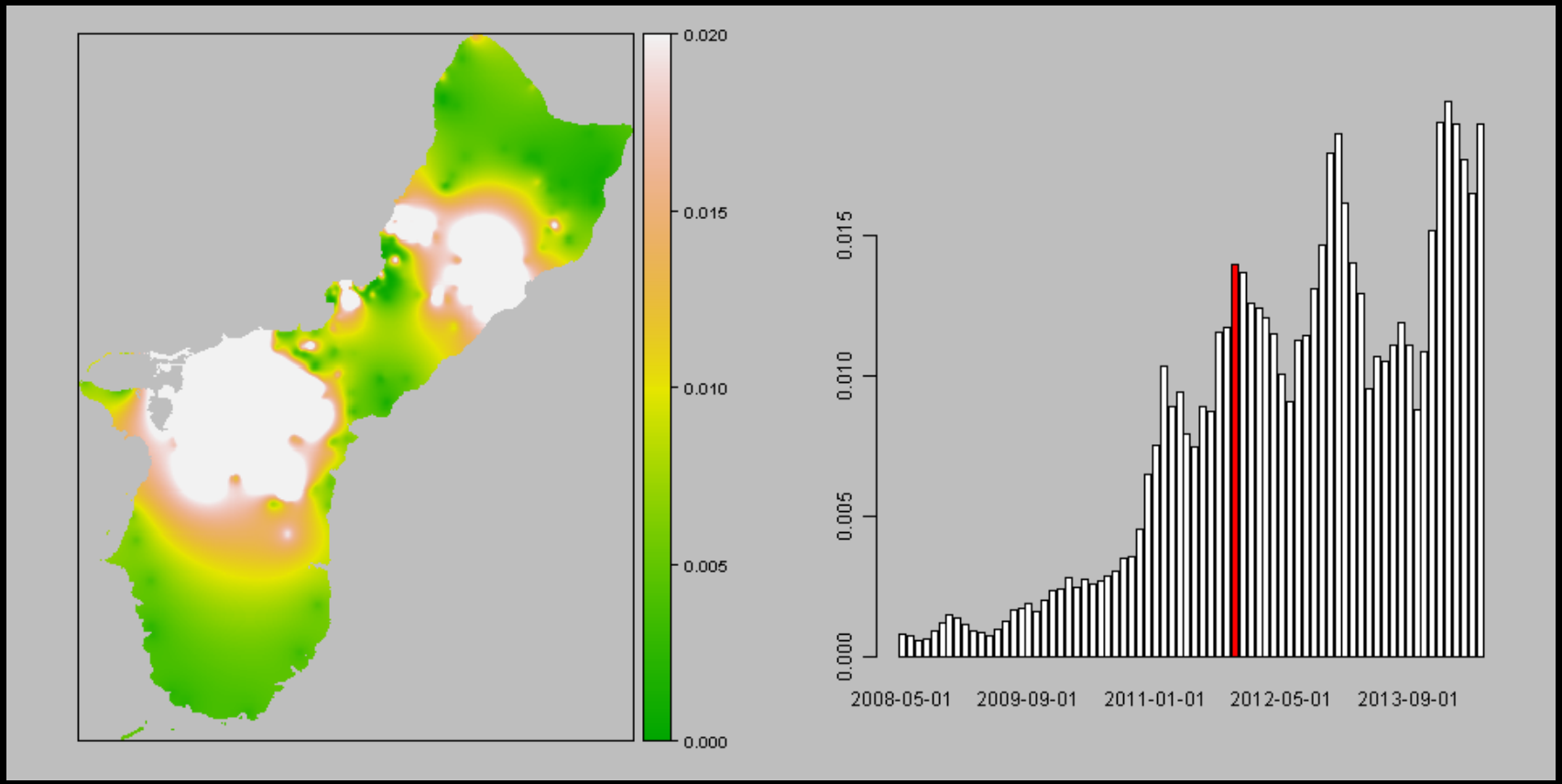
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2011



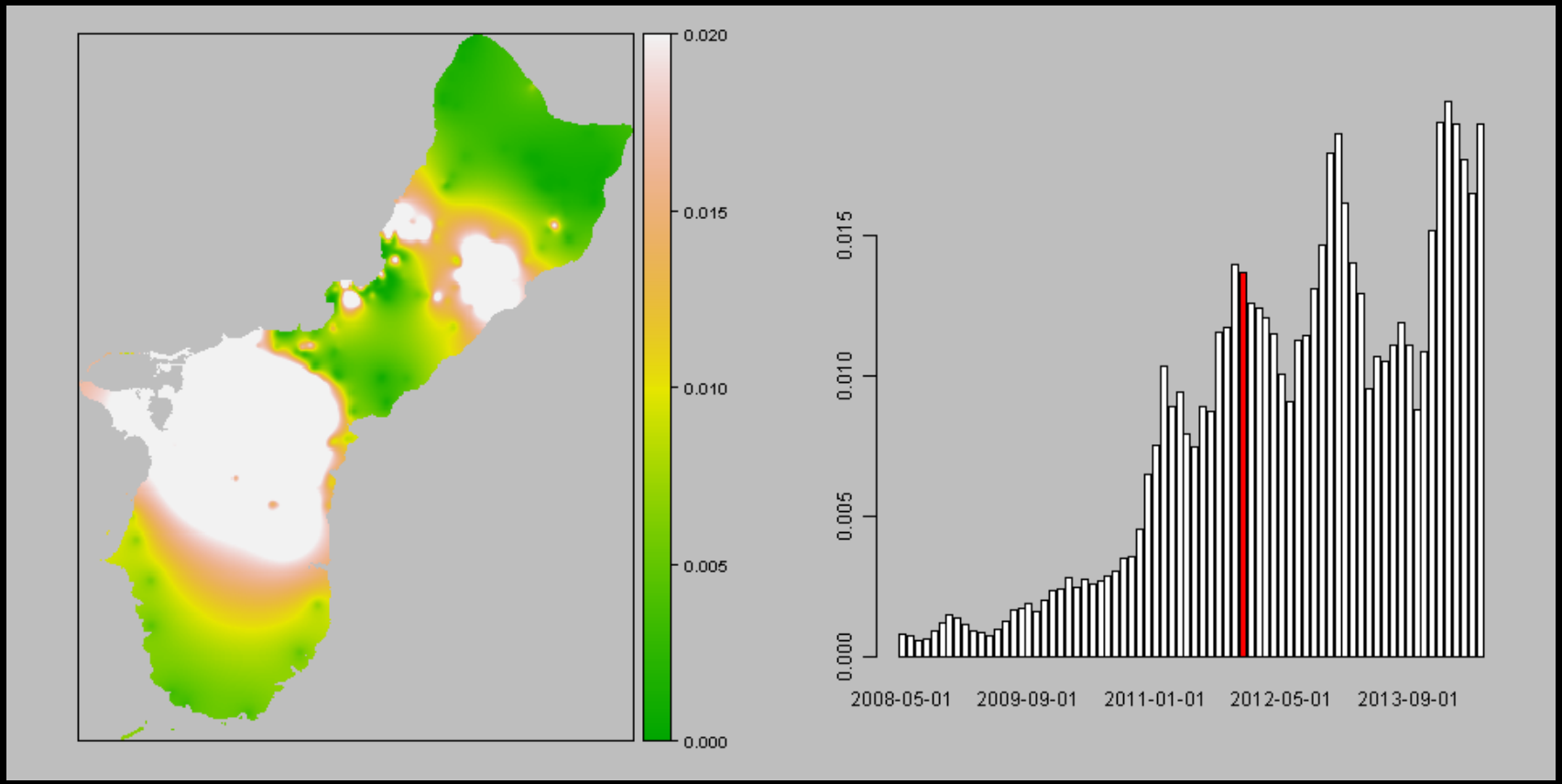
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2011



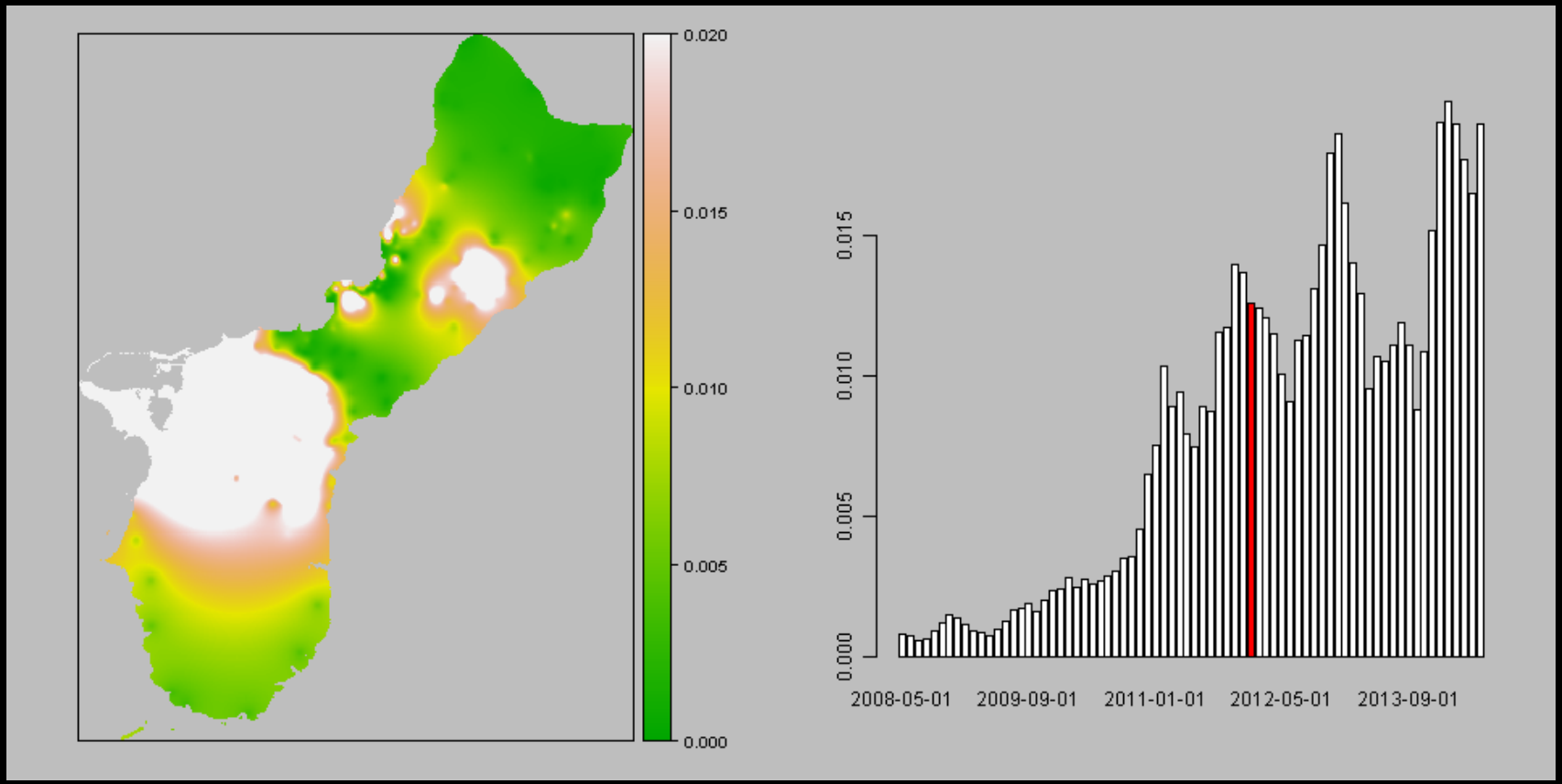
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2011



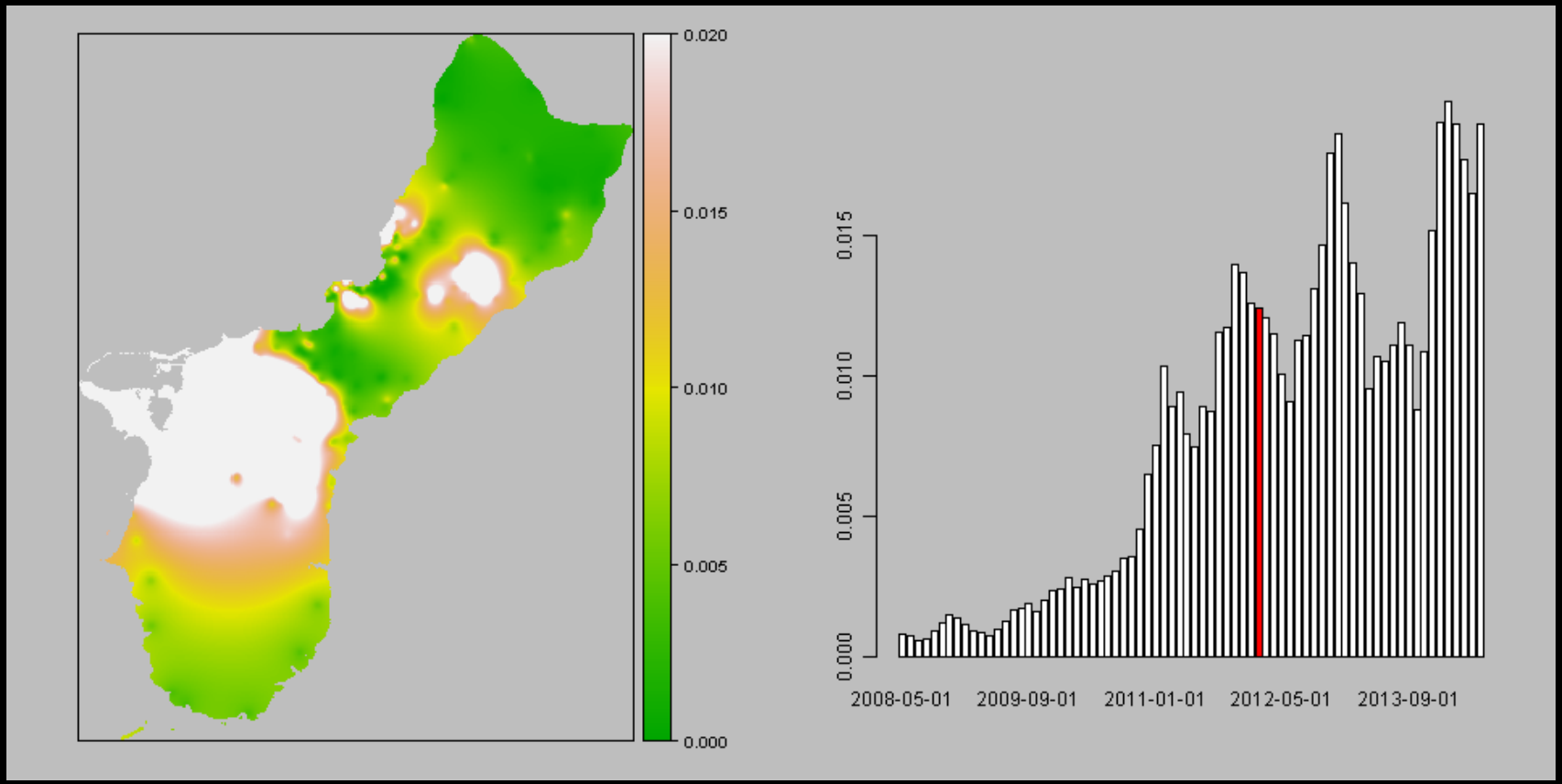
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2012



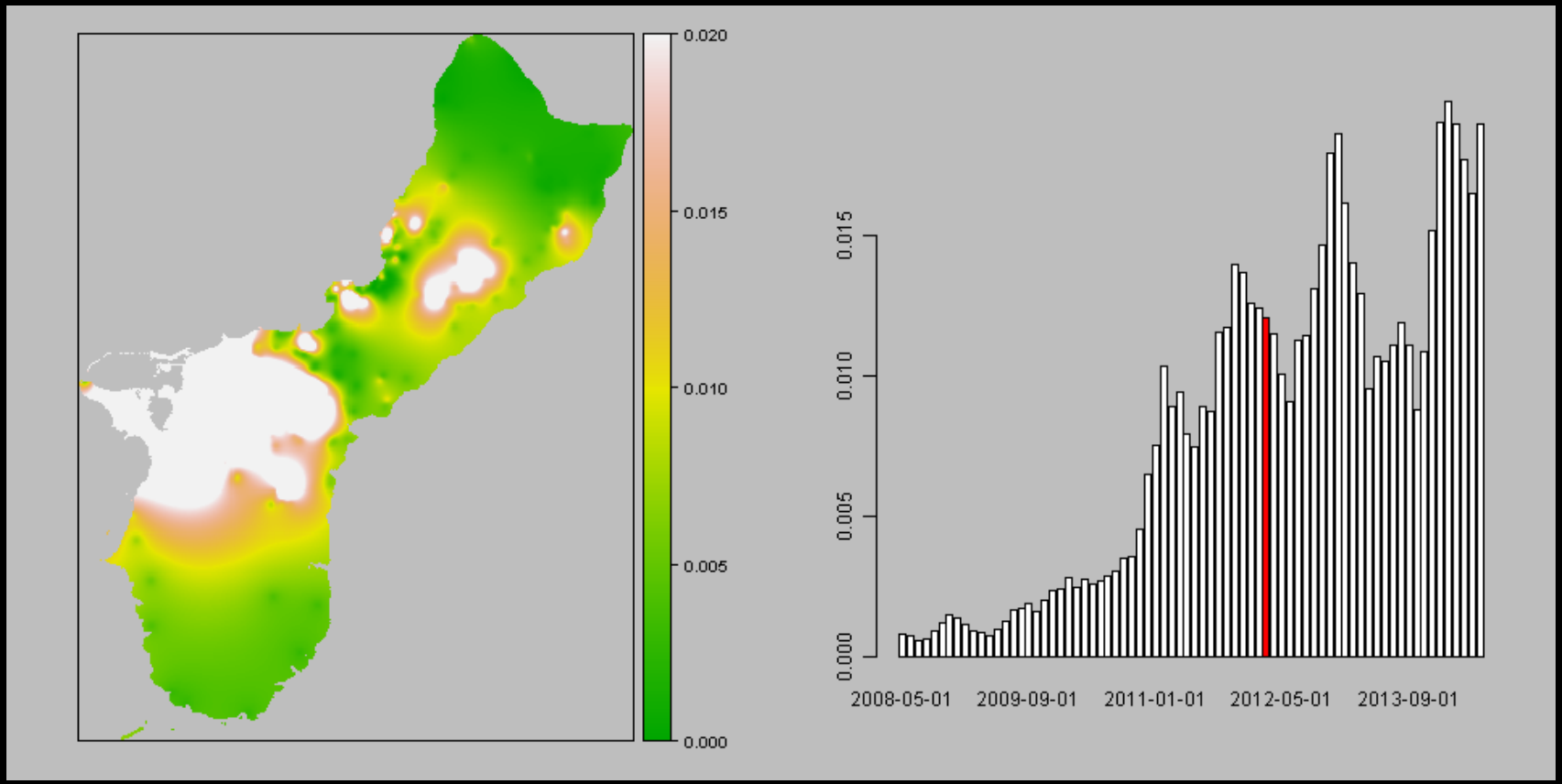
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2012



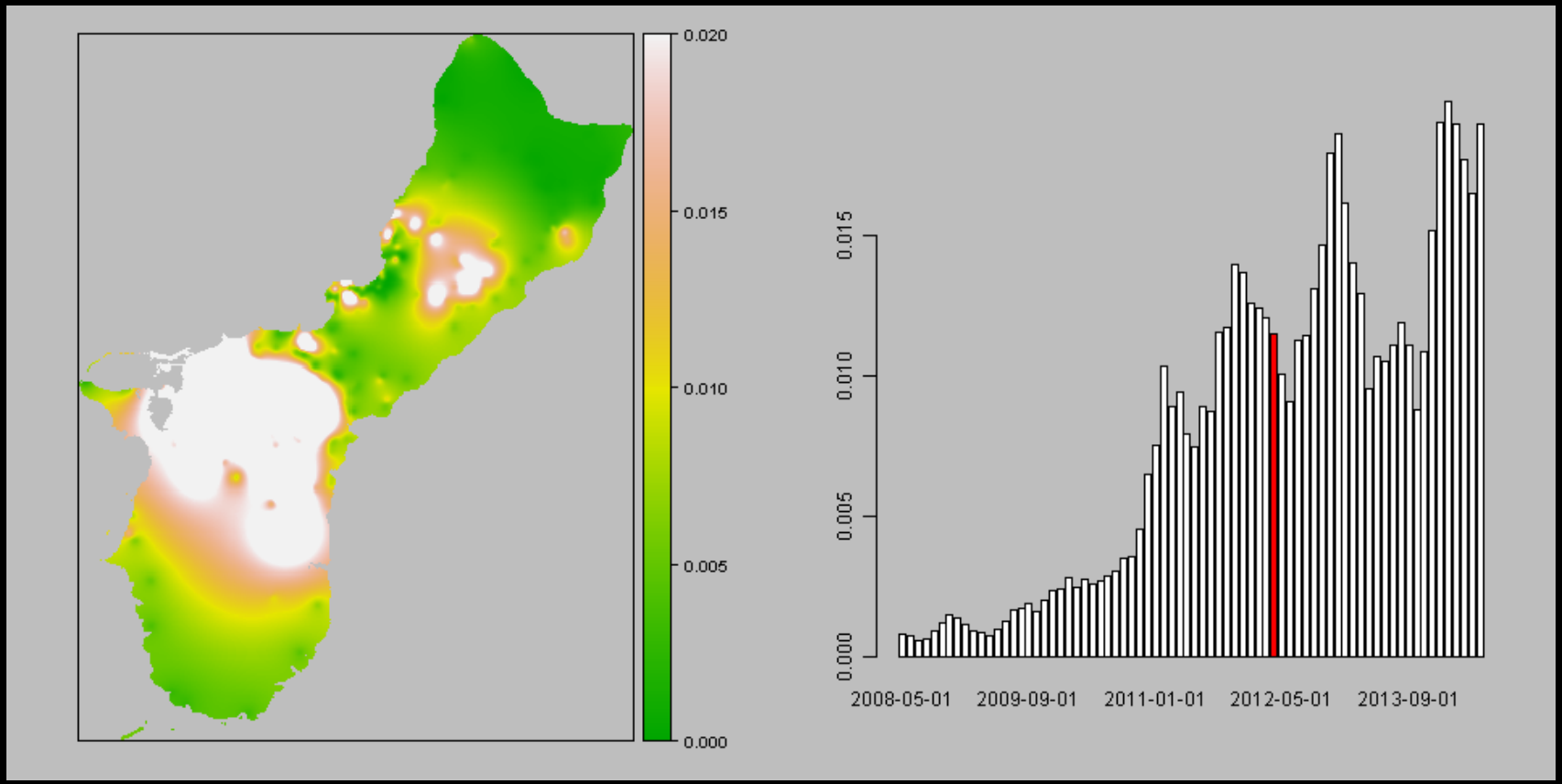
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2012



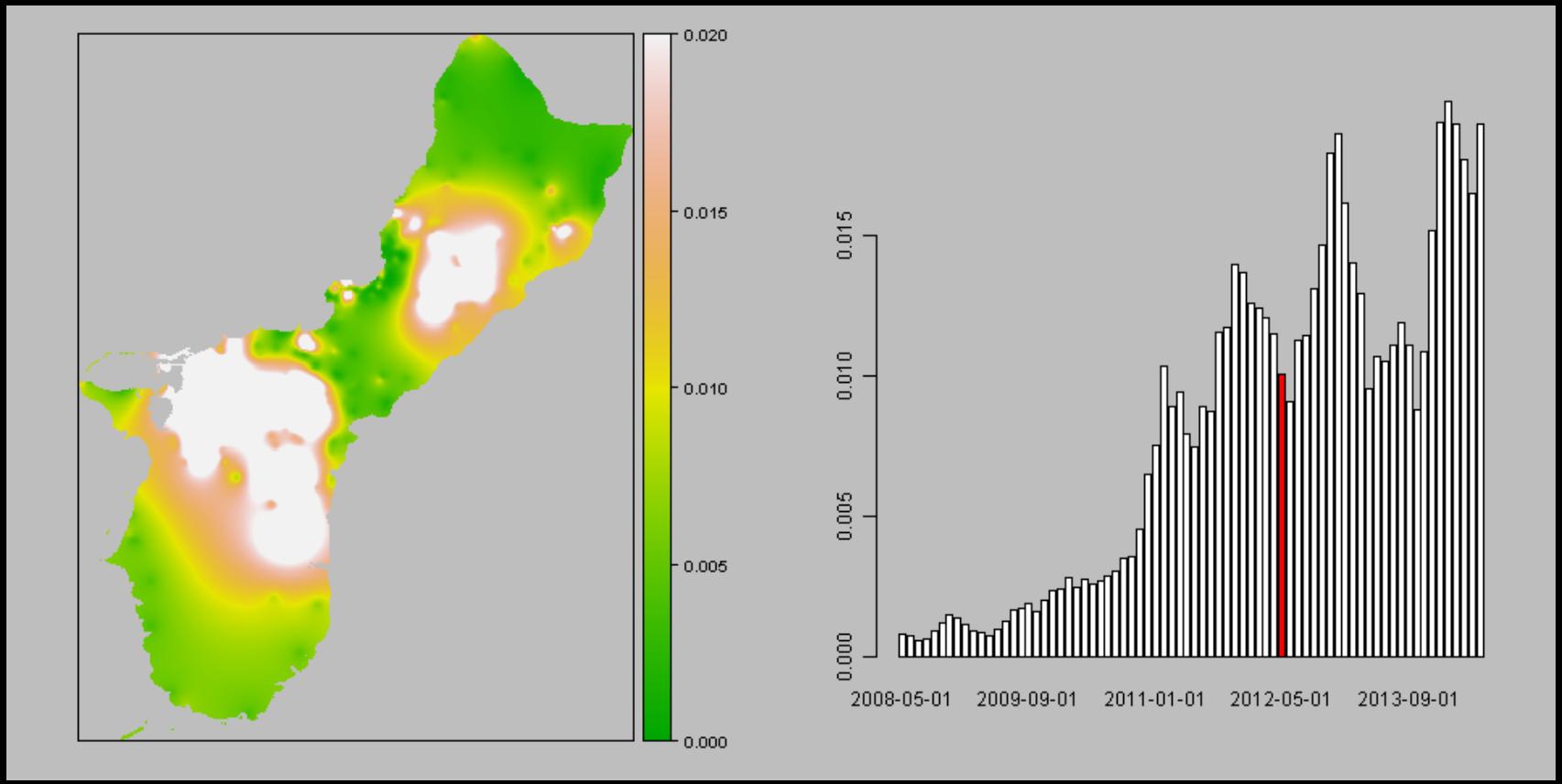
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2012



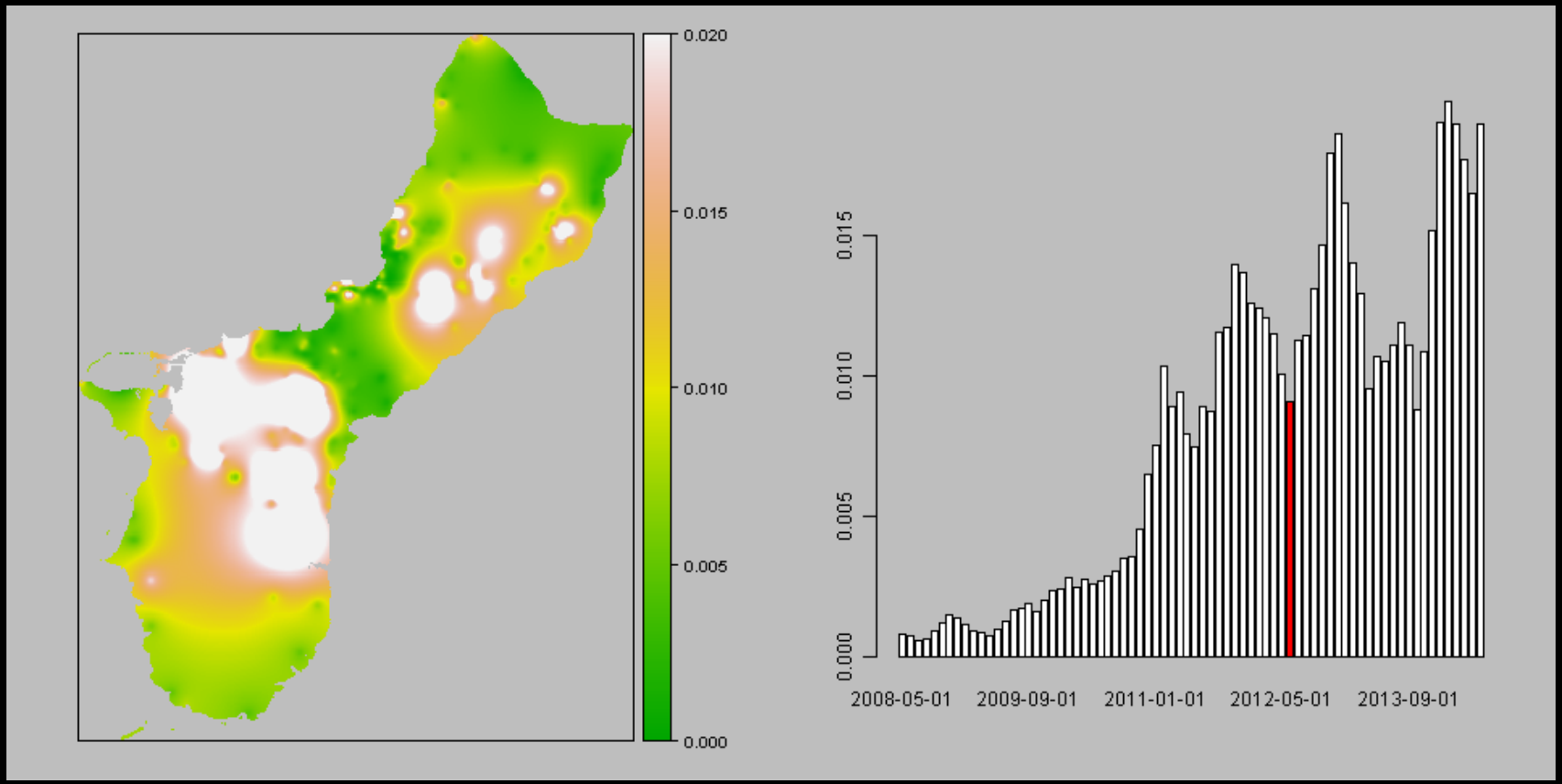
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2012



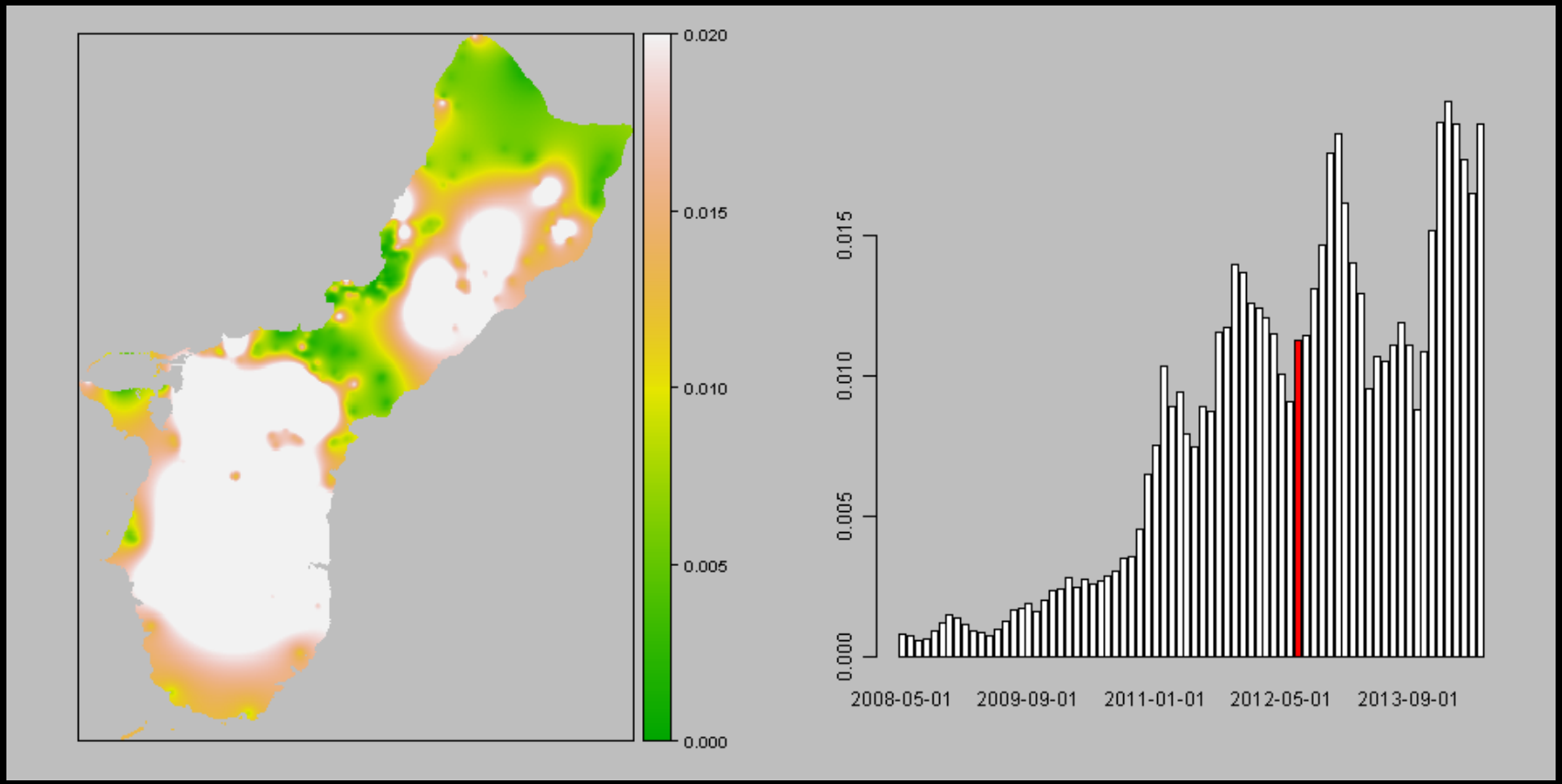
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2012



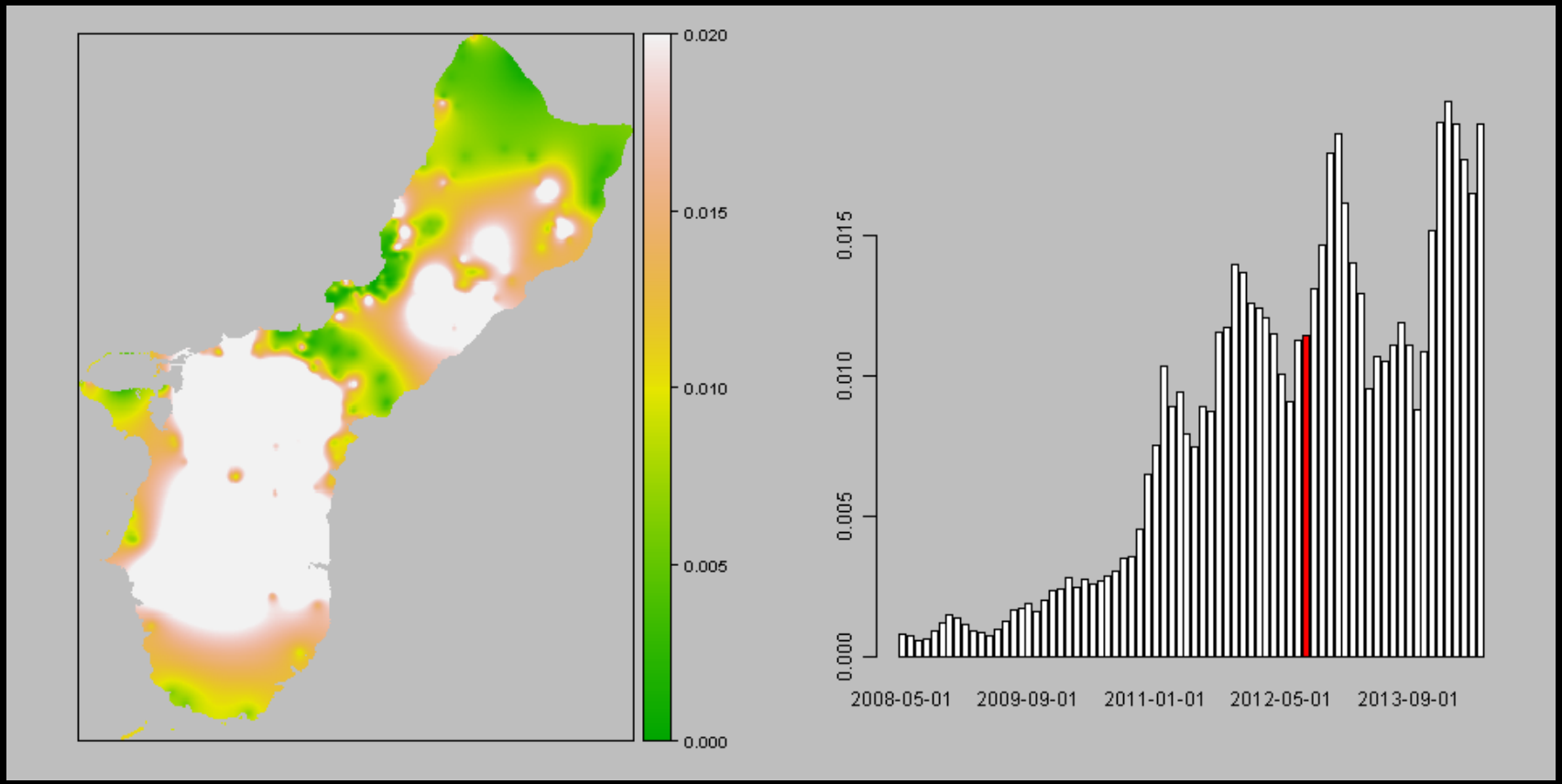
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2012



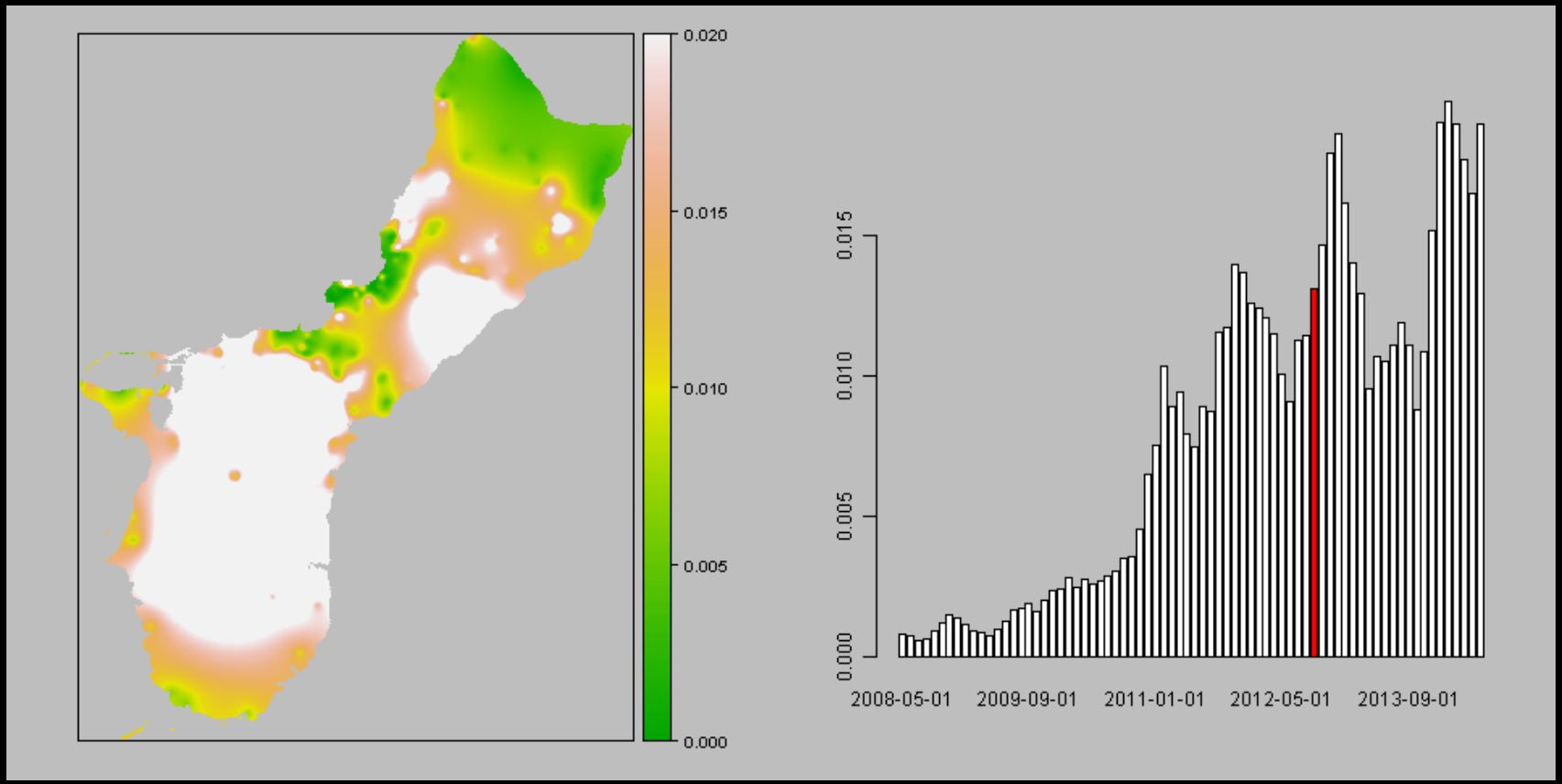
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2012



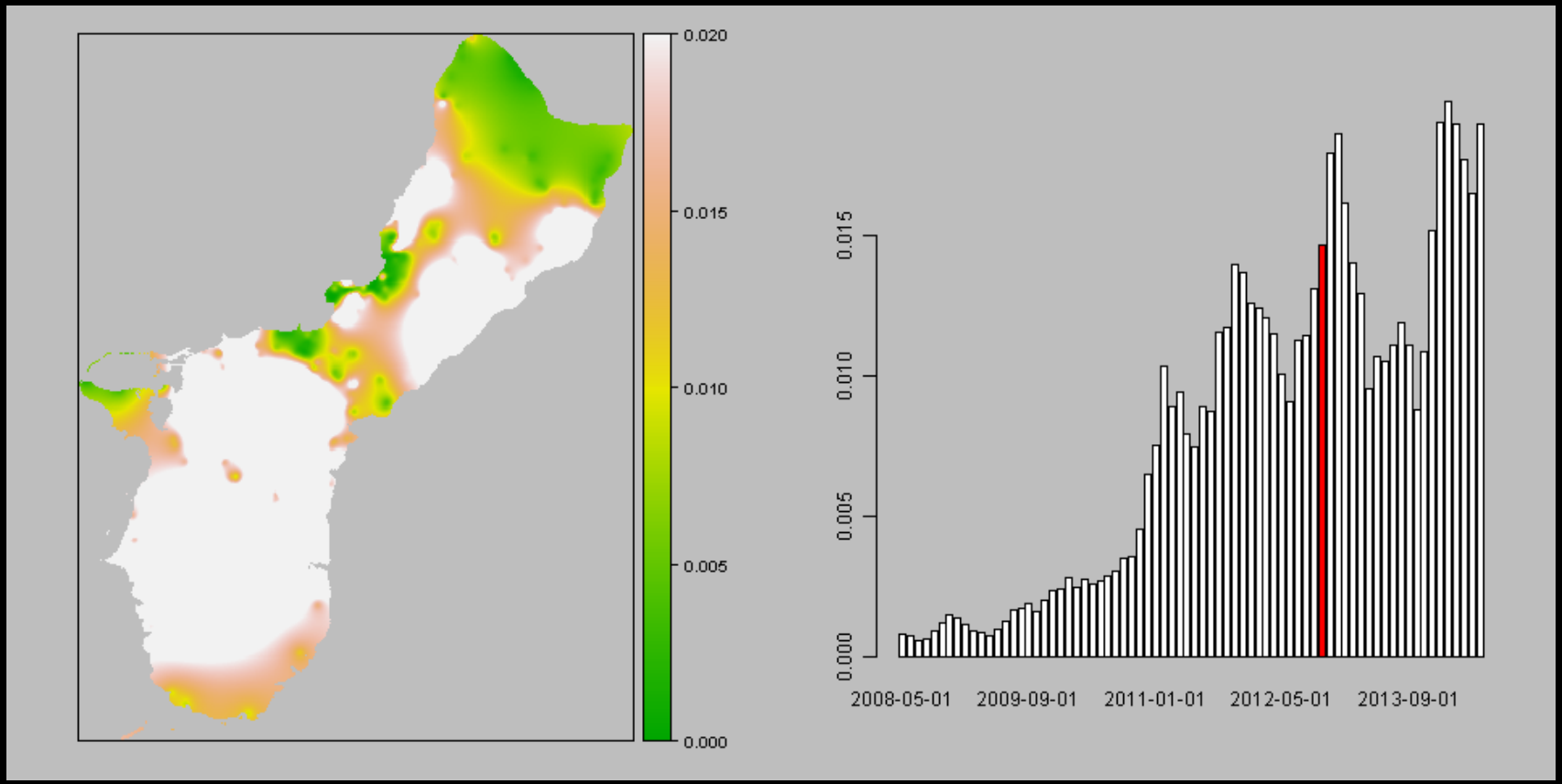
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2012



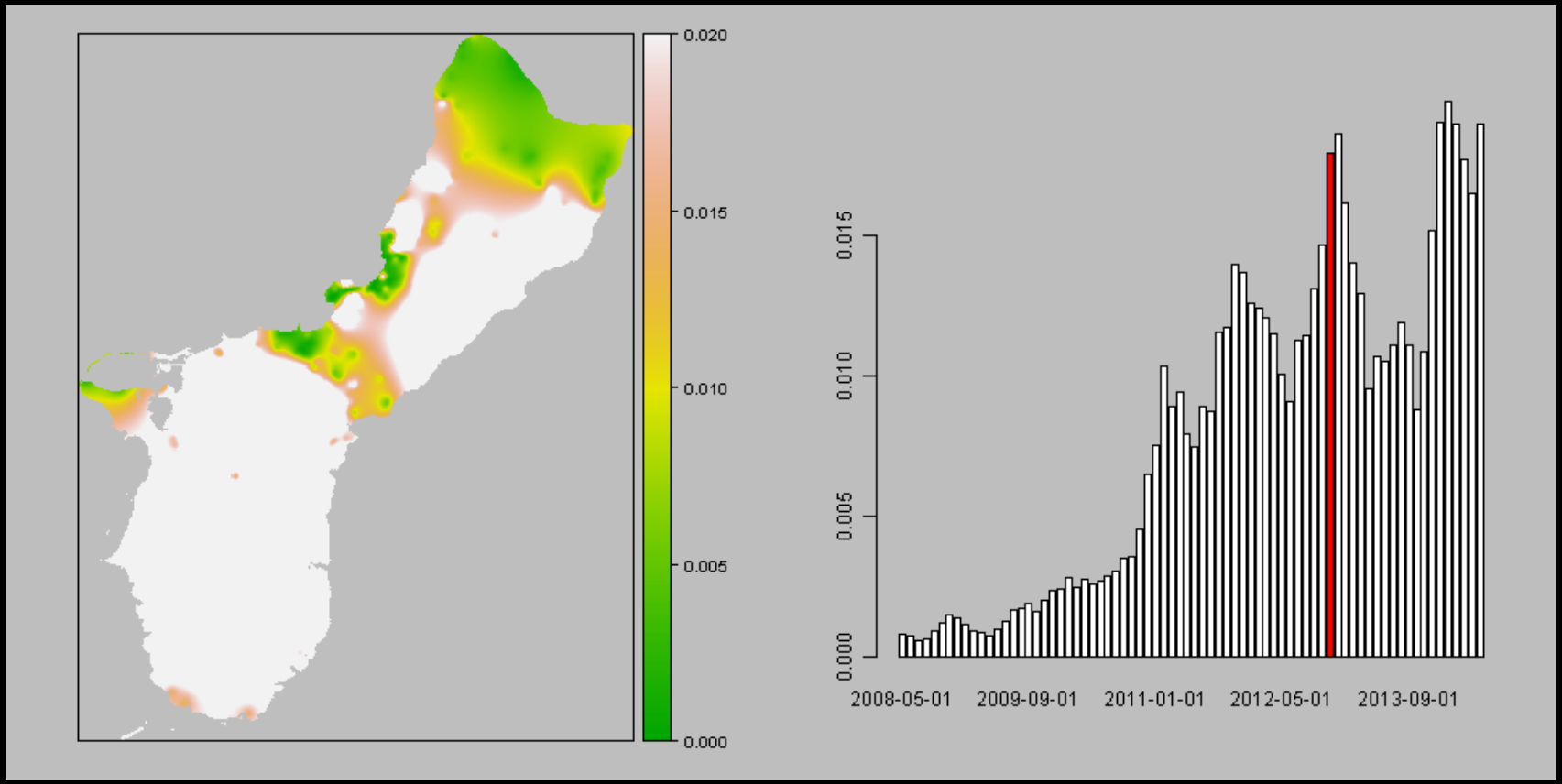
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2012



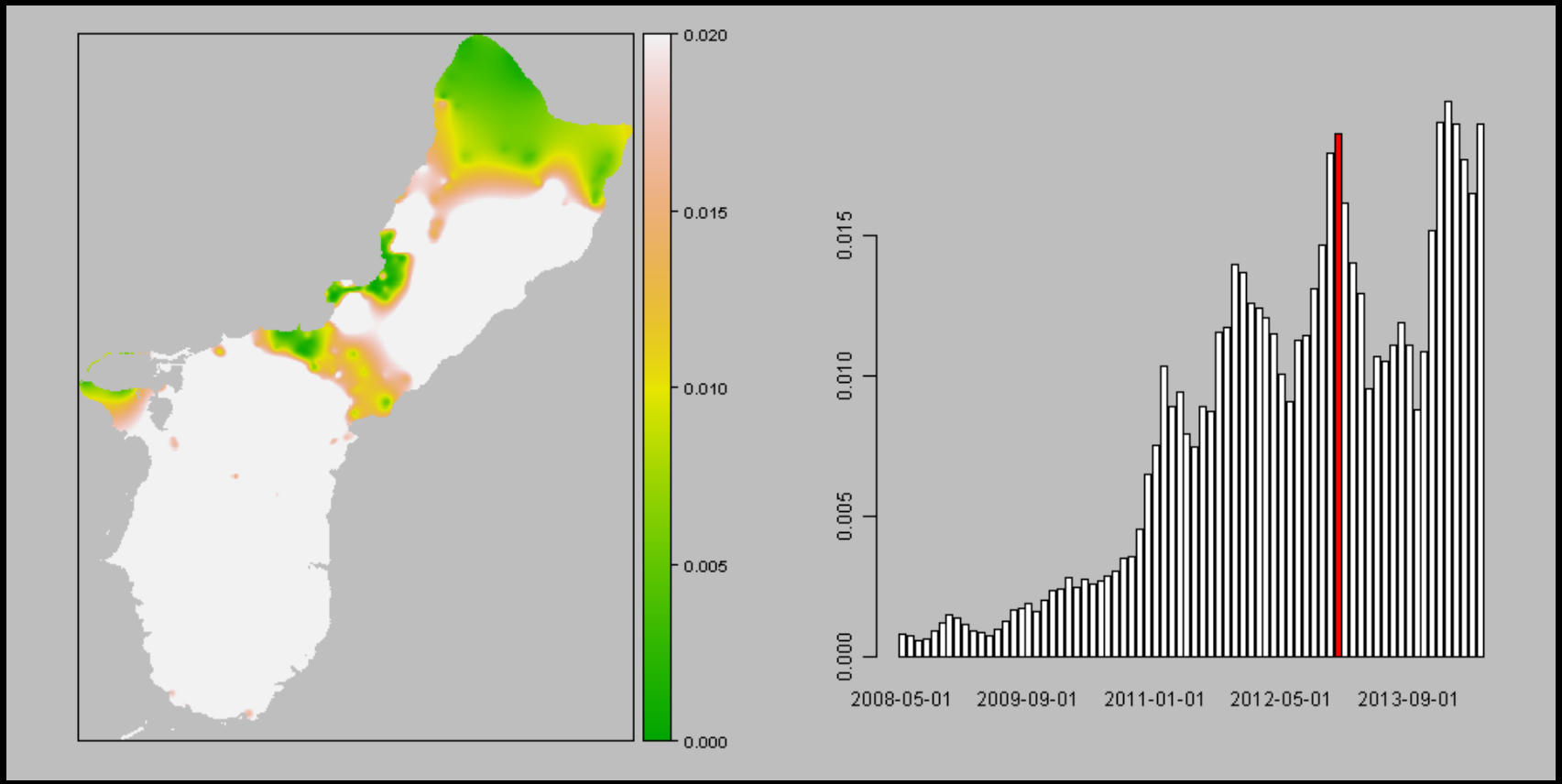
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2012



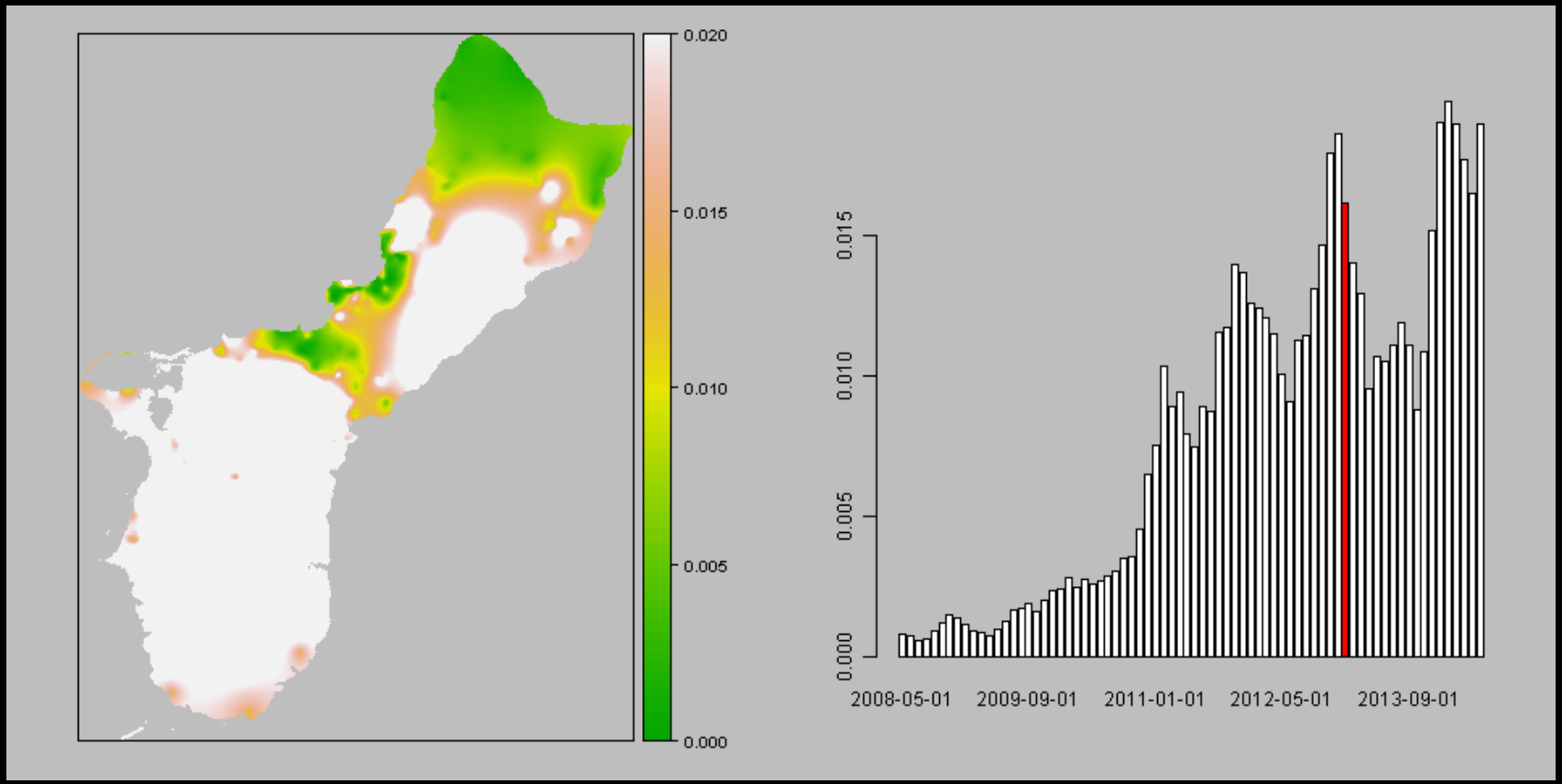
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2012



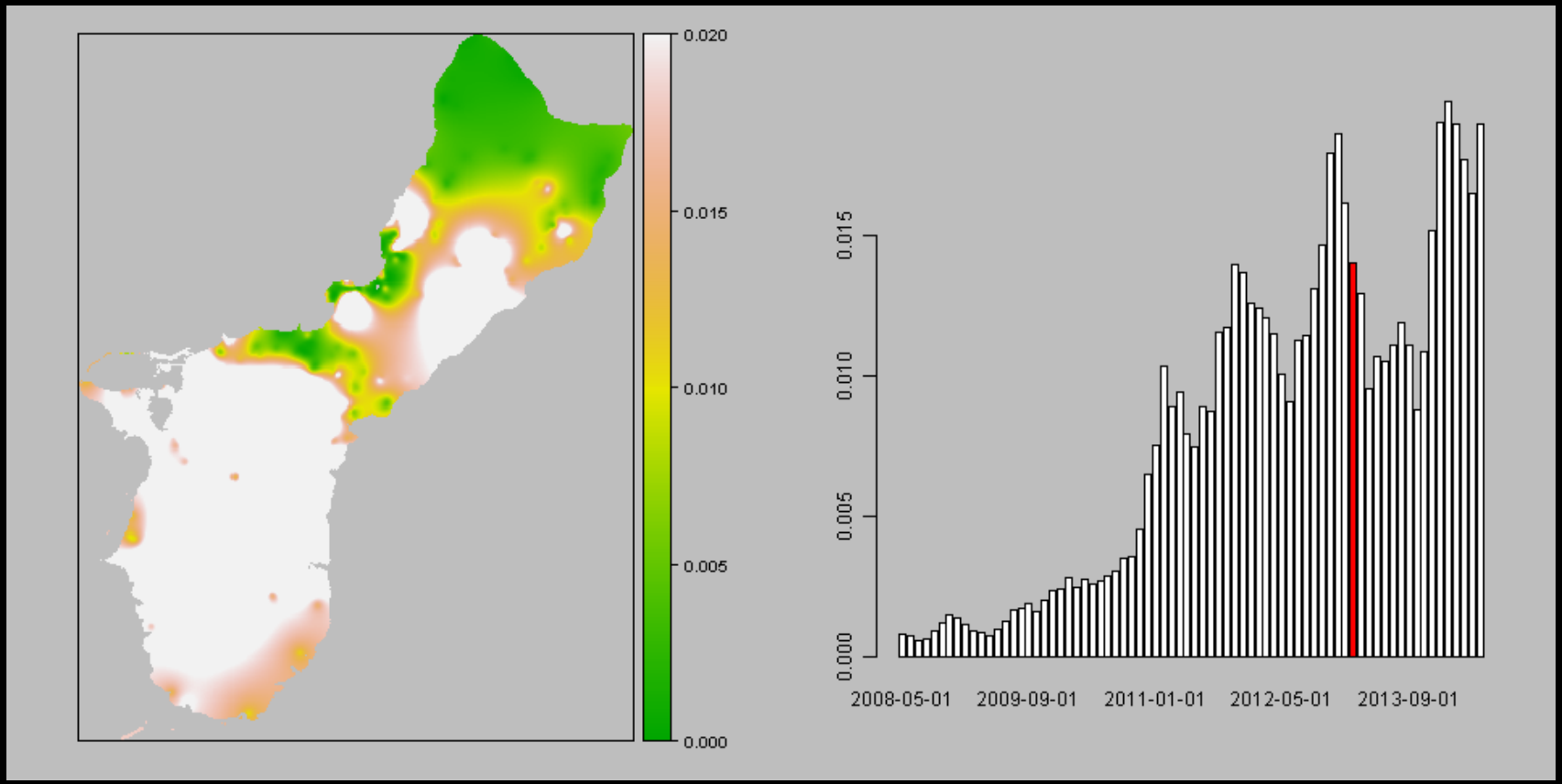
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2013



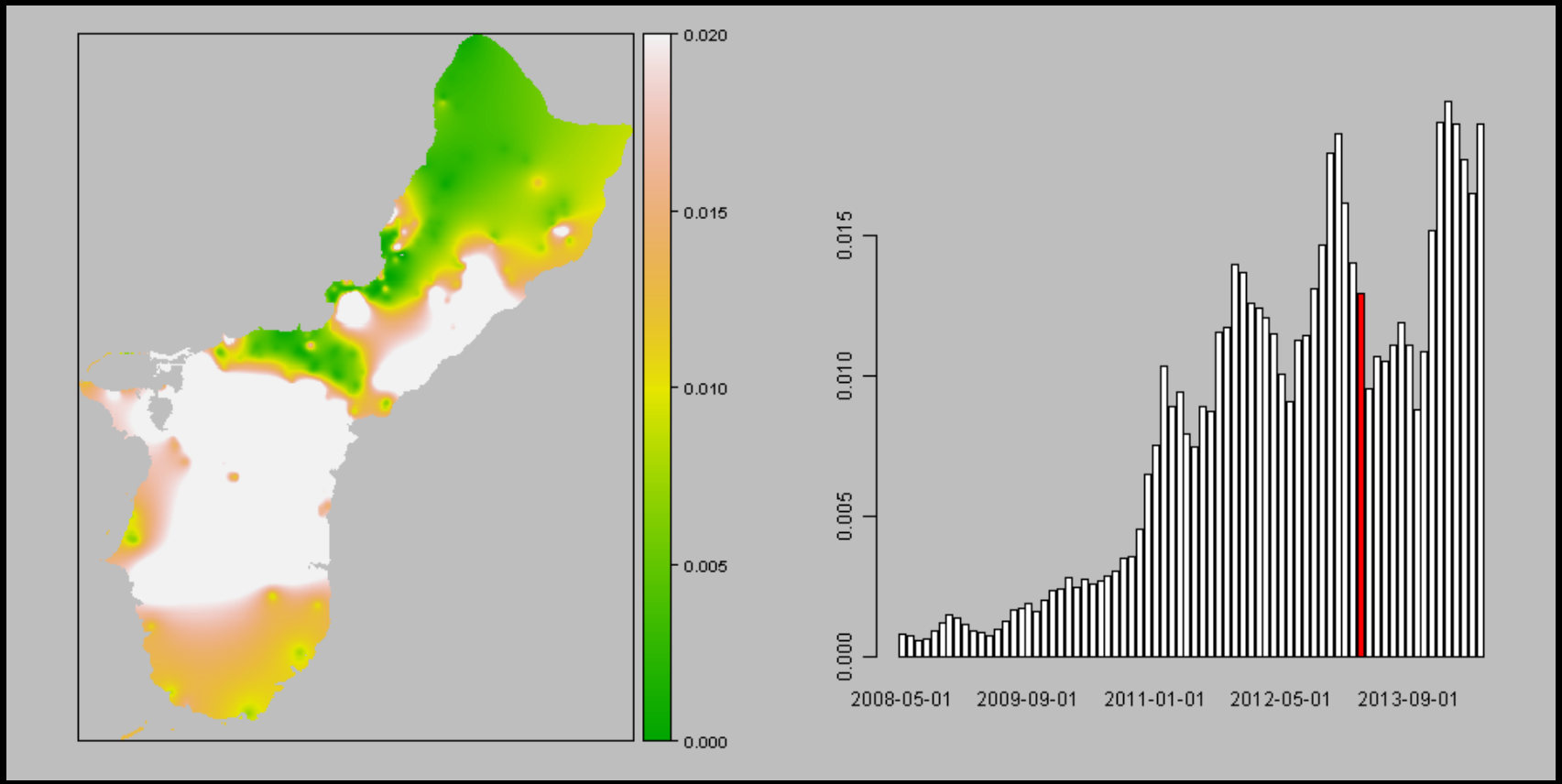
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2013



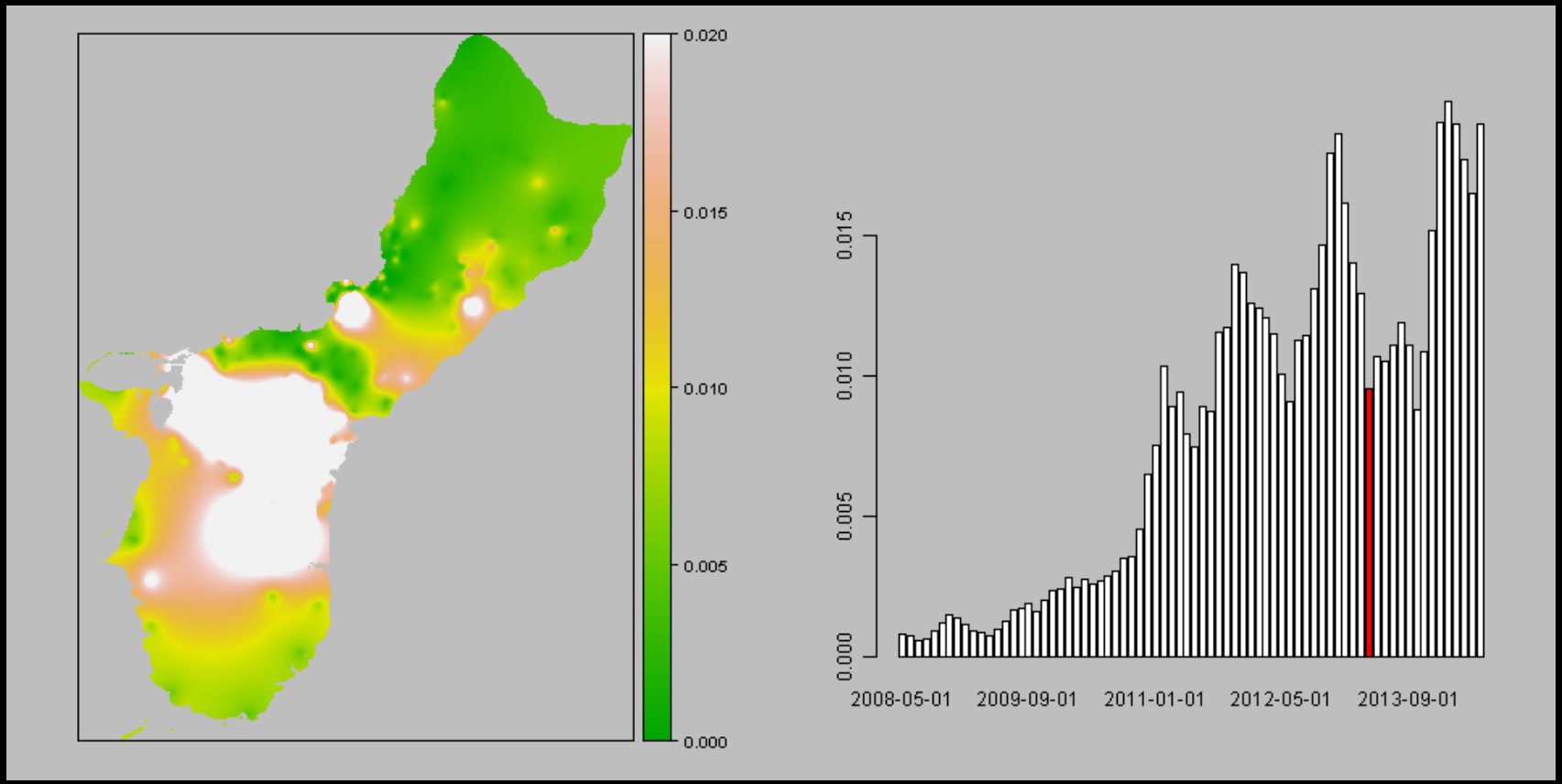
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2013



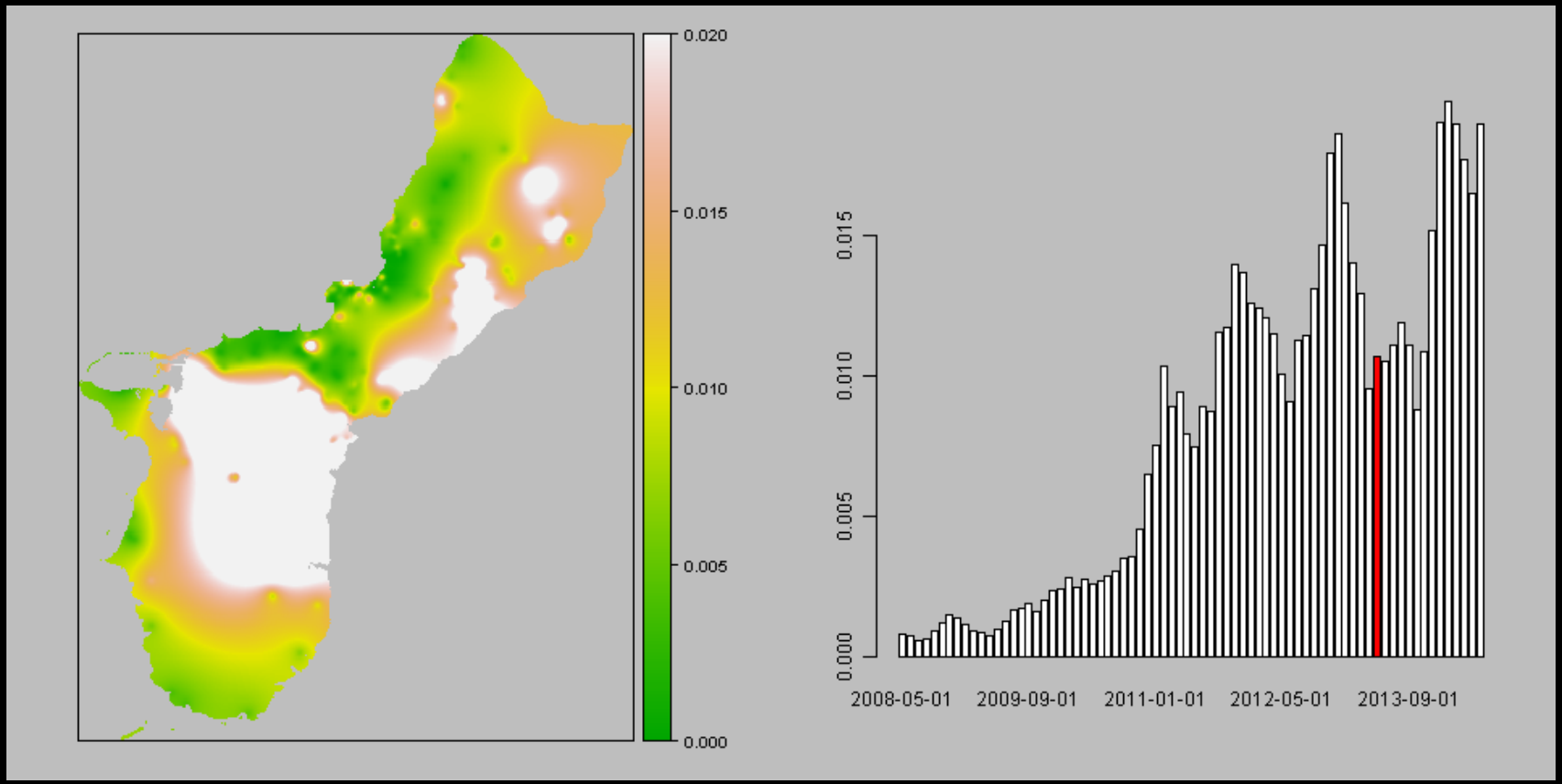
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2013



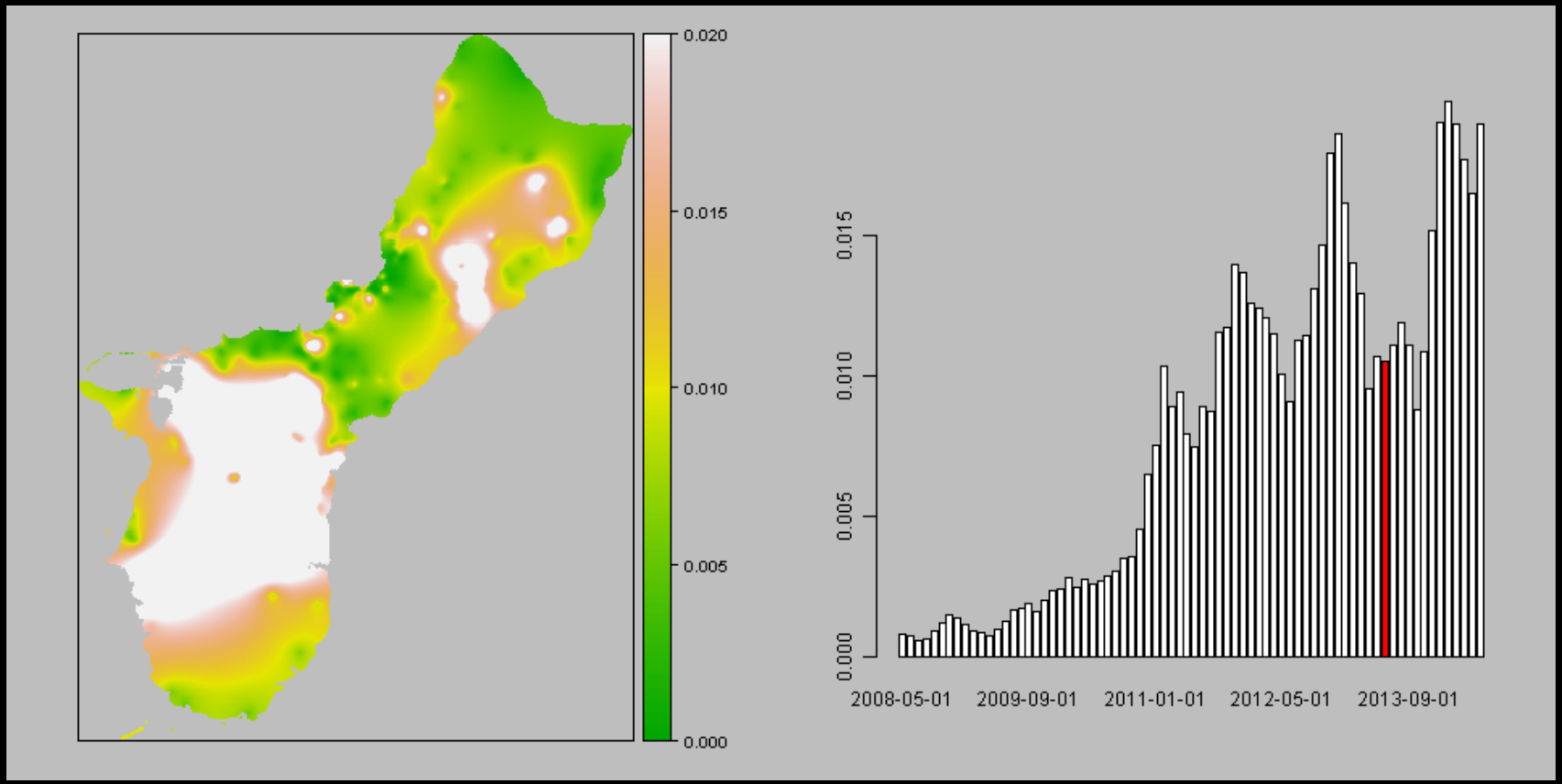
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2013



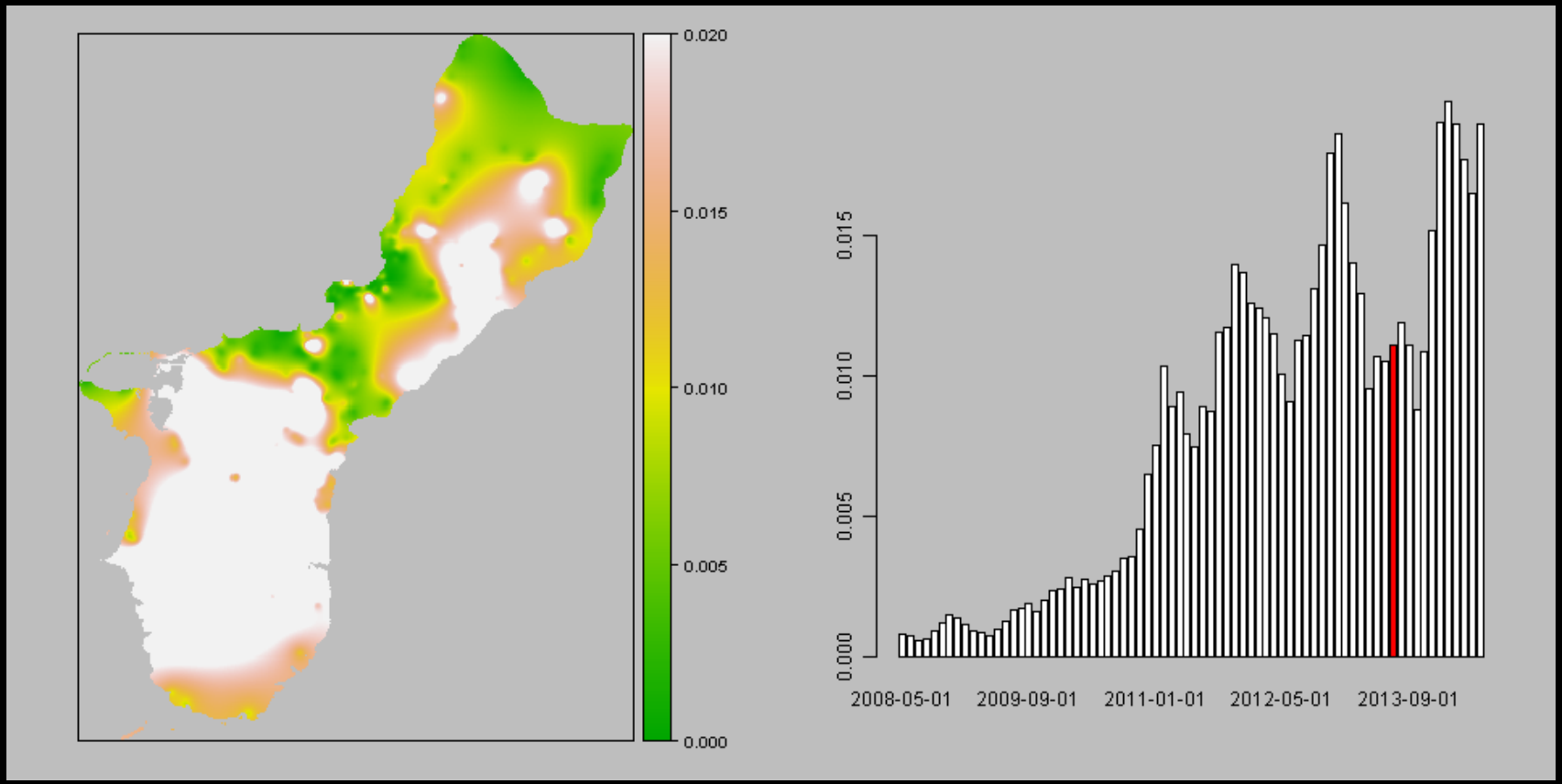
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2013



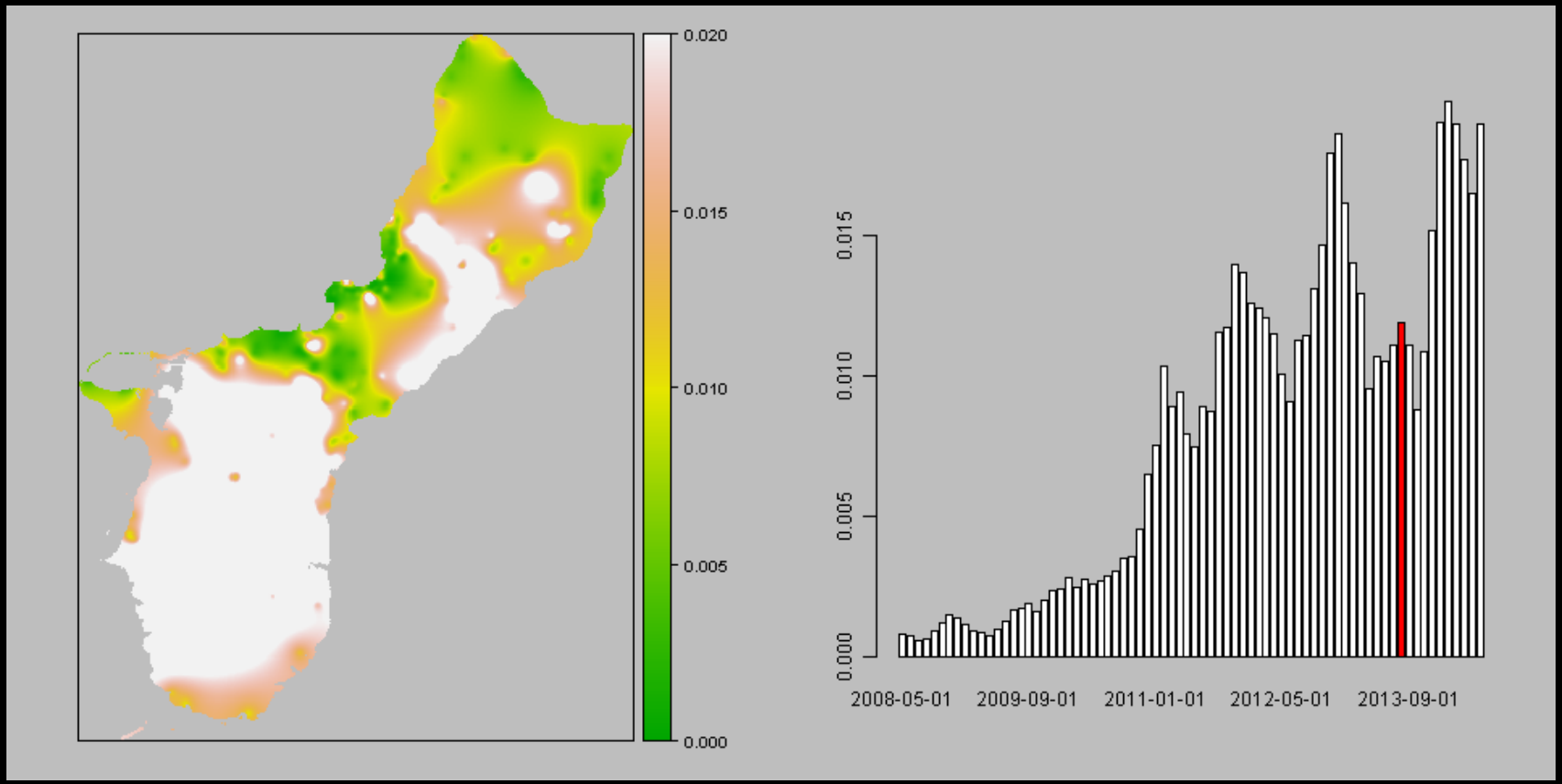
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jul 2013



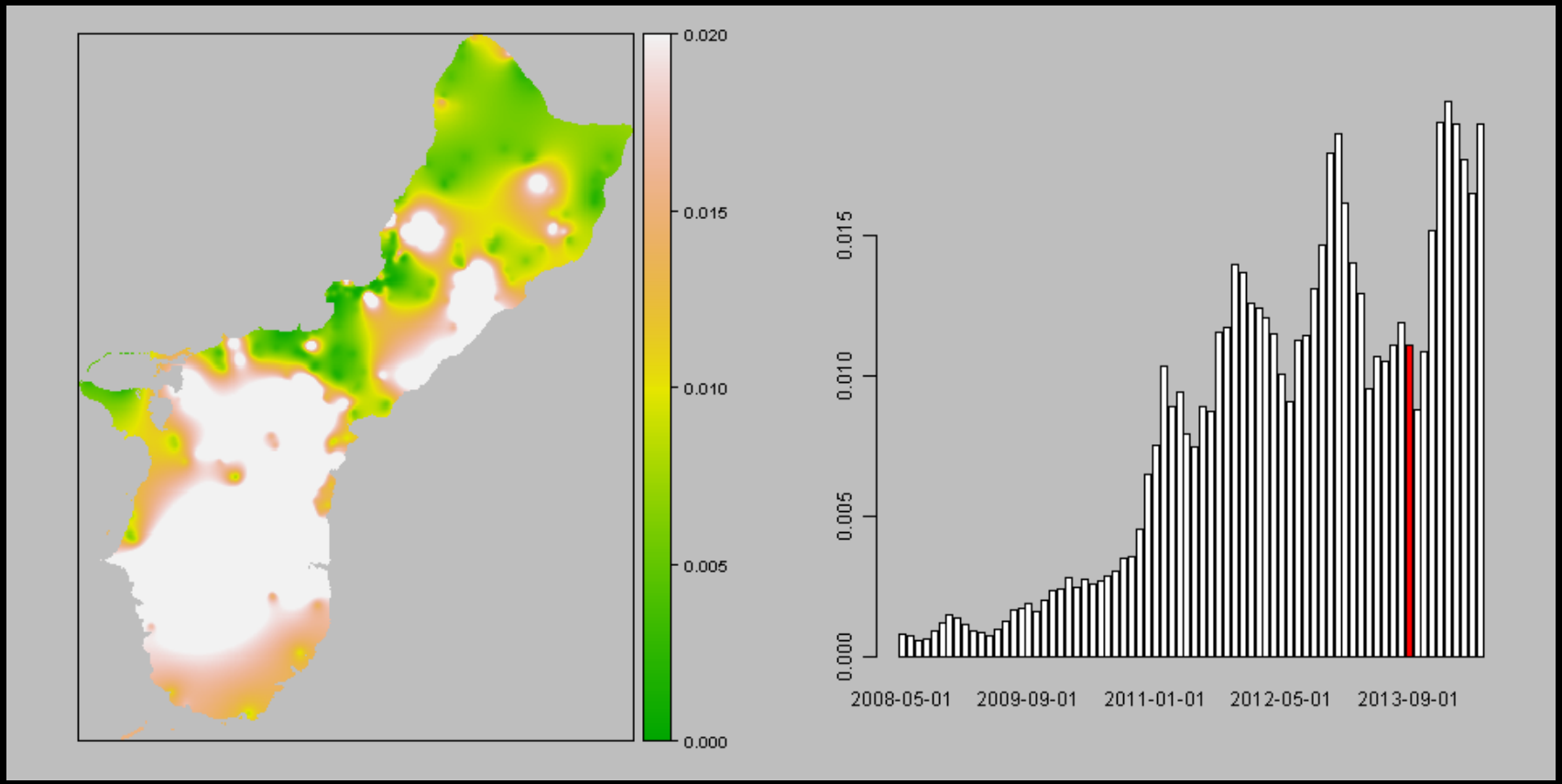
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Aug 2013



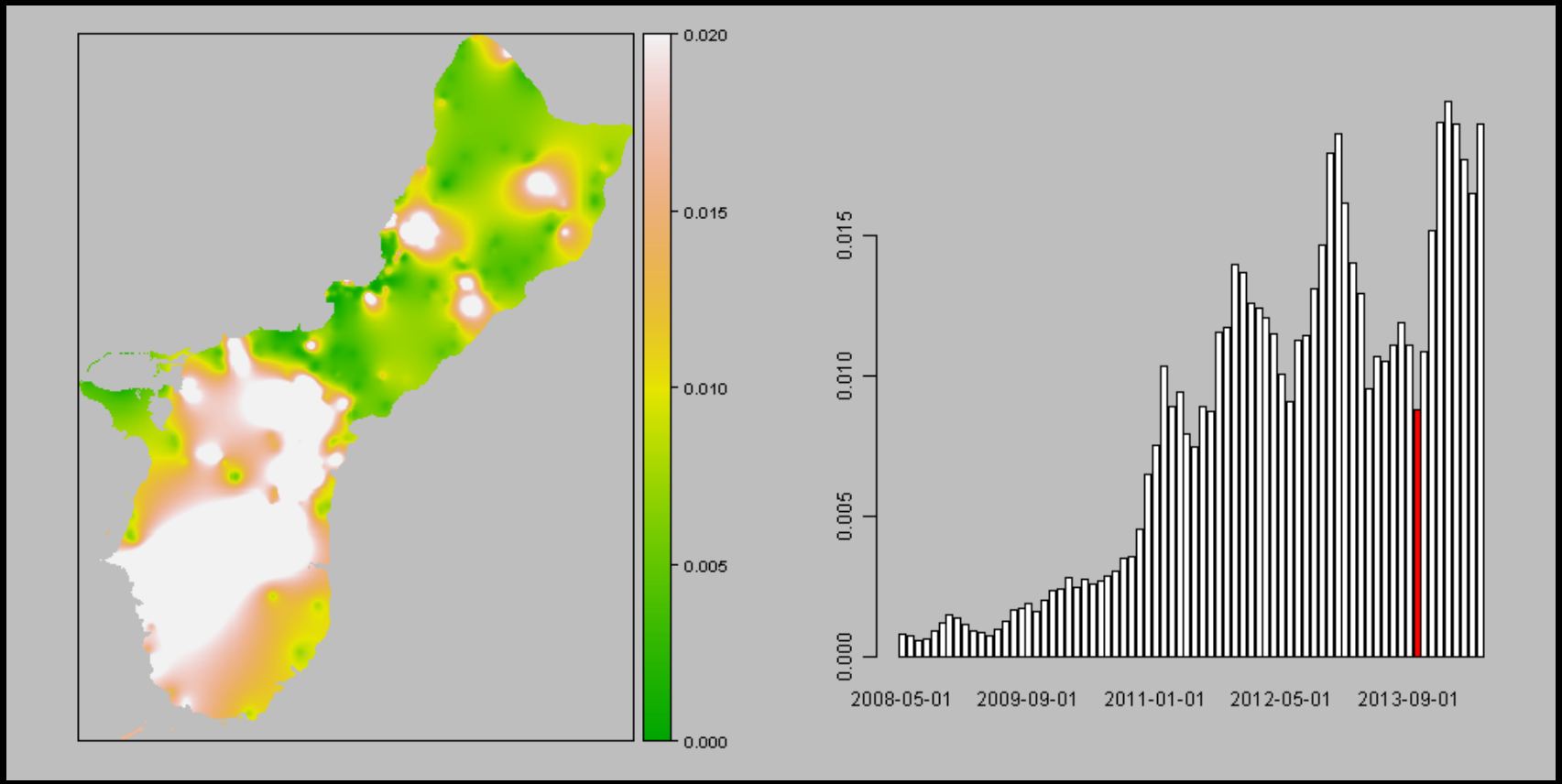
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Sep 2013



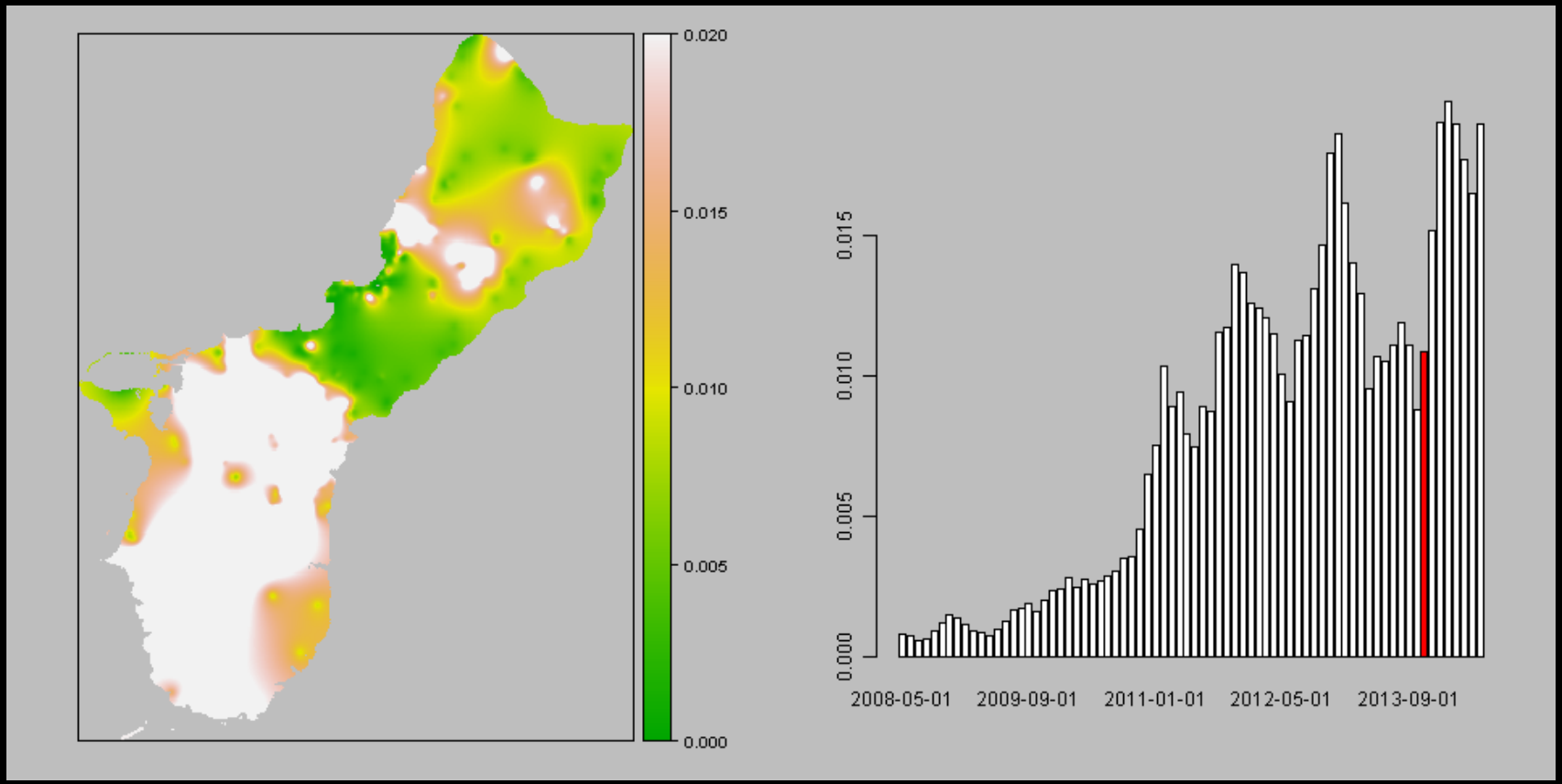
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Oct 2013



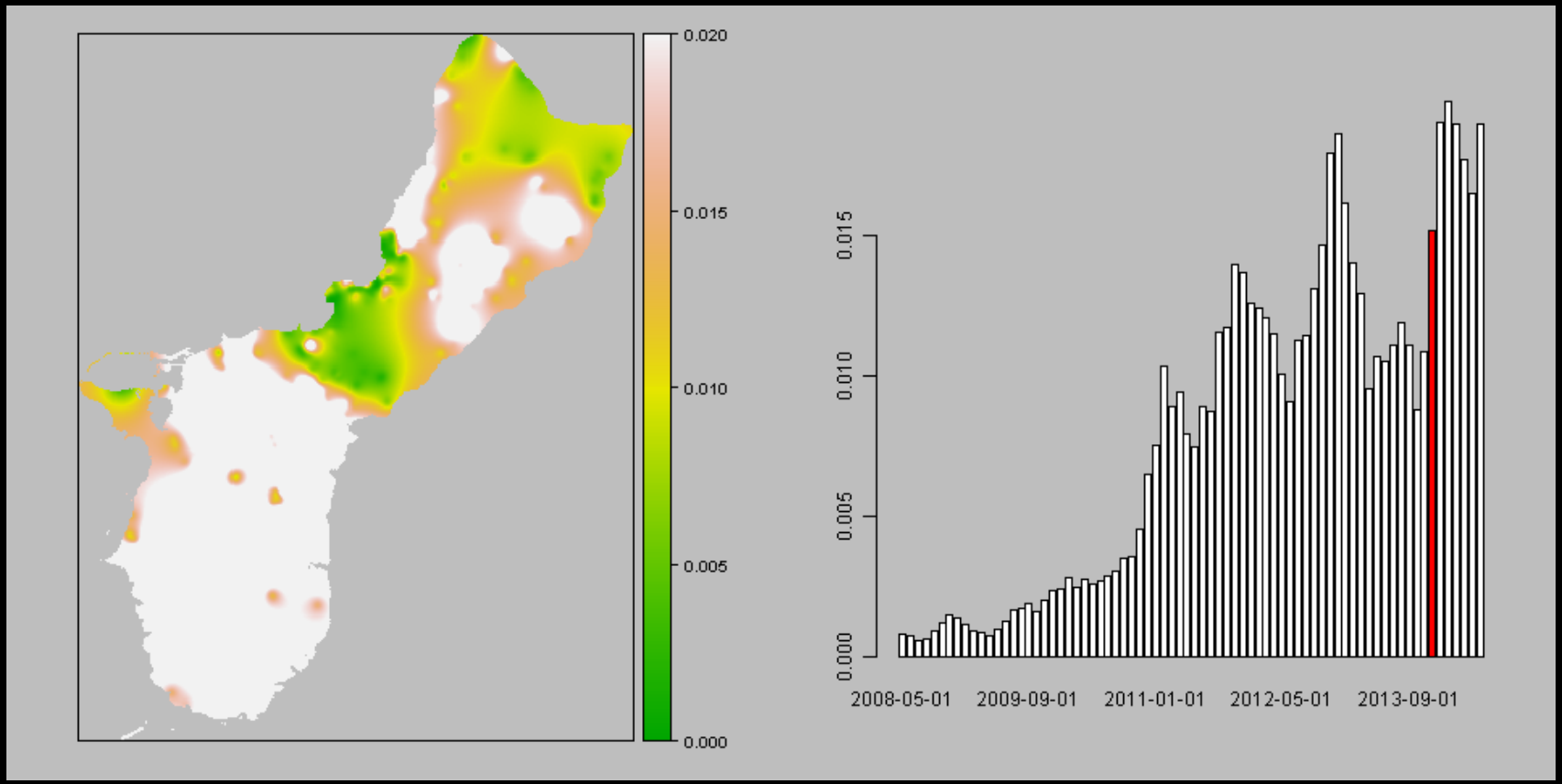
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Nov 2013



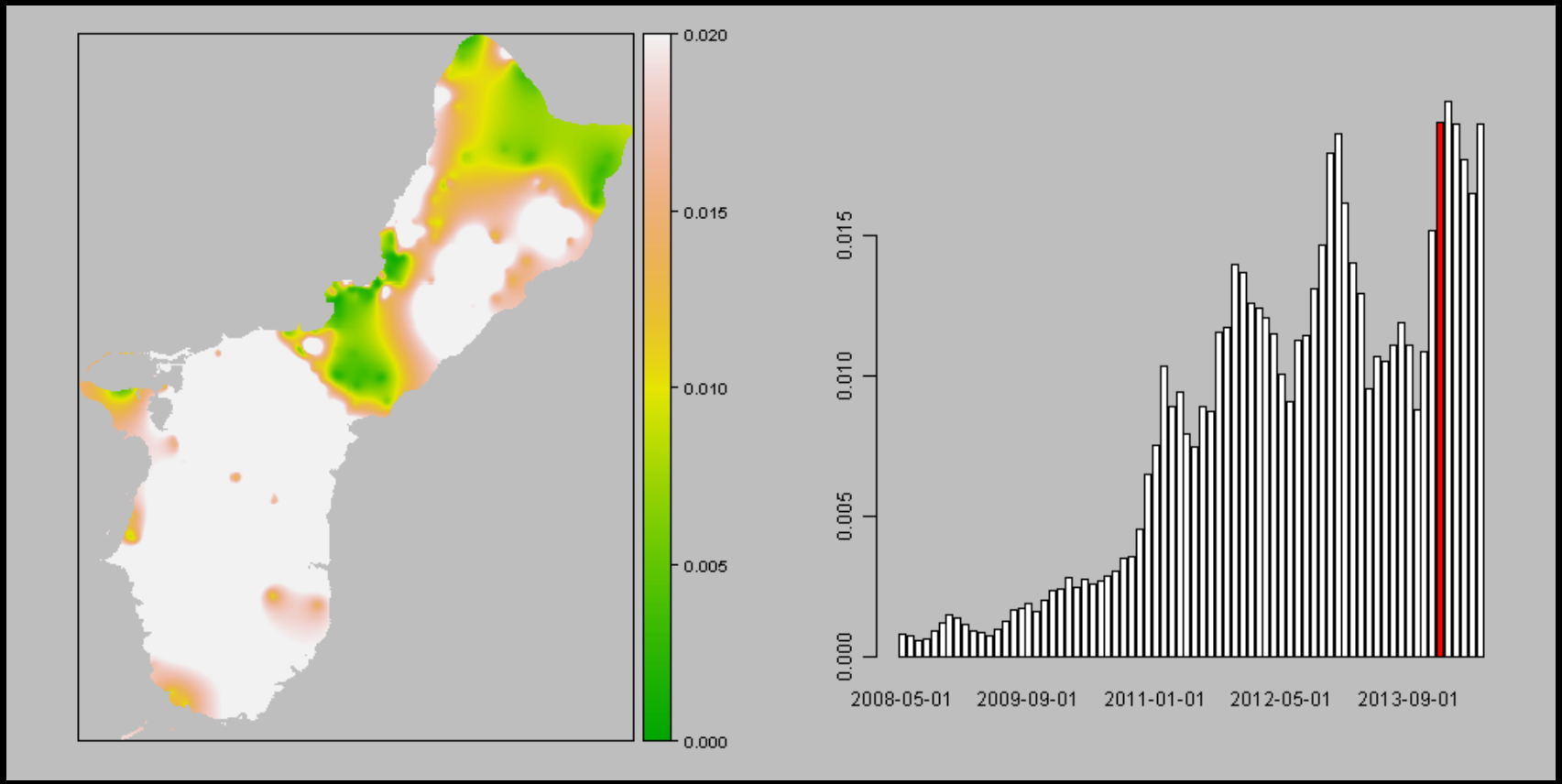
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Dec 2013



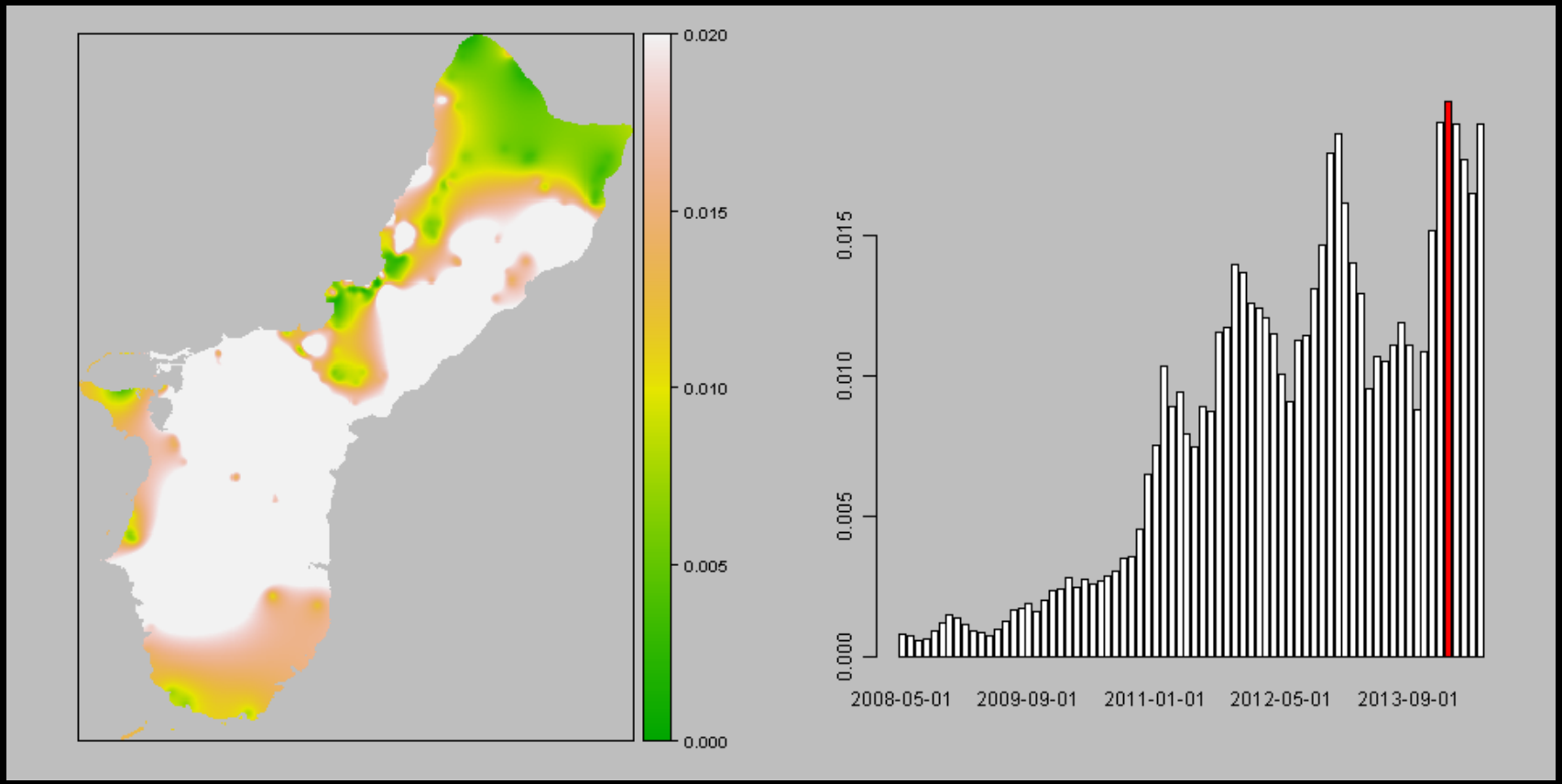
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jan 2014



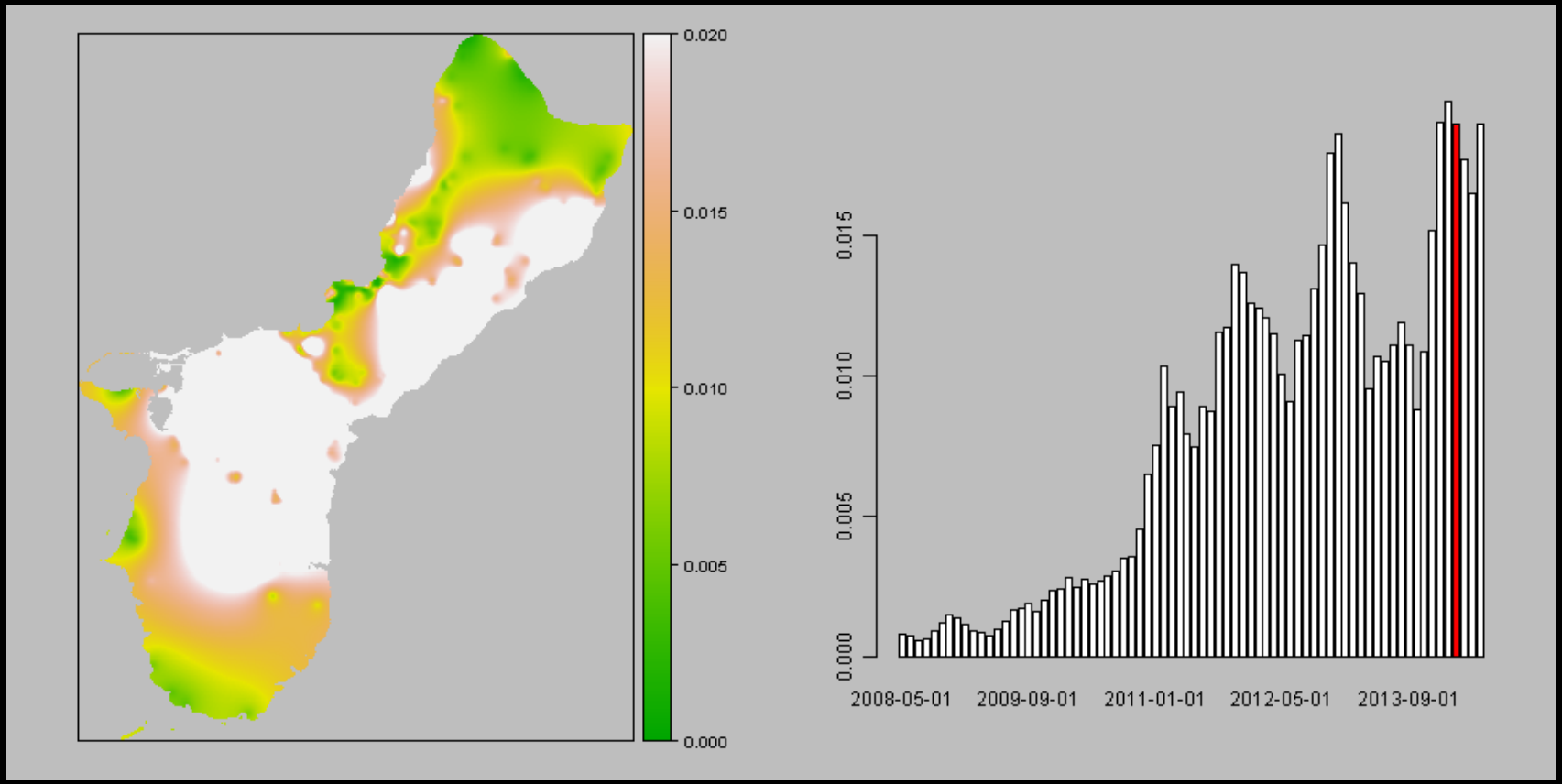
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Feb 2014



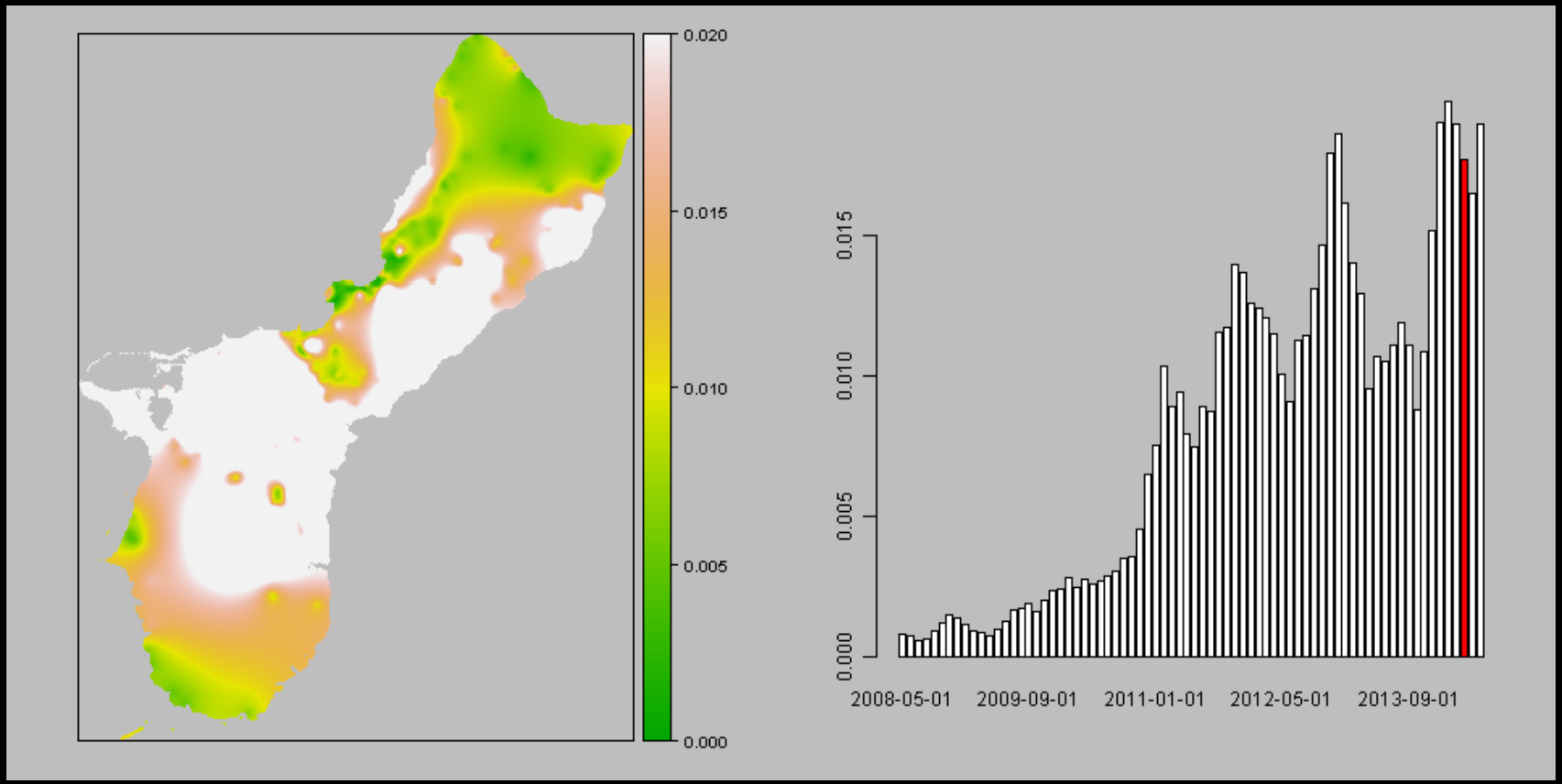
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Mar 2014



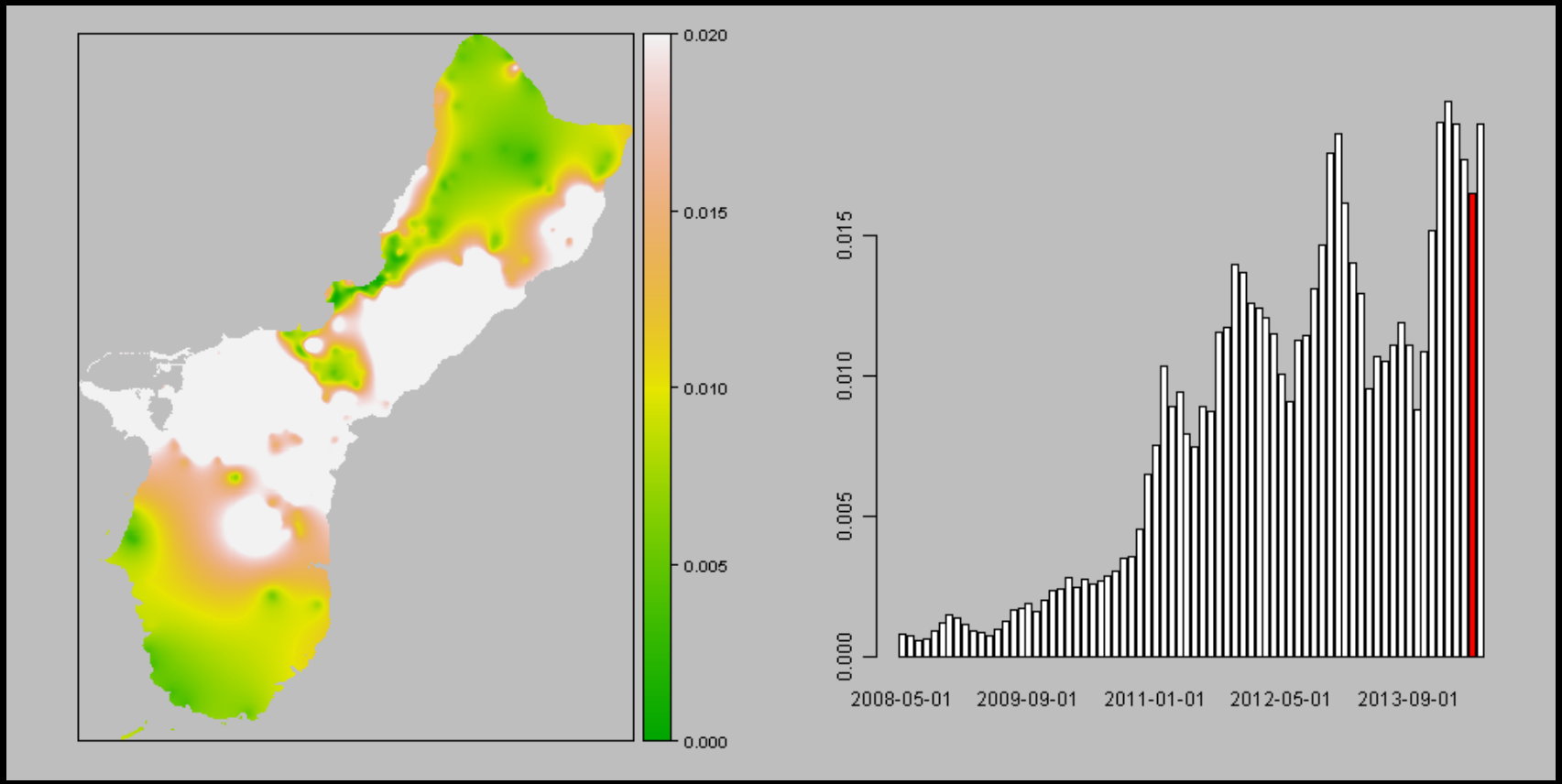
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Apr 2014



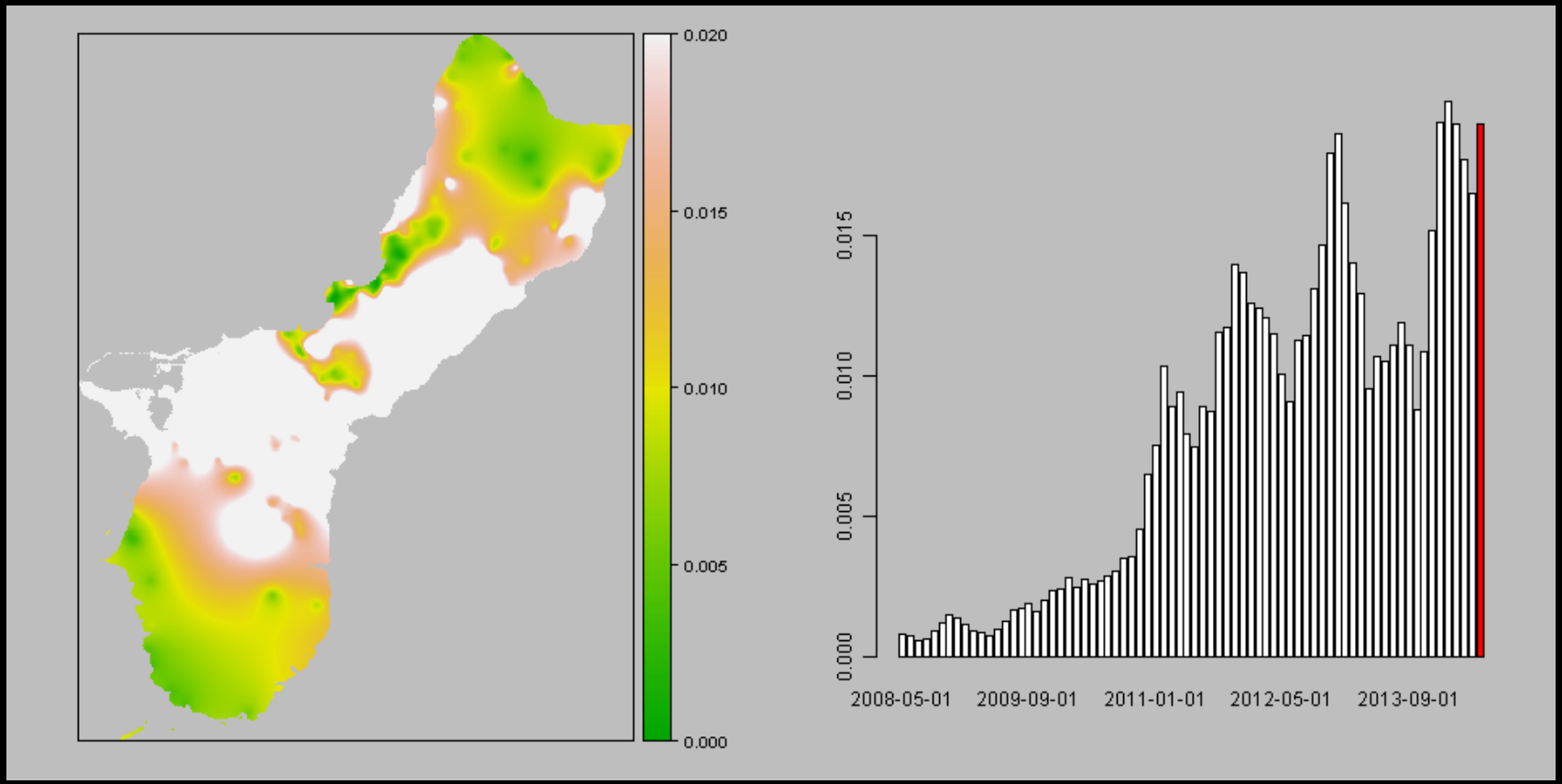
Mean number of beetles caught per trap-day

90 day trapping period ending on 01 May 2014



Mean number of beetles caught per trap-day

90 day trapping period ending on 01 Jun 2014



Mean number of beetles caught per trap-day

Sanitation

Sanitation

Novel CRB Behavior on Guam: Arboreal Development

CRB extracted from the crowns of 121 felled coconut palms

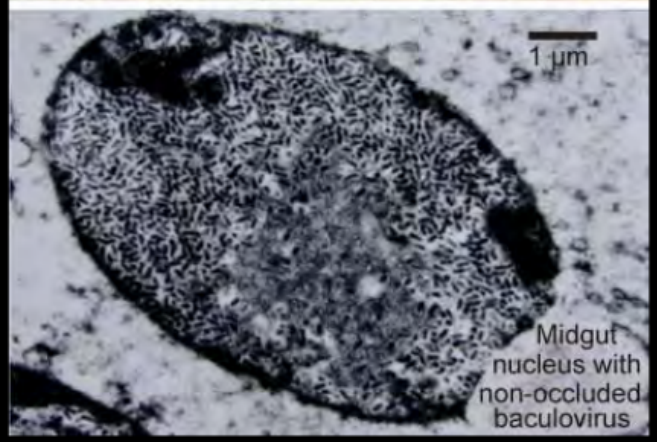
Eggs	99
L1	40
L2	72
L3	210
Pupae	25
Adult males	34
Adult females	30
Total	**510**
Mean per tree	**4.21**

DETECTOR DOGS


CHEMICAL
CONTROL

BIOCONTROL


2 cm
Palm rhinoceros beetle


1 µm
Midgut nucleus with non-occluded baculovirus

Failure Analysis of the Guam CRB Eradication Project

[Simberloff(2002)] proposed criteria for successful eradications:

1. Sufficient economic resources must exist for the project to be completed
2. Clear lines of authority must exist; someone must be in charge and must be able to compel cooperation
3. The biology of the target organism must be adequately researched and appropriate.
4. For many but not all eradication attempts, probability of rapid re-invasion must be low for success to ensue.

Economic Resources

- Although Guam had a draft rapid response plan for invasive species, there was no emergency funding available.
- There was a delay of several months while grant proposals were prepared, evaluated, and funded
- Money granted to Guam DOA was not readily available due to GovGuam fiscal procedures
- The Guam Ag Director asked the University of Guam to take over project management (fiscal, staffing, procurement)
- The project has been funded by many relatively small short-term grants from USDA APHIS, US Forest Service, and GovGuam Legislature.

Organizational Capabilities

- APHIS grants required us to run the project using the Incident Command System (weekly planning meetings, weekly conference calls)
- All ICS staff worked on the project part-time: UOG(2-3), APHIS(2-3), Guam Ag (1-2)
- All project staff (6-15) were short term UOG hires paid from multiple grants

Biological Knowledge

- Biological knowledge for CRB is relatively low when compared to what is known about other major pests.
- Lures and trapping methods are ineffective for population suppression and not very good for detection and surveillance.
- Available insecticides are not very effective.
- The Guam CRB population behaves differently:
  - it is able to go through its whole life cycle in arboreal breeding sites
  - it is genetically different from the pan-Pacific population
  - it is apparently resistance to Oryctes nudivirus.

Conclusions

- There is no single failure point.
- CRB could have been detected sooner.
- Lack of funds and manpower for an emergency response delayed project start up by at least 6 months, during which the CRB population increased and spread.
- CRB on Guam is a good example of the *escape from natural control*:
  - Abundant food and breeding sites in the form of large piles of rotting vegetation from typhoons
  - Few vertebrate predators (rats, birds, etc.)
  - No pathogens.
- Available tools for suppressing the Guam CRB population are weak and may be insufficient for driving the population to extinction, even when used optimally and in concert.

References I

Daniel Simberloff.
Today tiritiri matangi, tomorrow the world! are we aiming too low in invasives control.
Turning the tide: the eradication of invasive species, pages 4–12, 2002.
URL http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB0QFjAA&url=http%3A%2F%2Fwww.issg.org%2Fdatabase%2Fspecies%2Freference_files%2FTurTid%2FSimberloff%2520Keynote.pdf&ei=UqP8VPbbLcj3oASx2YDACg&usg=AFQjCNG2ZFFOIgd7i7lgPlhzIb0VwKHqtQ&sig2=HTVn3O5AyB2RHVri58wTJA&bvm=bv.87611401,d.cGU.