

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

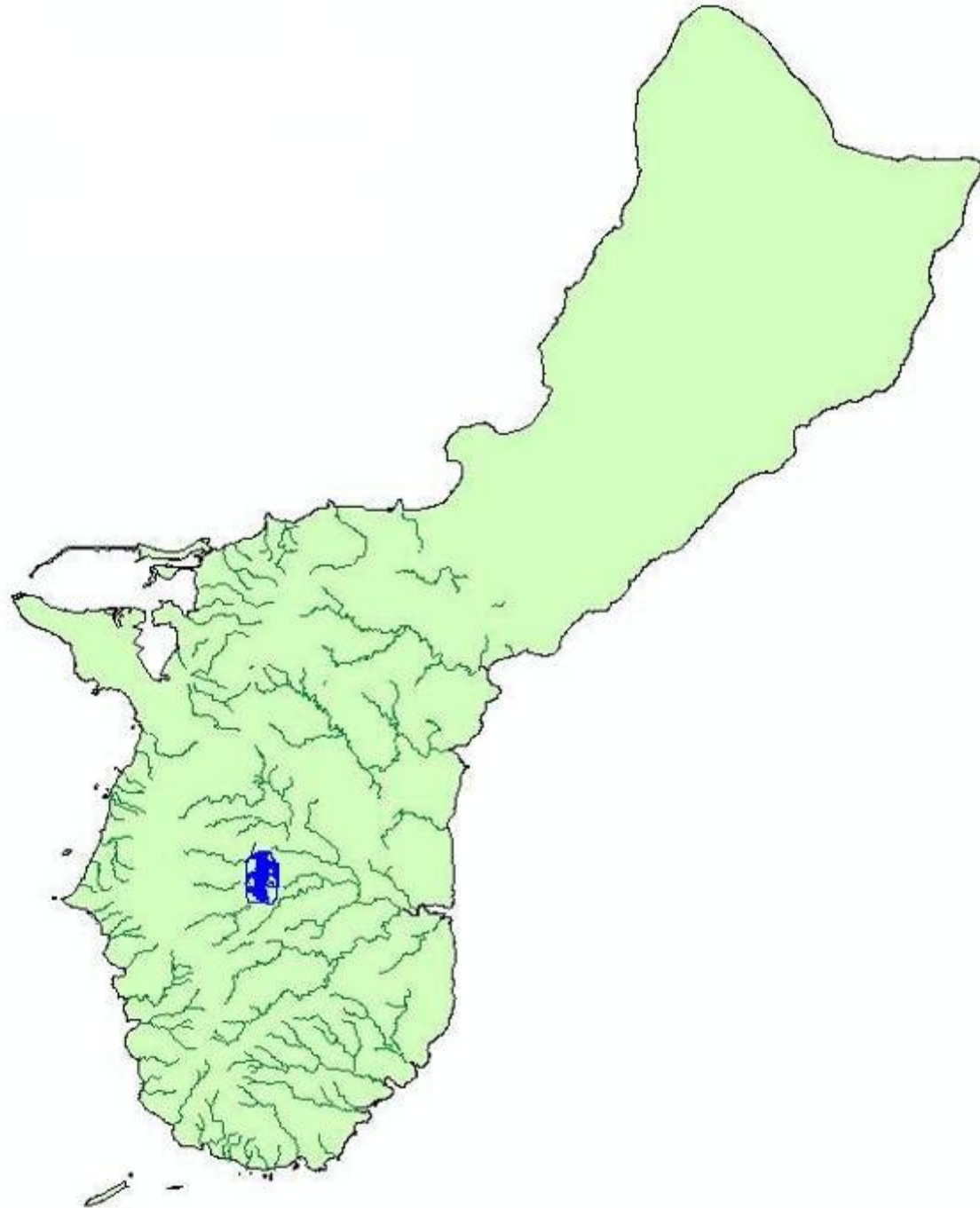
Guam's Physical Environment

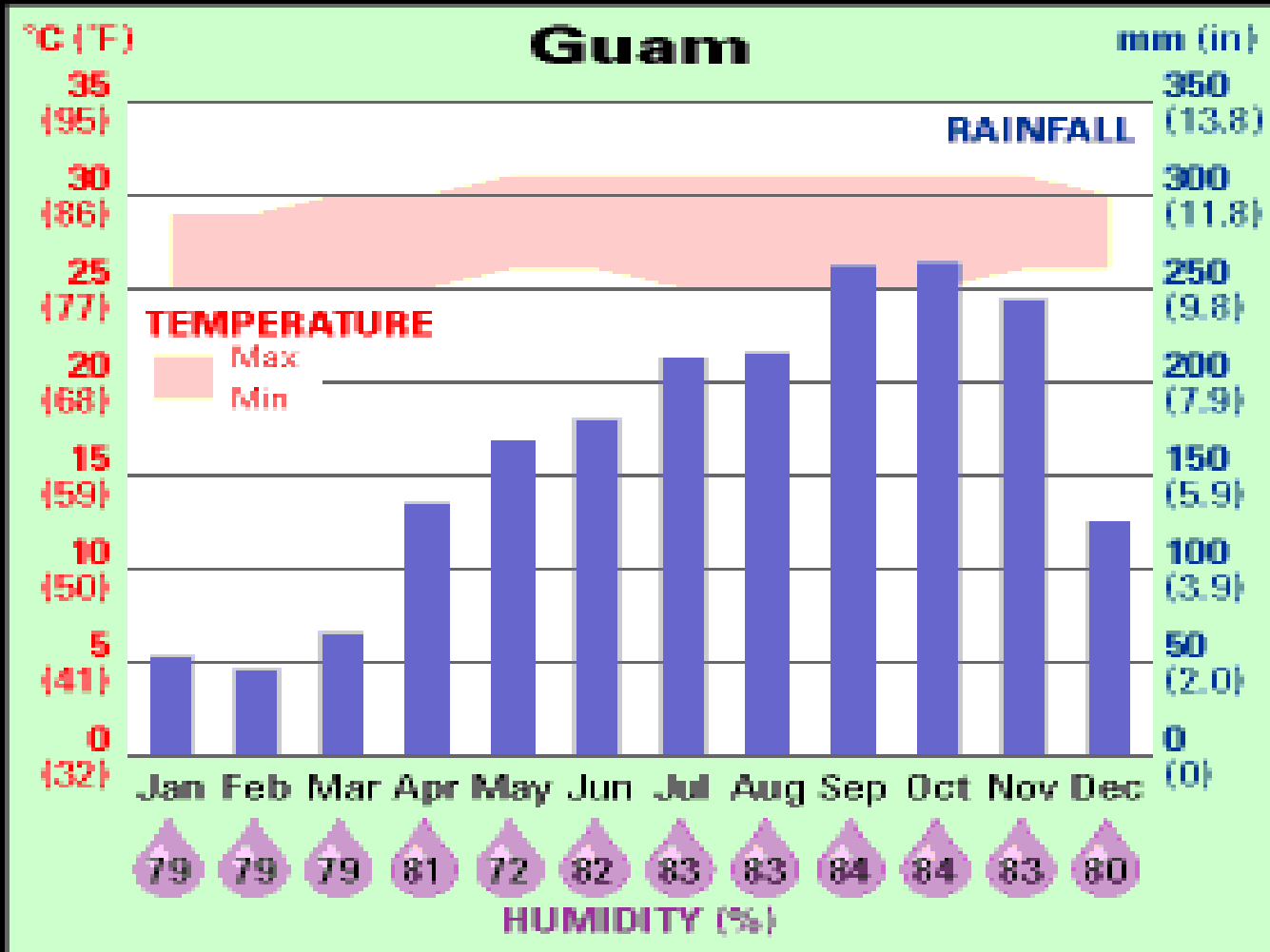
Age: 40 million years

Dimensions: 48 km
long; 6-9 km wide

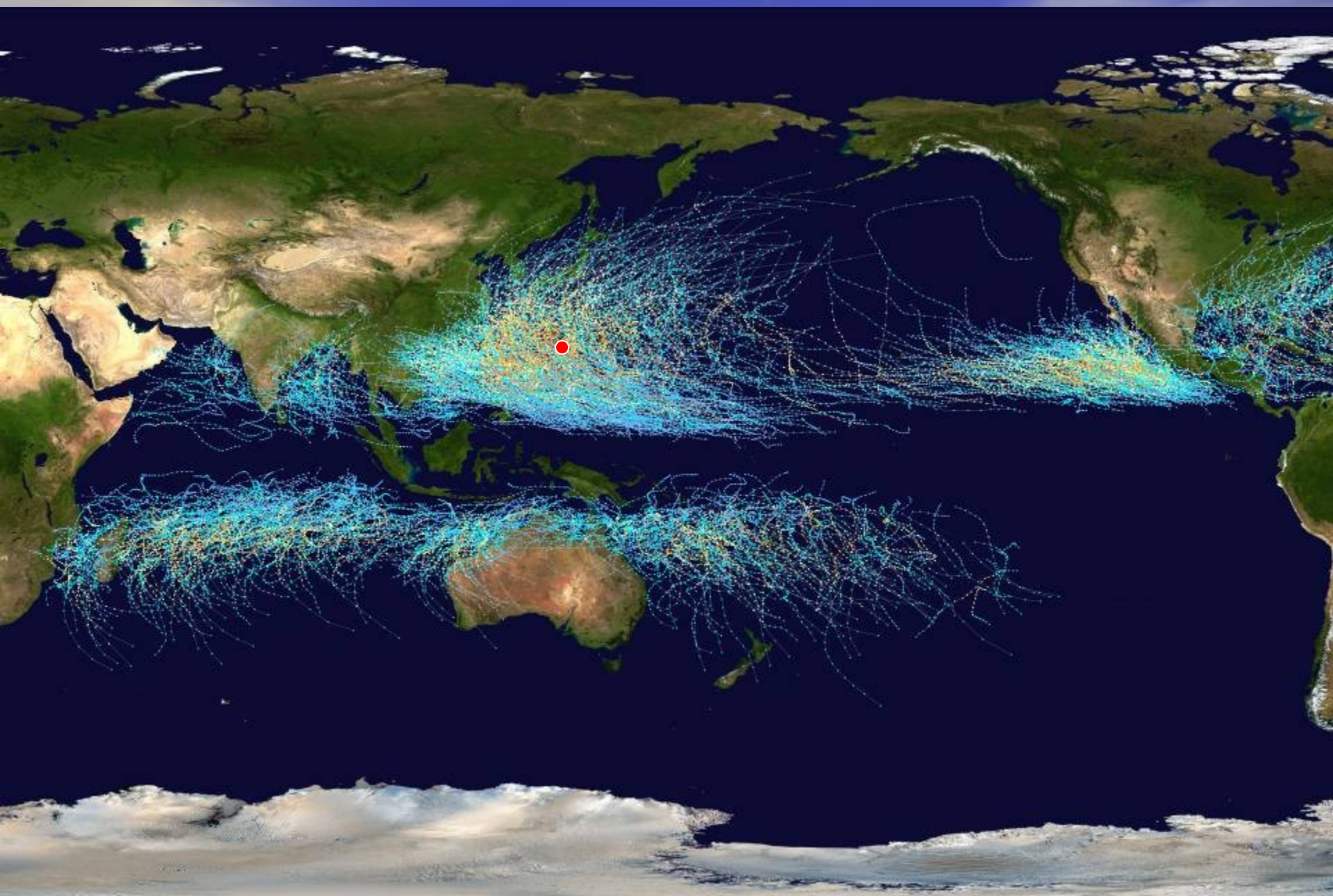
Area: 549 km²

Max. elevation: 407 m



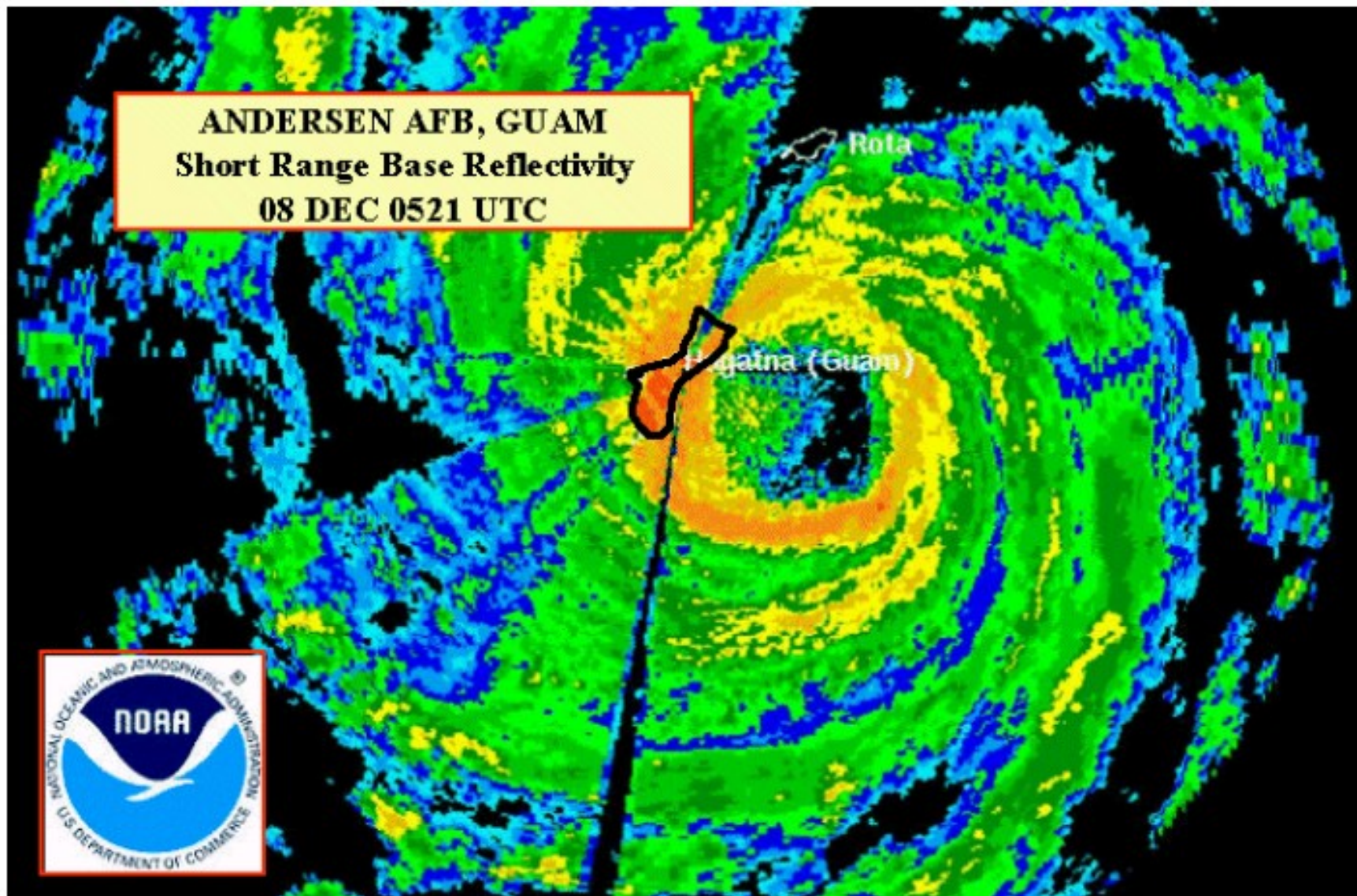


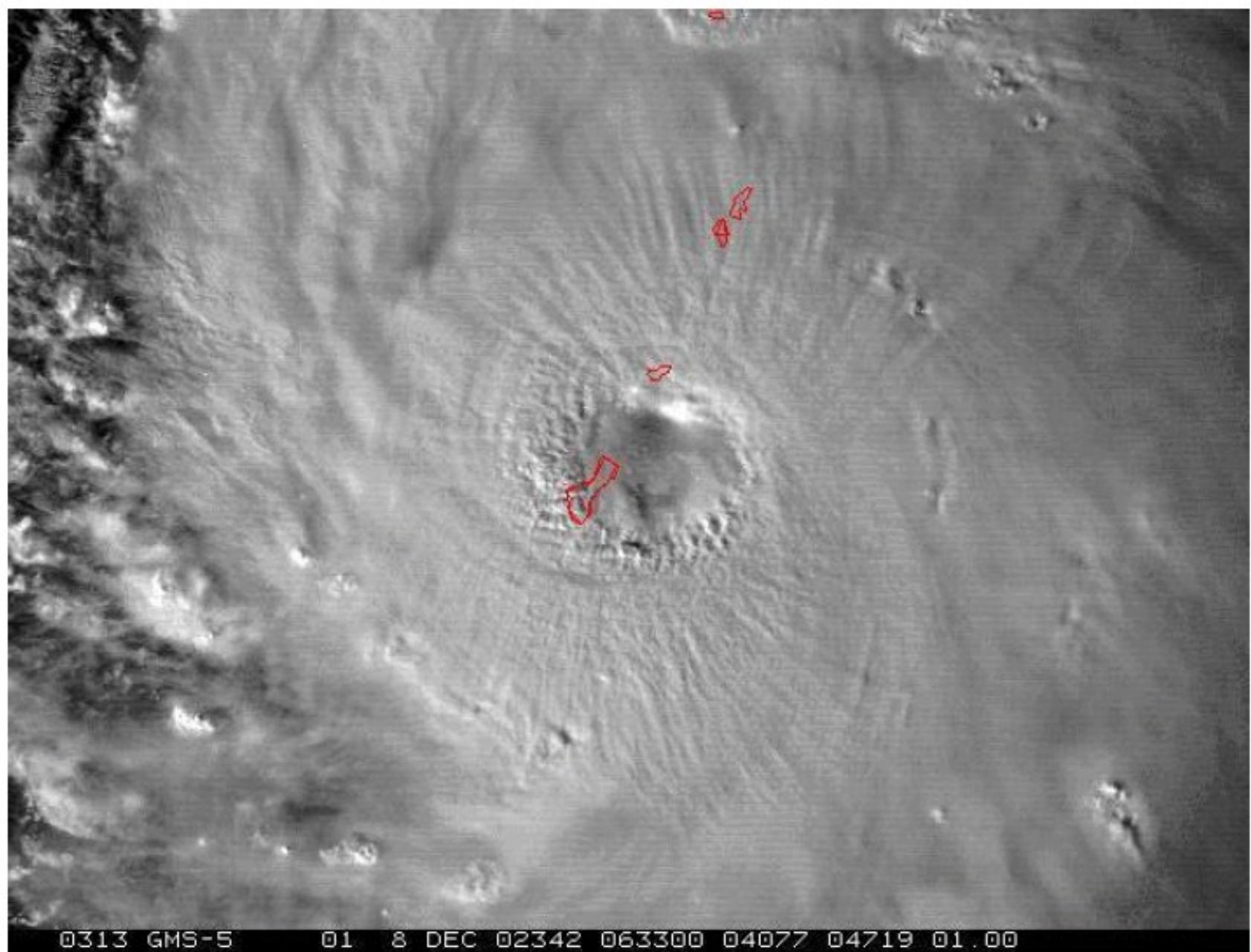
This map shows the tracks of all Tropical cyclones which formed worldwide from 1985 to 2005.



Super Typhoon Pongsona

December 8, 2002





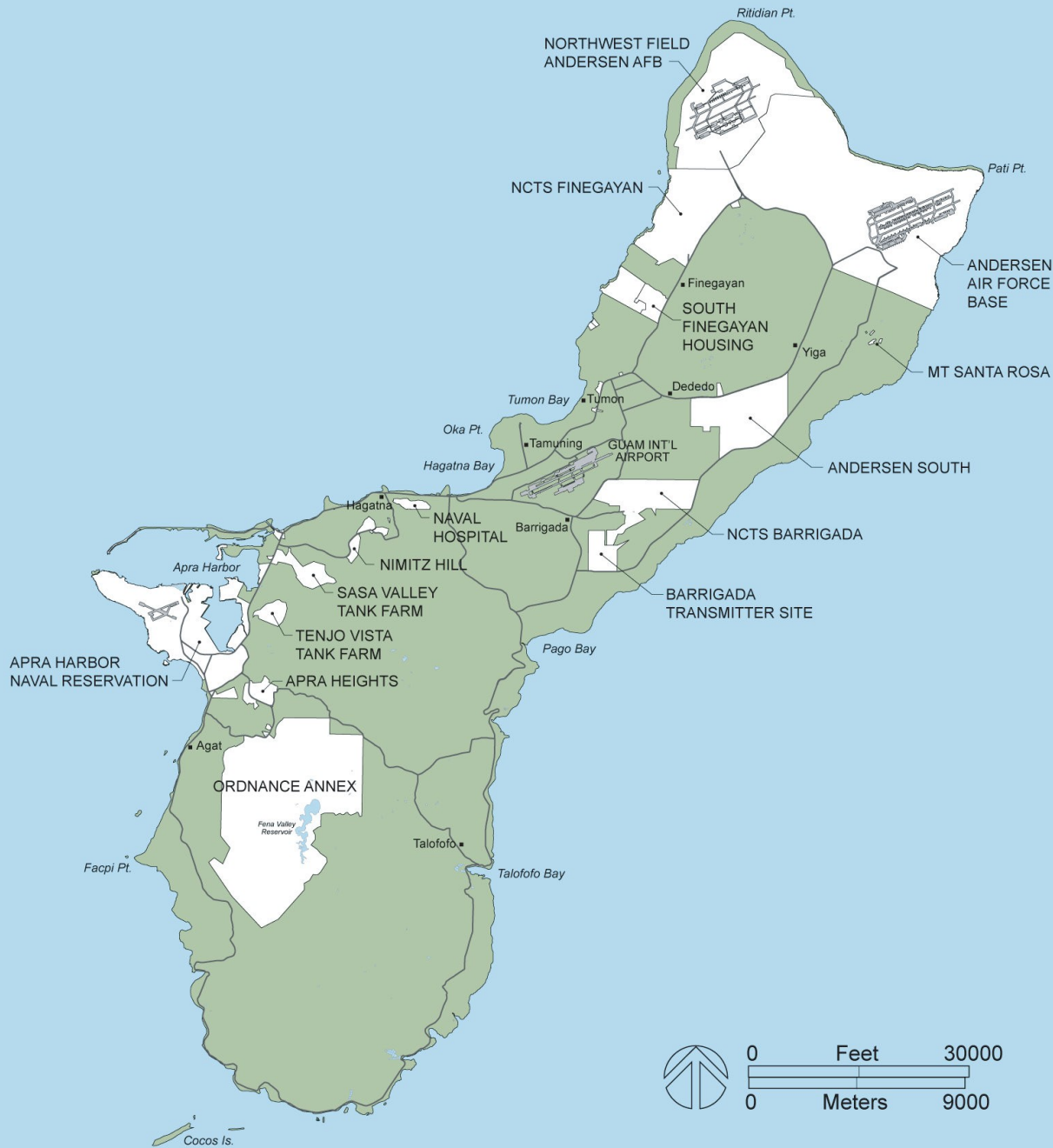
0313 GMS-5 01 8 DEC 02342 063300 04077 04719 01.00
Visible satellite image of Pongsona as seen by the Japanese Geostationary Meteorological Satellite (GMS-5) at 4:30 p.m., December 8, 2002. The island of Rota is located just north of the eye. (Courtesy of the Wisconsin Co-operative Institute for Meteorological Satellite Studies)



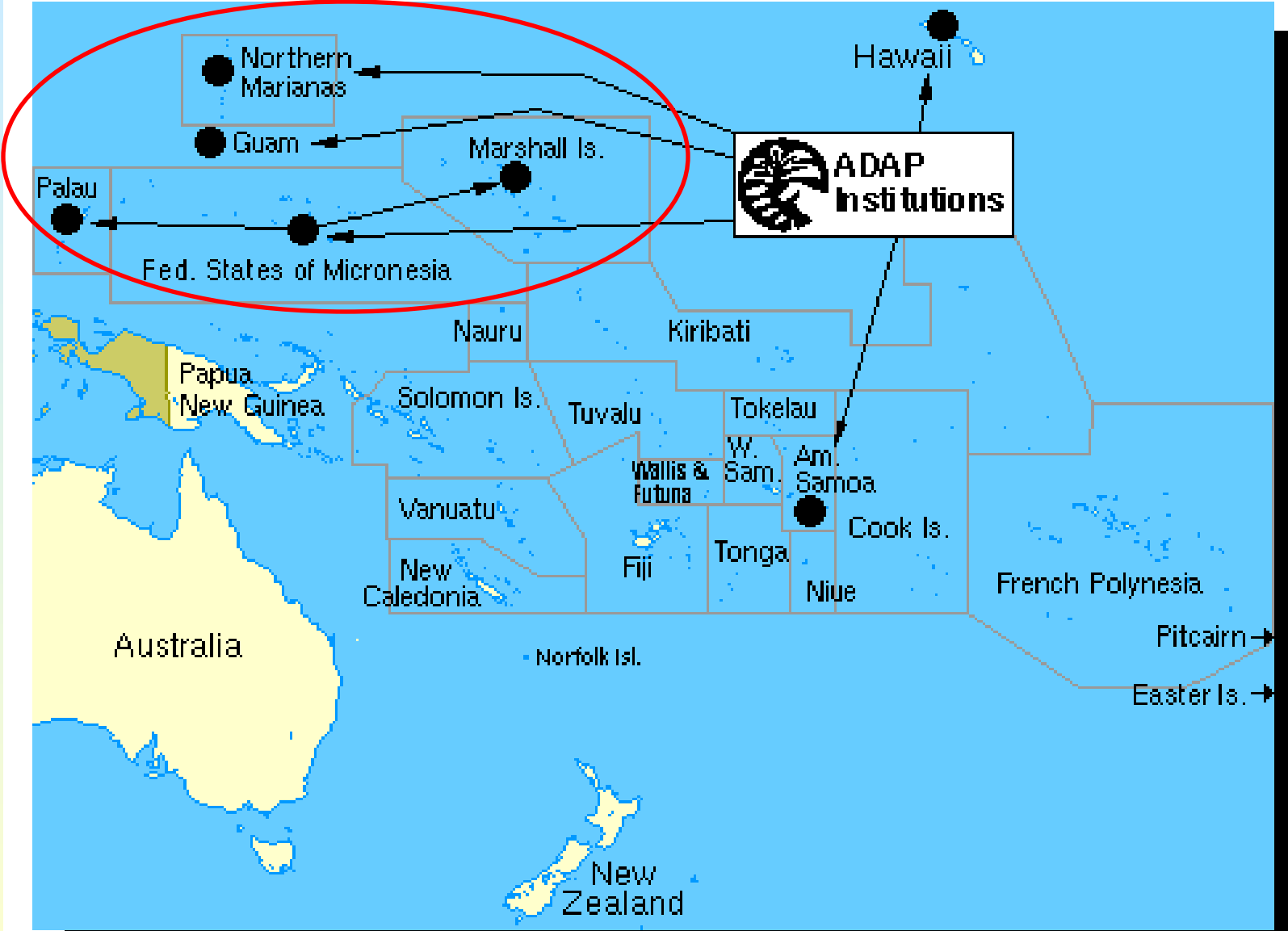


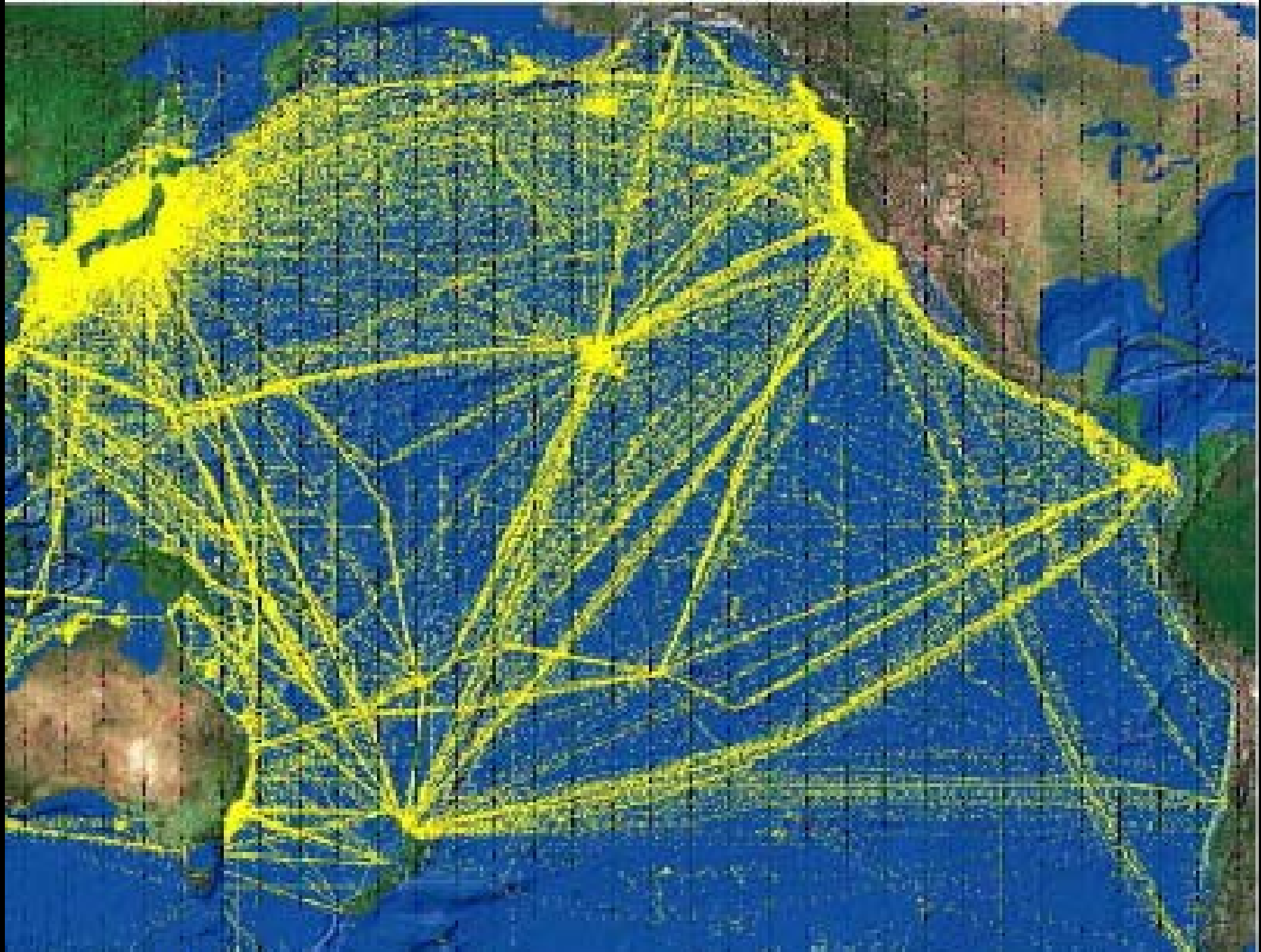
History of Guam

- 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.

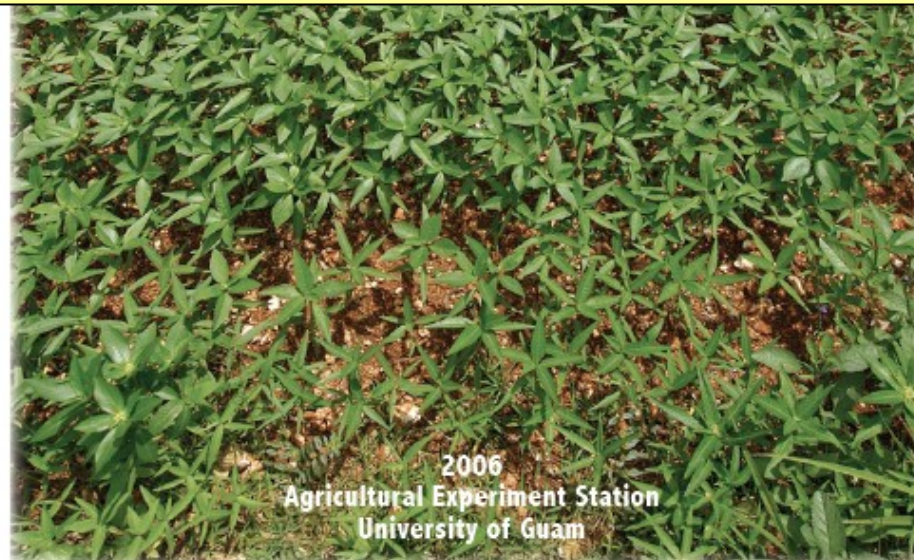
Much ecological and environmental damage is done when newly arrived species undergo an initial population explosion because:

- 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



Weed #B2





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

Point: 13°26'18.00" N, 144°29'27.27" E

Streaming 100%

Eye alt: 21665 ft



Image © 2007 DigitalGlobe

© 2005

Google

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

Streaming ||||| 100%

Eye alt 2268 ft



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

Image © 2007 DigitalGlobe

Streaming ||||| 100%

© 2005 Google

Eye alt 2848 ft



Image © 2007 DigitalGlobe

© 2005 Google

Point: 12°27'52.98" N, 144°28'52.25" E

Streaming: 100%

Eye alt: 6044 ft



Image © 2007 DigitalGlobe

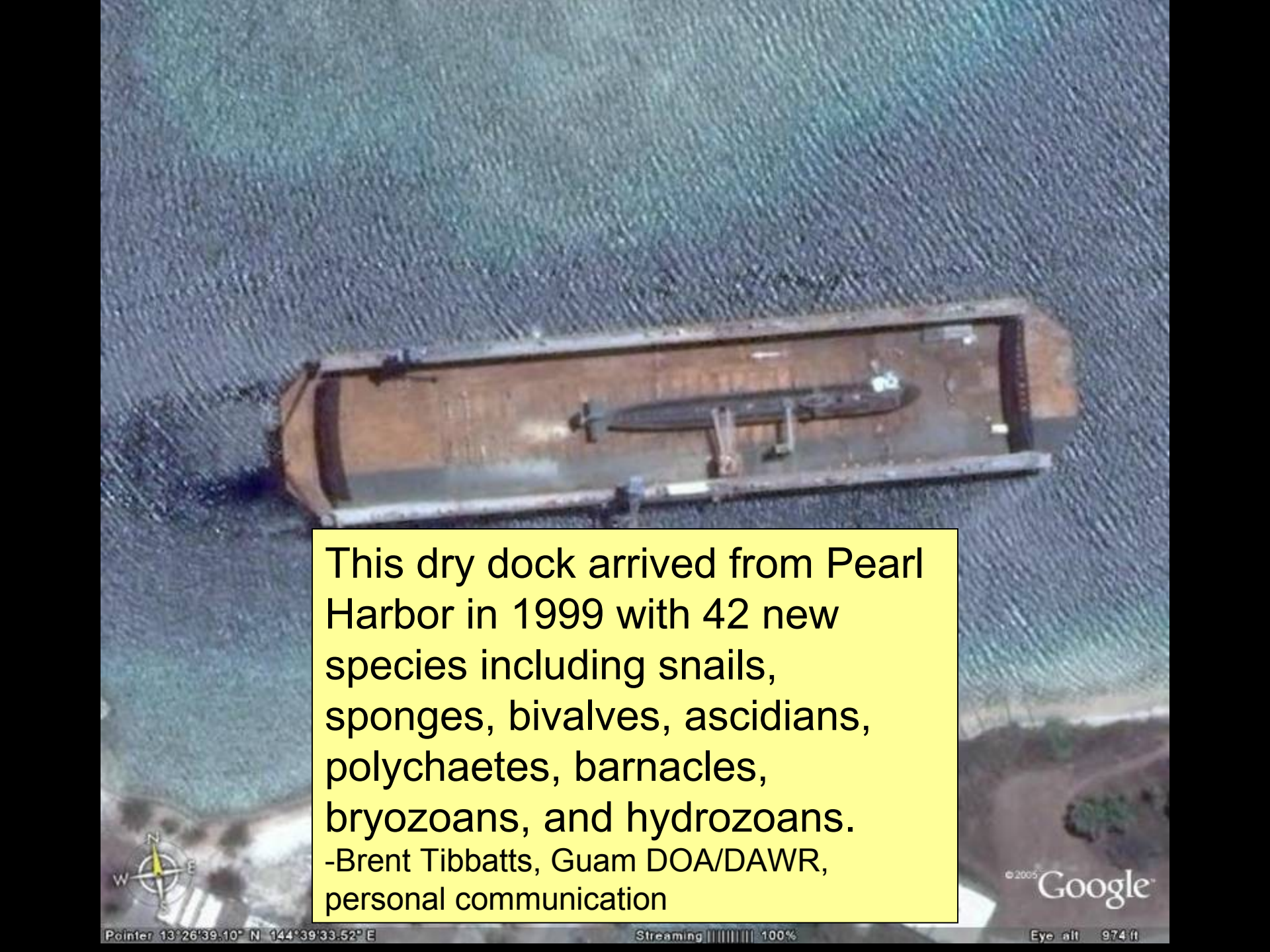
© 2005 Google

Point: 42°26'44.41" N, 144°27'49.71" E

Streaming: 100%

Eye alt: 1662 ft





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



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>Myloccerus 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?

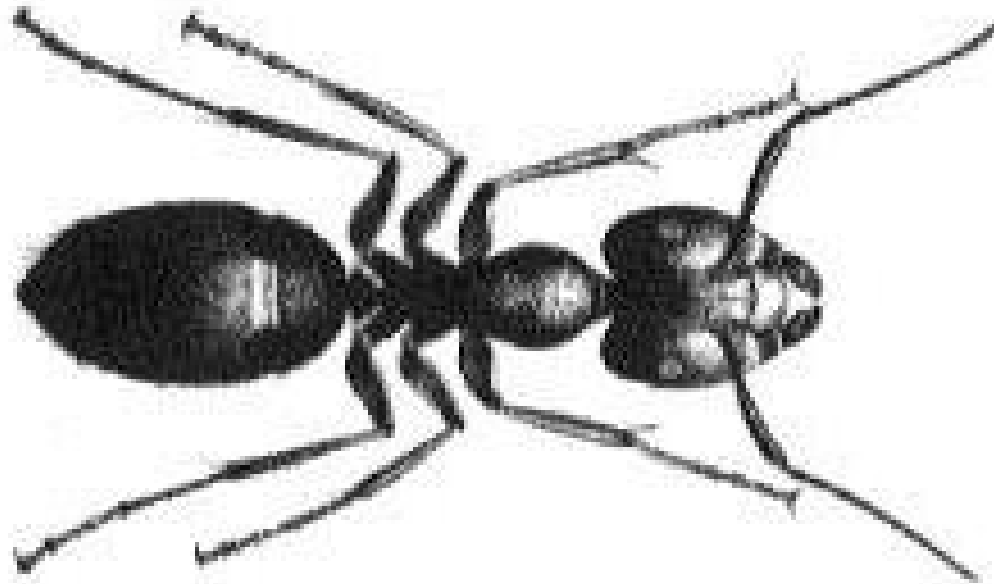
(The order Hemiptera include scales, mealybugs, whiteflies, aphids, psyllids, leafhoppers)

- 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.

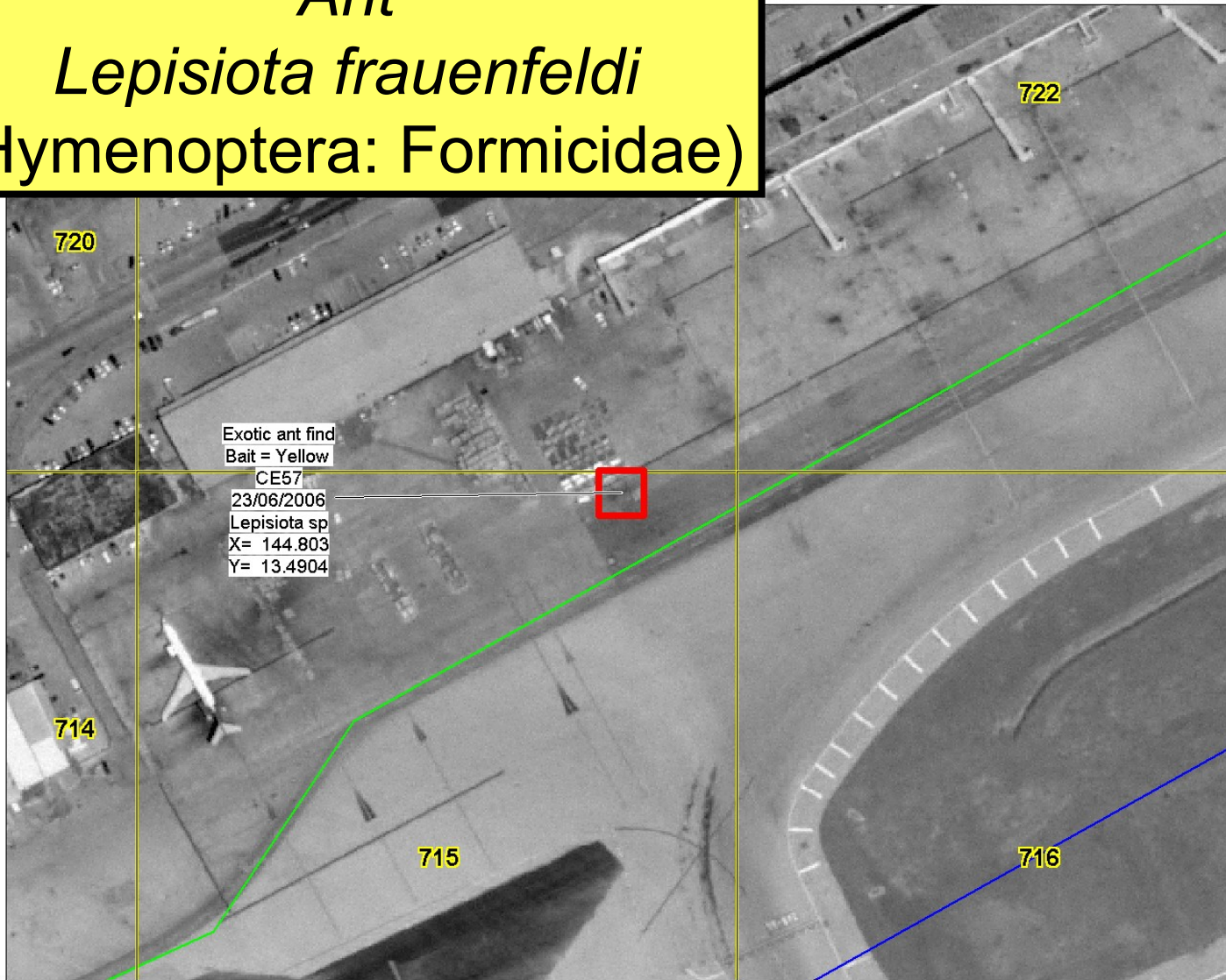
30 species



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 mtr Buffer from Risk Area - (draft boundary)
- A4 page grid



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

[1] Armed Forces Pest Management Board Technical Guide No. 31 RETROGRADE WASHDOWNNS: 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 contains a list of insects intercepted on USAF aircraft arriving in Honolulu from Guam.

■ Coleoptera

- Curculionidae
 - *Myloccerus* sp. (10/27/1987; 6/10/1986)
- Elateridae
 - *Conoderus* sp. (6/11/1989)
- Chrysomelidae
 - *Altica* sp. (10/11/1984)
 - *Rhypanida* sp. (10/18/1984)
- Scarabeidae
 - *Adoretus sinicus* (8/28/1987; 4/1/1990; 7/29/1990)
 - *Anomola* 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)
 - *Popillia lewisi* (7/22/1991; 8/2/1991; 6/8/1990)
 - *Protaetia orientalis* (11/22/1984; 5/10/1993)
- Tenebrionidae
 - *Caedius* 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)

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Popillia lewisi

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

2004: spread
throughout Guam



Prottaetia orientalis

~1970: first detected
on Guam

2002: first detected
on Oahu at Hickam
AFB golf course



Brachygyttarus 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



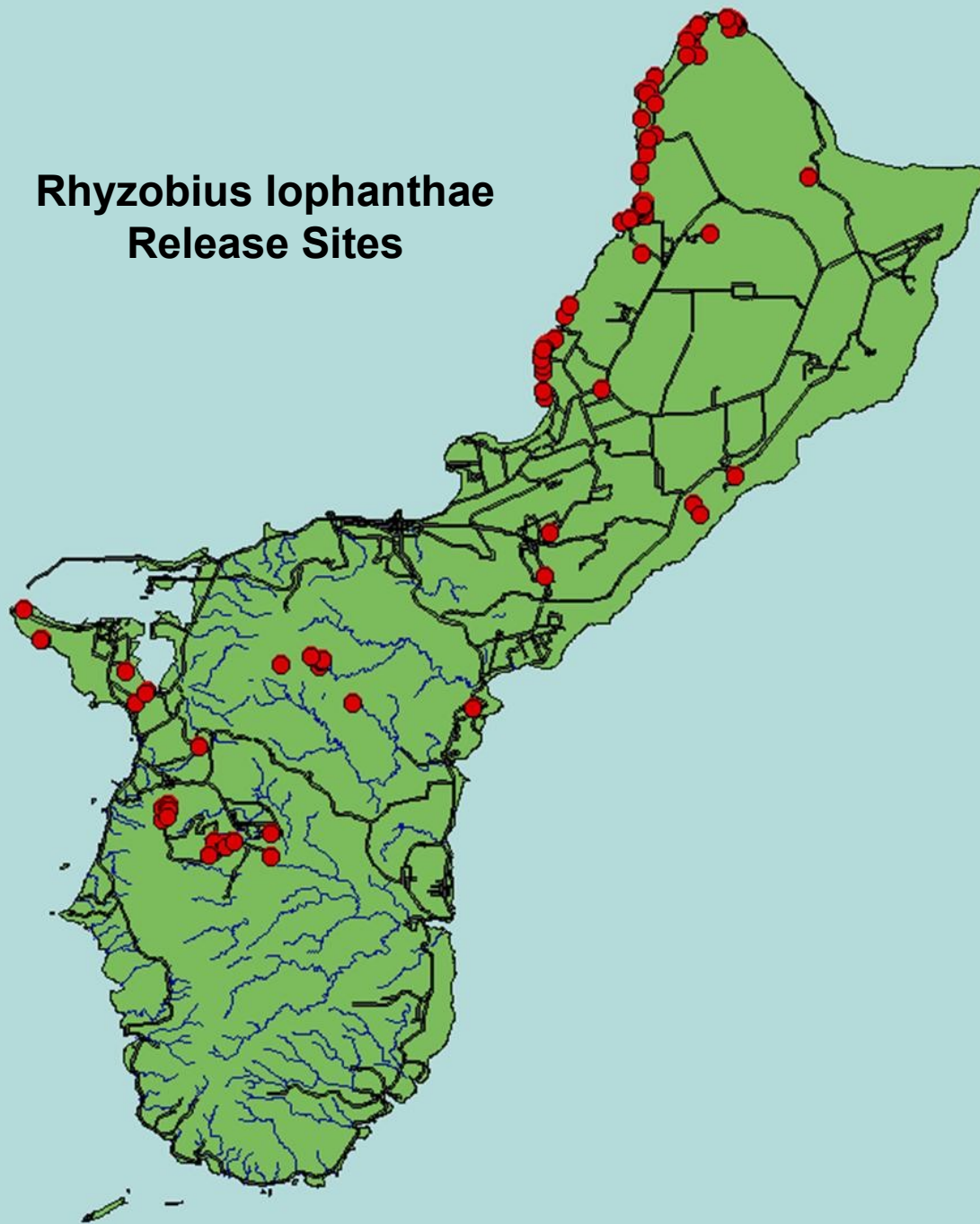
Timeline for Cycad *Aulacaspis* Scale

- 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,
Aplopolepis 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 lophanthae* 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 lophanthae
Coccinellidae



2003
Herbivore

Aulacaspis yasumatsui
Diaspididae



Endemic Plant

Cycas micronesica



Cycas micronesica infested by *Aulacaspis yasumatsui*.

2003
Herbivore

Erechthias sp.
(Tineidae: leafminer)



LEGEND

Invasive species

Endemic species

Introduced
biocontrol agent

Attendant Ants



Anoplolepis gracilipes *Tapinoma indicum*
Iridiomyrmex anceps *Tapinoma melanocephalum*
Paratrechina bourbonica *Tetramorium bicarinatum*
Paratrechina longicornis *Technomyrmex albipes*
Pheidole megacephala
Pheidole oceanica

2005
Herbivore

Chilades pandava
Lycaenidae



Herbivore

Dihammus marianarum
Cerambycidae



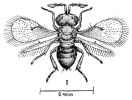
Omnivore

Sus scrofa
Feral pig



Endemic Parasitoid

Trichogrammatoidea
guamensis
Trichogrammatidae

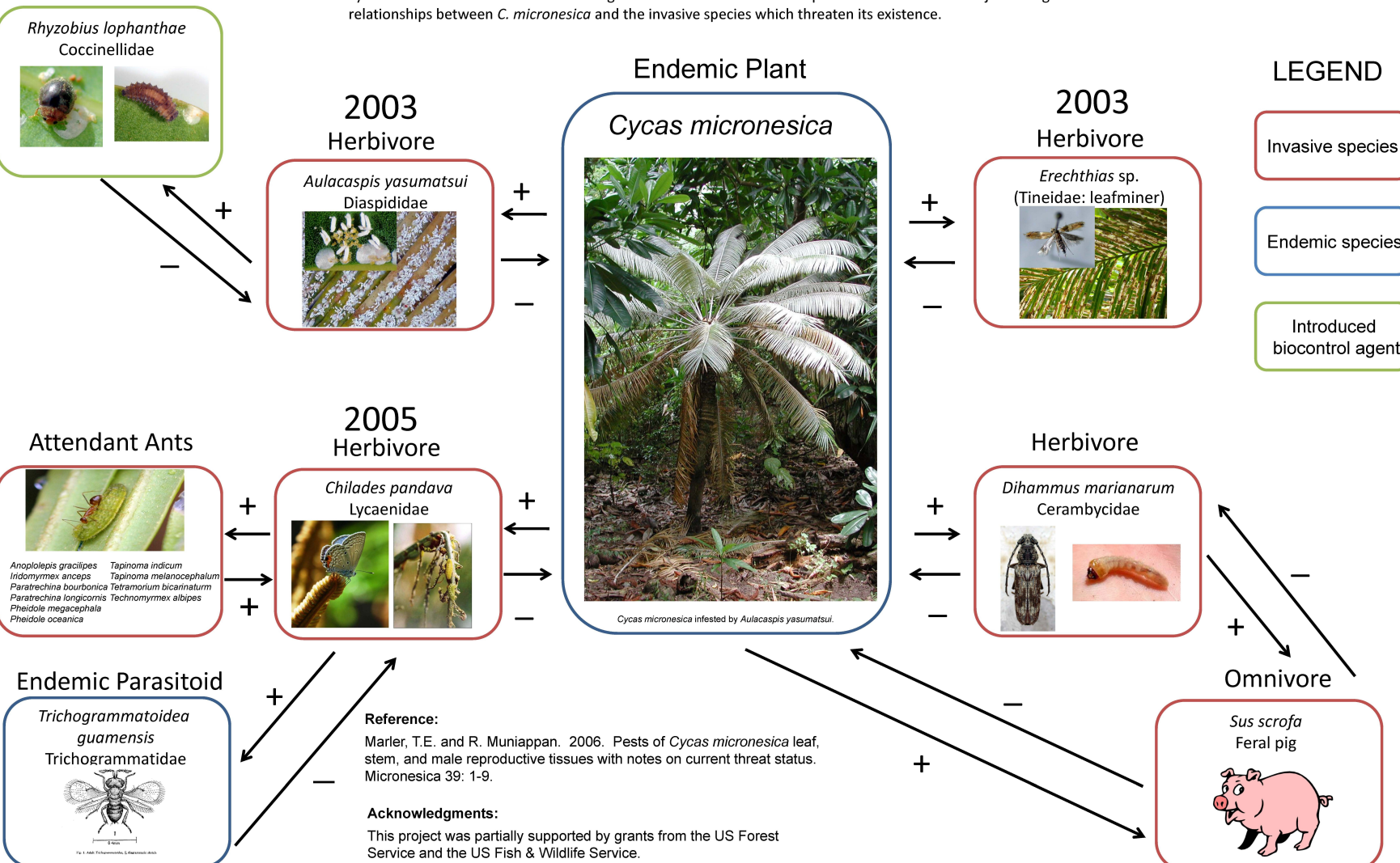


Reference:

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

Acknowledgments:

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



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





FELCO 2
SWISS MADE





Local Organizations

Guam Plant Inspection Facility

Guam Invasive Species Advisory Committee

Guam Invasive Species Council

Regional / Federal Organizations

Western Micronesia Regional Invasive Species Council

Pacific Plant Protection Organization

Secretariat of the Pacific Community

- Pest surveys
- PPQ training

Western Plant Diagnostic Network / National Plant Diagnostic Network

- First Detector Training
- Field Exercise Scenarios

USDA / APHIS

- CAPS Surveys
- PPQ Training

University of Hawaii

- Biosecurity Training

Main Page

WM-RISC Wiki

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WELCOME

Welcome to the [Western Micronesia Regional Invasive Species Council](#) Wiki. This site is intended to facilitate access to information on Micronesia's [invasive species](#). Unlike most web sites, this [wiki](#) can be edited online by collaborators. If you are interested in becoming a collaborator, please [create an account](#) or [log in](#) to enable you to add and edit web pages. For more information, you may contact Dr. Aubrey Moore, University of Guam at (671) 735-2086 or amoore@uguam.uog.edu. See the [MediaWiki Handbook](#) for help.

INVASIVE SPECIES REGISTRY

Each invasive species in the registry has its own web page containing a species profile (scientific name, taxonomy, images, when it arrived, etc.).

[Click here to add or edit a species profile.](#)

To locate a page for a taxon, enter its scientific or common name in the search box, or follow links from here:

[Animals](#) | [Plants](#) | [Fungi](#)

PROJECTS

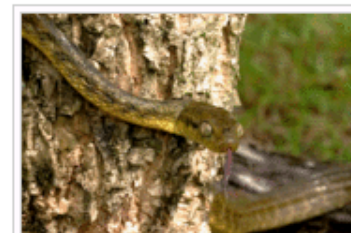
[Asian cycad scale](#) | [Guam Emergency Response Plan](#)

LINKS

[Invasive Species Weblog](#) | [Invasive Species Specialist Group](#)

ACKNOWLEDGMENT

Development of this wiki was partially funded by a USDA TSTAR grant to survey invasive insects in Micronesia awarded to Dr. Ross Miller at the University of Guam.



brown treesnake,
Boiga irregularis



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Daphnis nerii

Web pages Images

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- 4 First Island Records for Micronesia

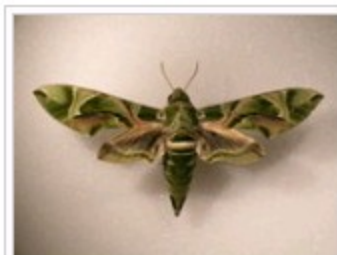
Images



Late instar *Daphnis nerii* caterpillar



Daphnis nerii damage to oleander



Daphnis nerii adult

Taxonomy

Kingdom Animalia -- animals

Phylum Arthropoda -- arthropods

Class Insecta -- insects

Order Lepidoptera -- moths, butterflies

Family Spingidae -- spinx moths, hawk moths, hornworms

Species *Daphnis nerii*

Common Names

oleander hawk moth

First Island Records for Micronesia

Saipan 2003 http://www.pestnet.org/photo/show_pest.asp?id=443&hp=Insect

August 2005 Moore, A. 2005

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WESTERN PLANT DIAGNOSTIC NETWORK



Workshop Announcement

Title: Response to Invasive Species: First Detector Training Workshop

Date & Time: Saturday, October 24, 2009, 9:00 am to 12:00 noon

Location: ALS Building, Room 127, University of Guam

Activity: University of Guam students are invited and encouraged to attend this workshop, which is cosponsored by the University of Guam Cooperative Extension Service and the Western Plant Diagnostic Network (WPDN). During the workshop you will learn what to do when you encounter a plant or animal which you suspect is new to Guam. Rapid detection and implementation of an emergency response plan will reduce economic and environmental damage caused by invasive species.

For more information, contact Roger Brown, University of Guam, 735-2094/2080.



www.wpdn.org
www.npdn.org

WESTERN PLANT DIAGNOSTIC NETWORK



All suspected new invasive species should be reported to:

Dr. Russell Campbell

Guam/USDA Plant Inspection Facility

Telephone: 475-1426/27

Fax: 477-9487

Email: russell.campbell@agriculture.guam.gov

Information on Guam's invasive species can be found online at:

<http://guaminsects.net/gisac>



www.wpdn.org
www.npdn.org

SPC / APHIS PPQ Training 2008



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