ARS Screwworm Research
Remote Sensing and GIS Program

# Incorporating Spatial Analysis for Detection and Surveillance of Screwworm

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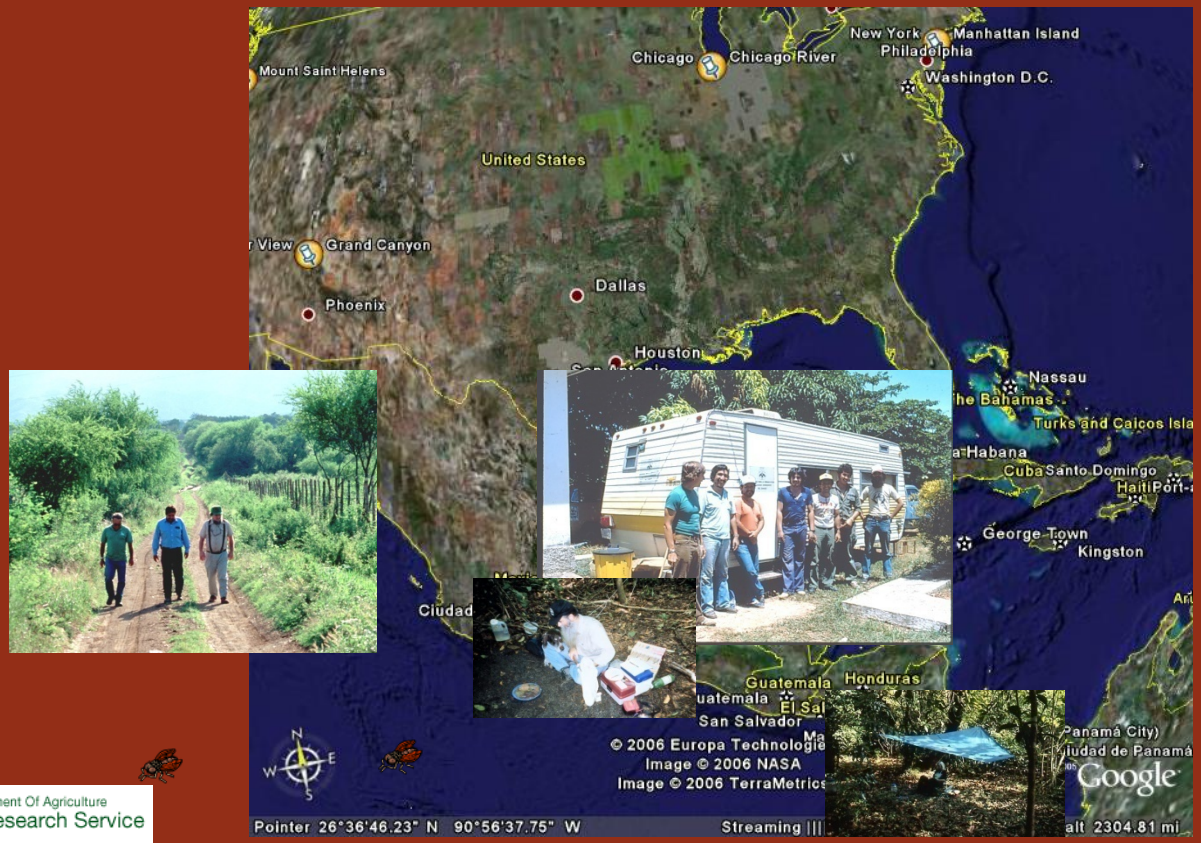
USDA United States Department Of Agriculture
Agricultural Research Service

# Background – Repeat from the Past

Basic field research – took the observations of various scientists working from 1940's to 1990's and from Texas to Costa Rica. For eradication and control programs always the question of where to find the insect pest. More efficient and thus more effective use of time and money. Used their observations in the field of fly activity and occurrence.

*Always learning from the past and always trying to improve our knowledge base.*

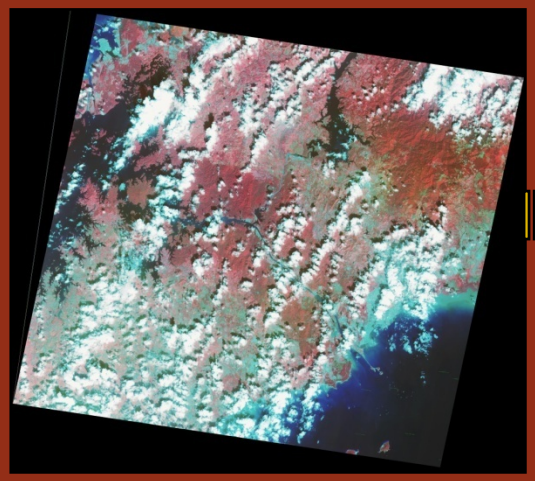


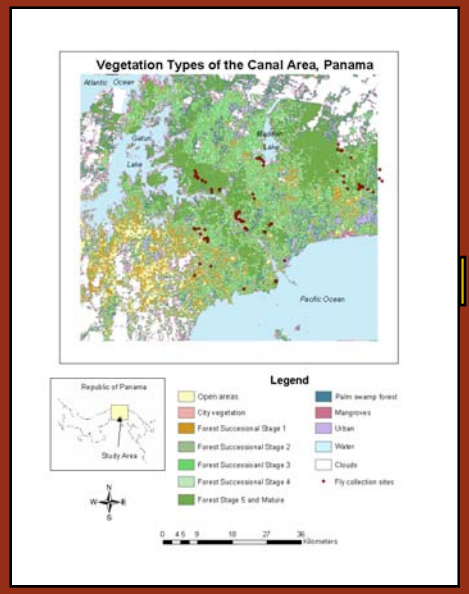
# In Panama Canal Area

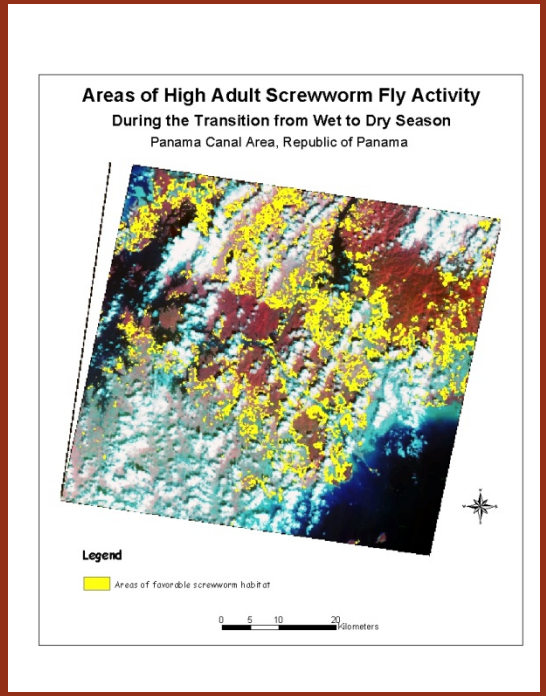
- Remote sensing analysis and model based on field studies of native flies in Panama Canal Area.
- Collected quantitative data on tropical habitats and fly activity , temperature, humidity and related these data to remote sensing data.

# In Panama Canal Area

Allowed us to better understand the relationship of habitat, season, geographical distribution of what seems to be happening in the field by using spatial analysis of satellite data.

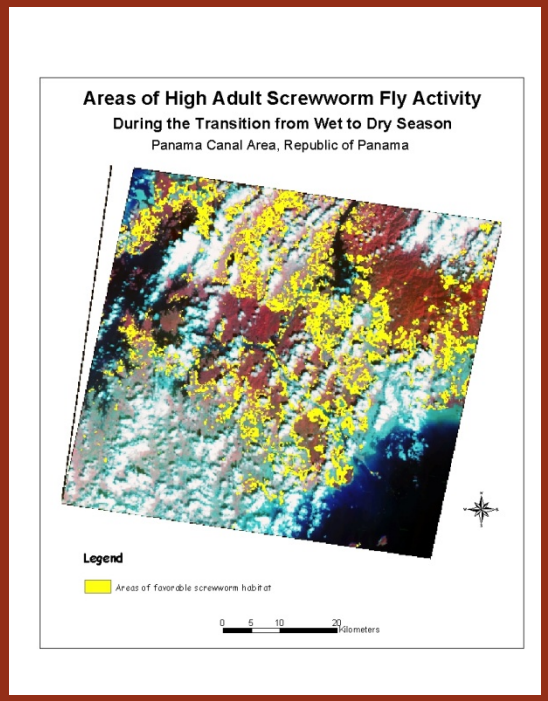




# Results of Field and Spatial Analysis Study

- Identified the vegetation types most likely to provide preferred habitat for flies.
- Easy to map on remote sensing data at many scales (aerial photo or satellite data.)
- Can be done visually or by using simple classification programs.

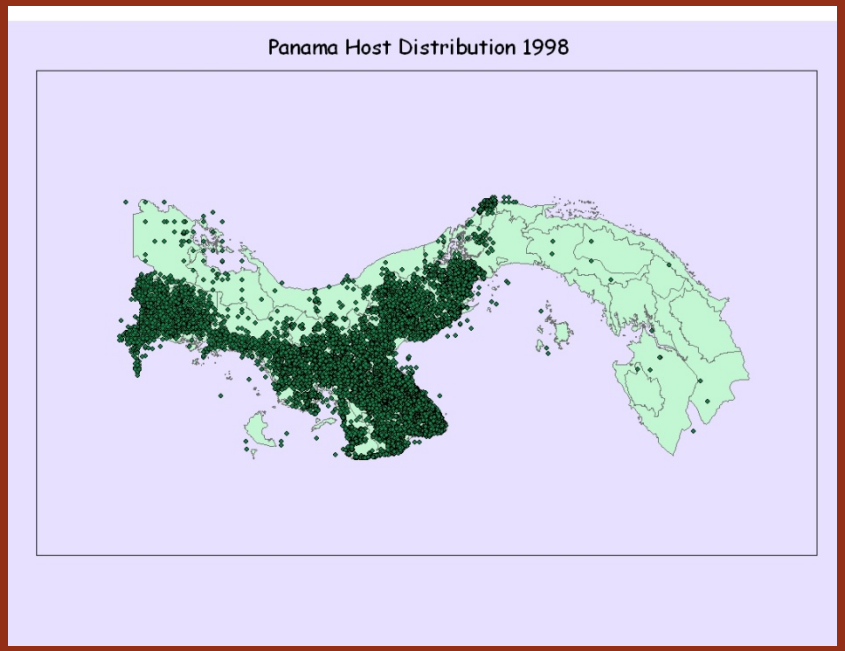


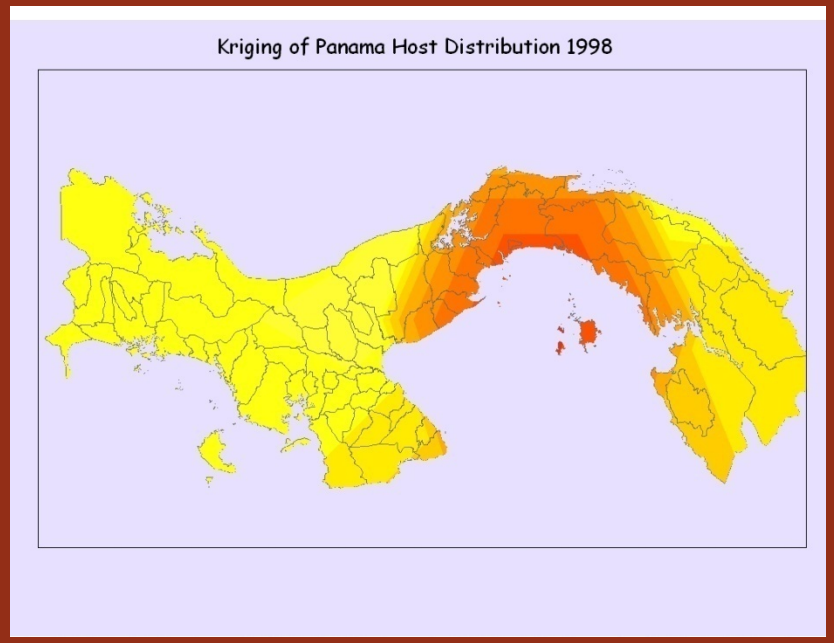
Habitat Mapping
Layer in Fly Distribution Model

# Hosts

Important – Population at Risk

# Mapping the distribution of Hosts
# GIS Layer in Fly Distribution Model



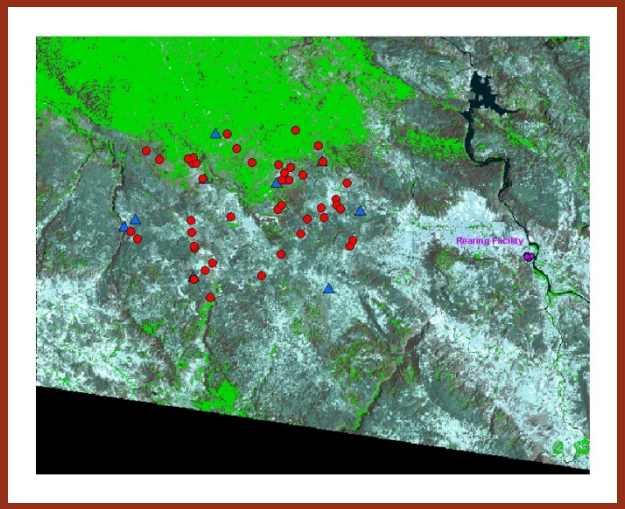

Spatial Distribution of Hosts

Host Mapping
Layer in Fly Distribution Model

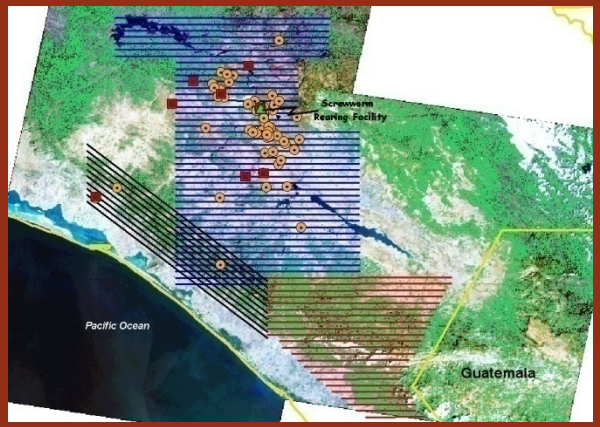
# Application to Screwworm Eradication Program

## Screwworm Outbreaks

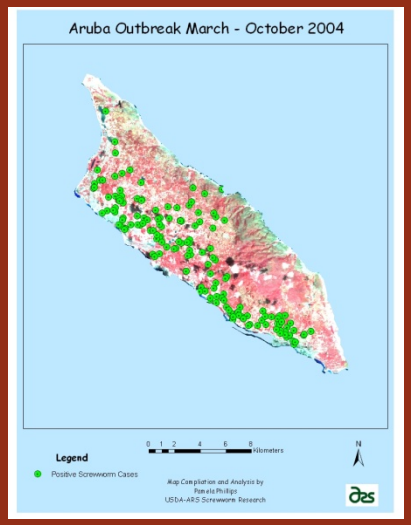
Chiapas, Mexico 2001



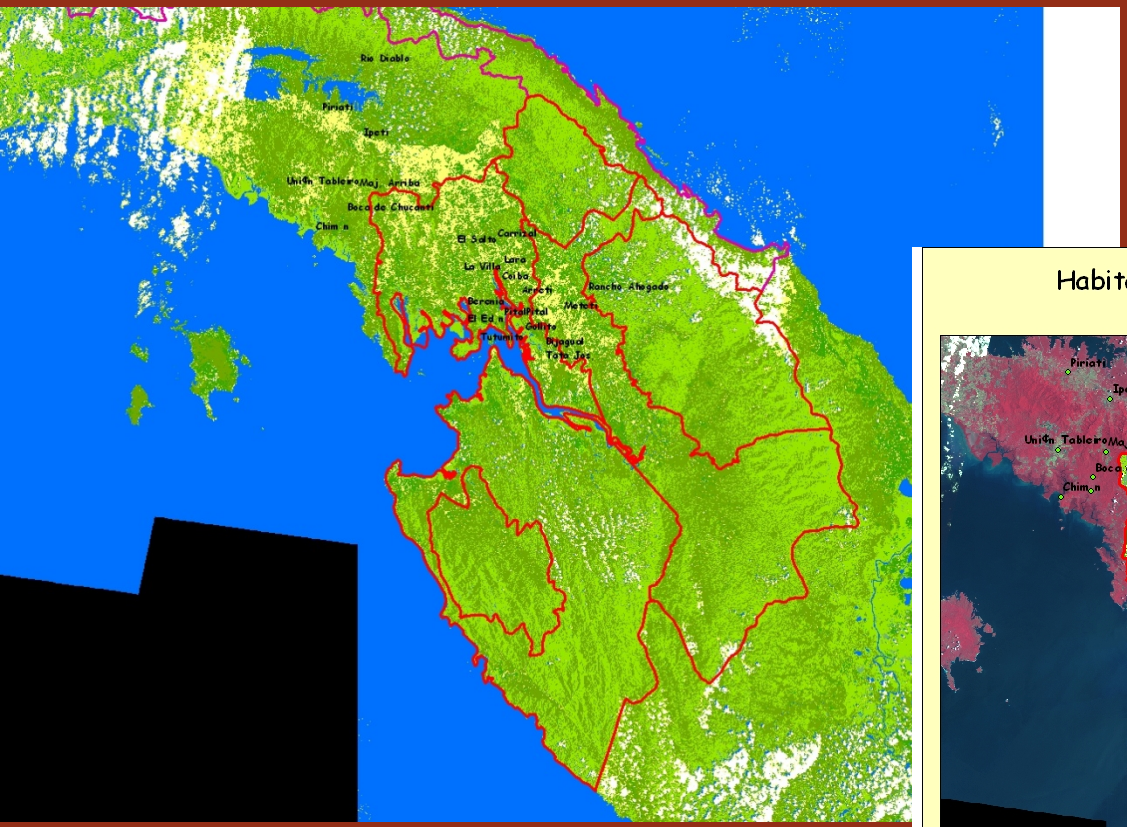

Chiapas, Mexico 2003

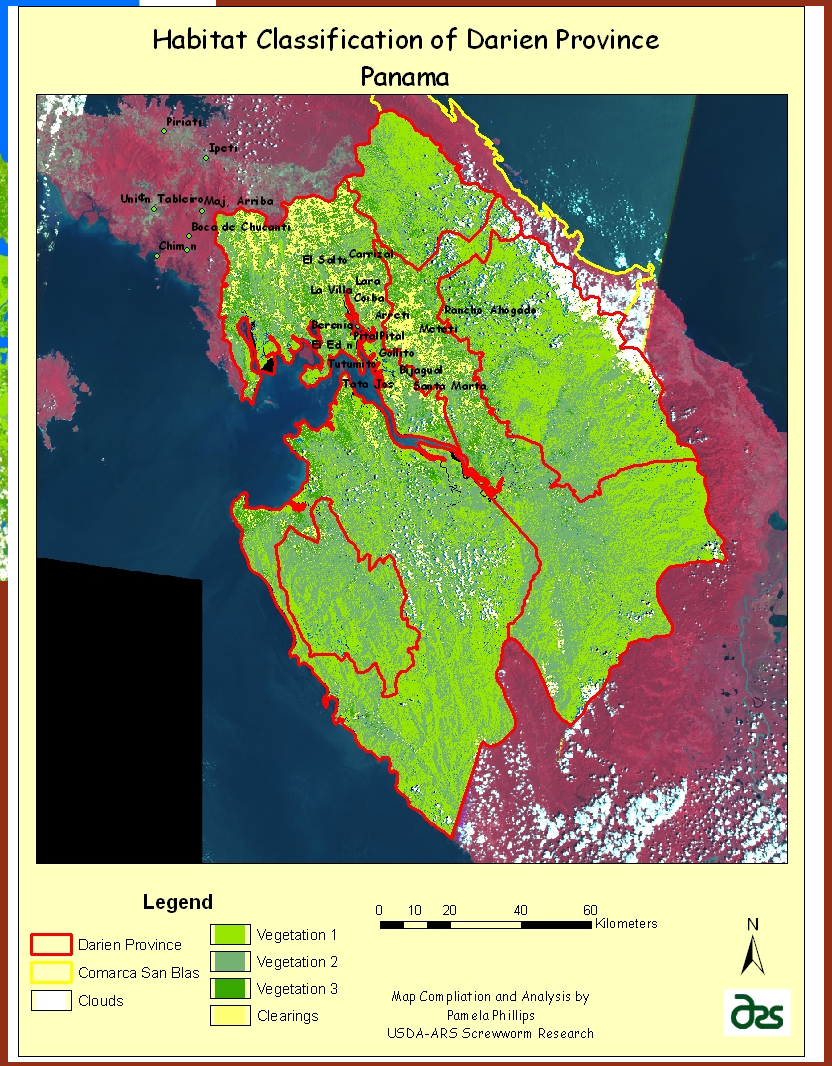



Aruba, 2004



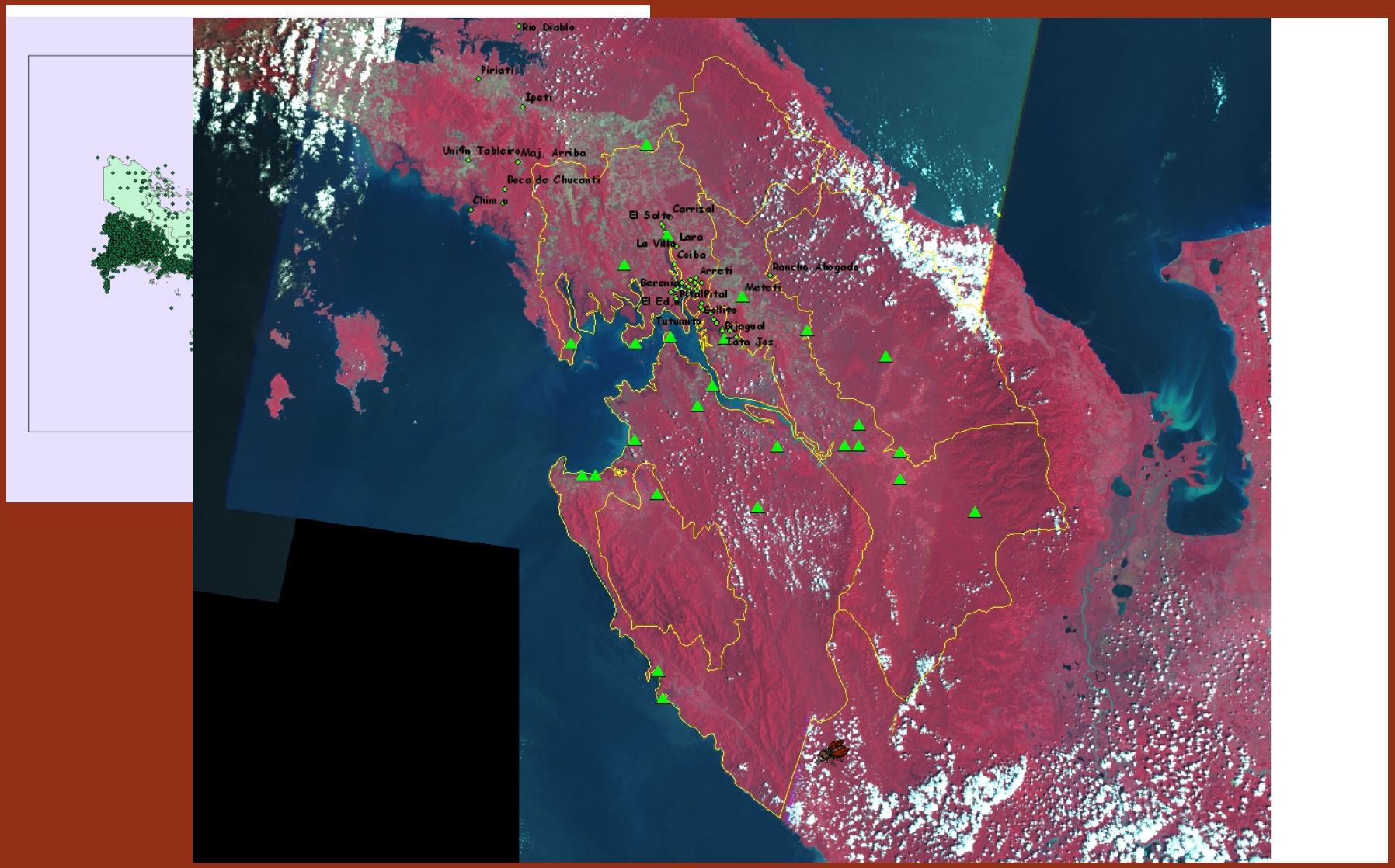

- All outbreaks were different all responses were different
- Remote Sensing and Spatial Analysis used to Direct Field Operations



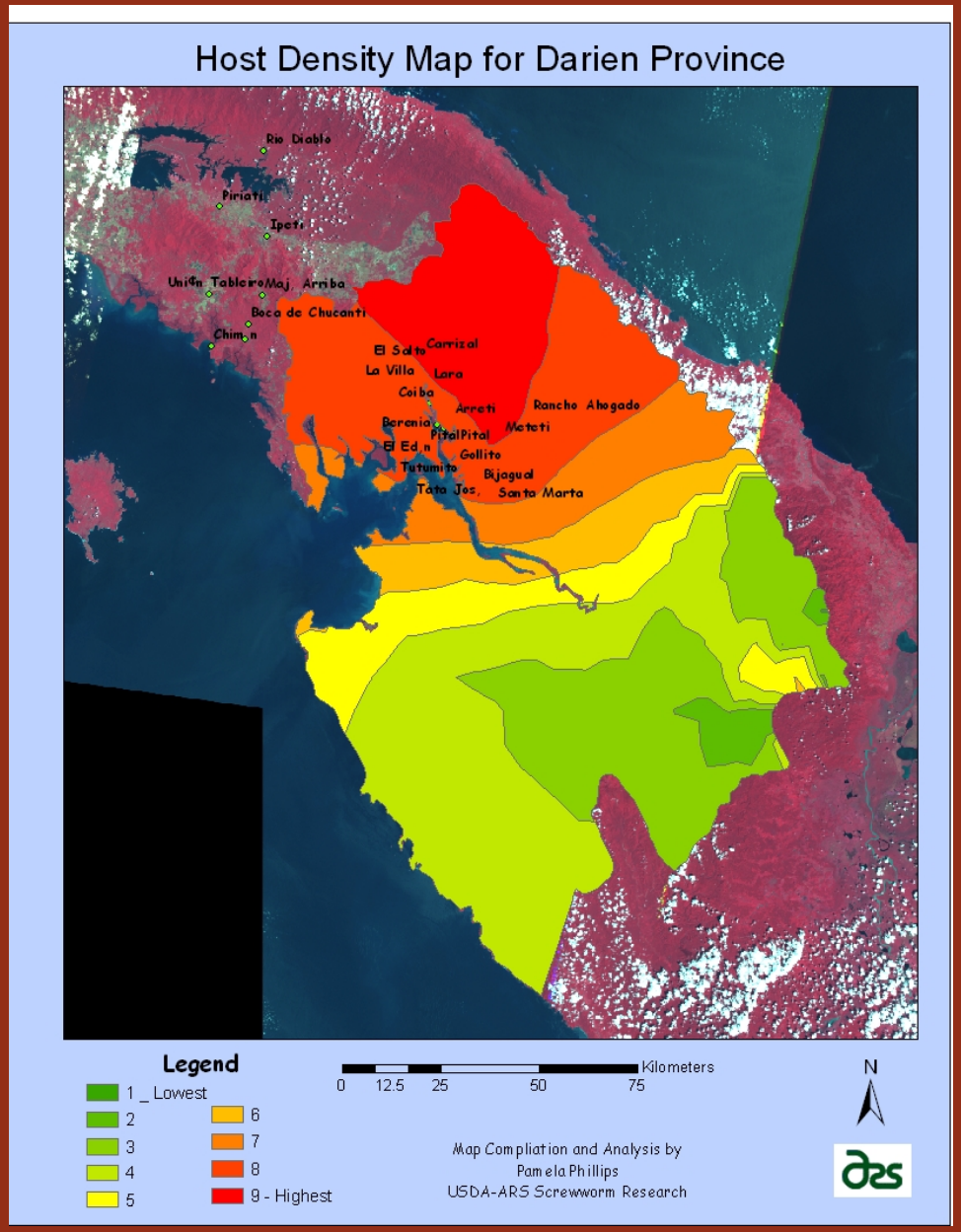




# Application to the Barrier Zone, Panama

# Remote Sensing and GIS Applications to the Barrier Zone in Panama

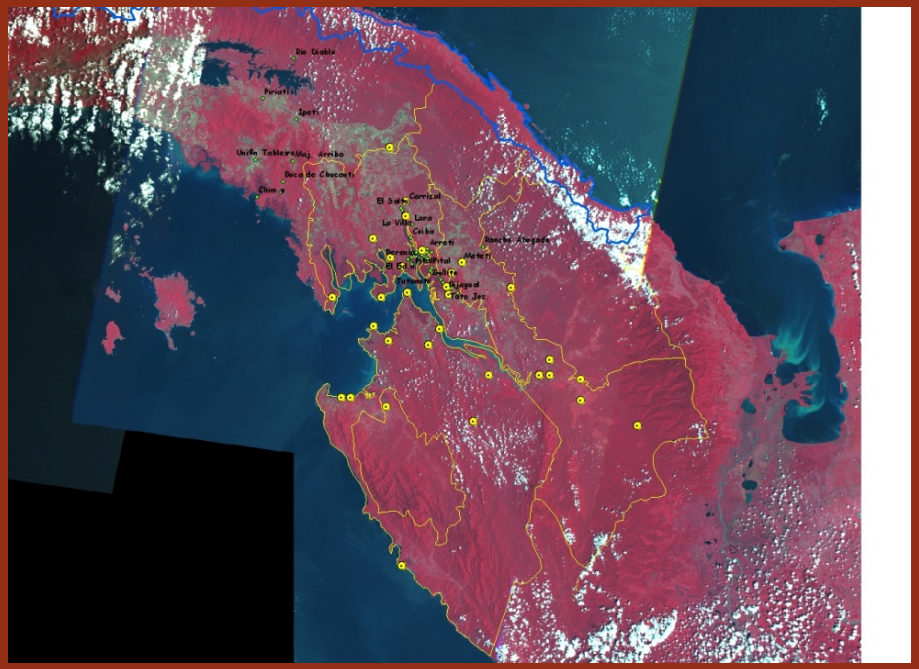



Host Data for Darien Province 200?



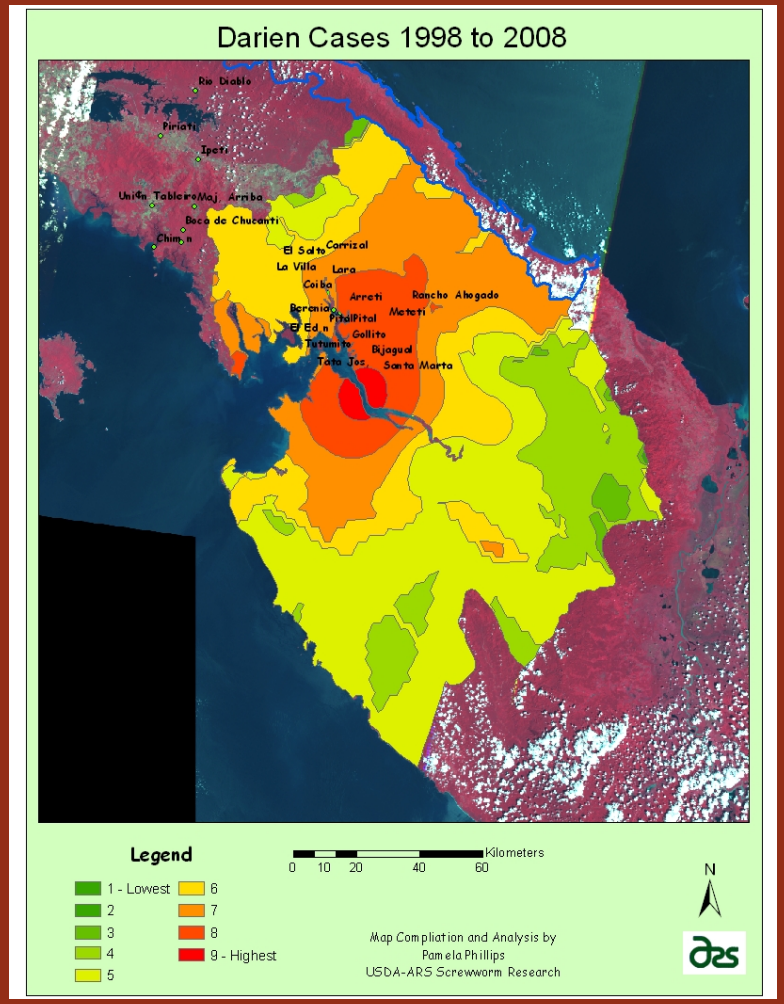

- Used host density points to create Original Kriging (OK).

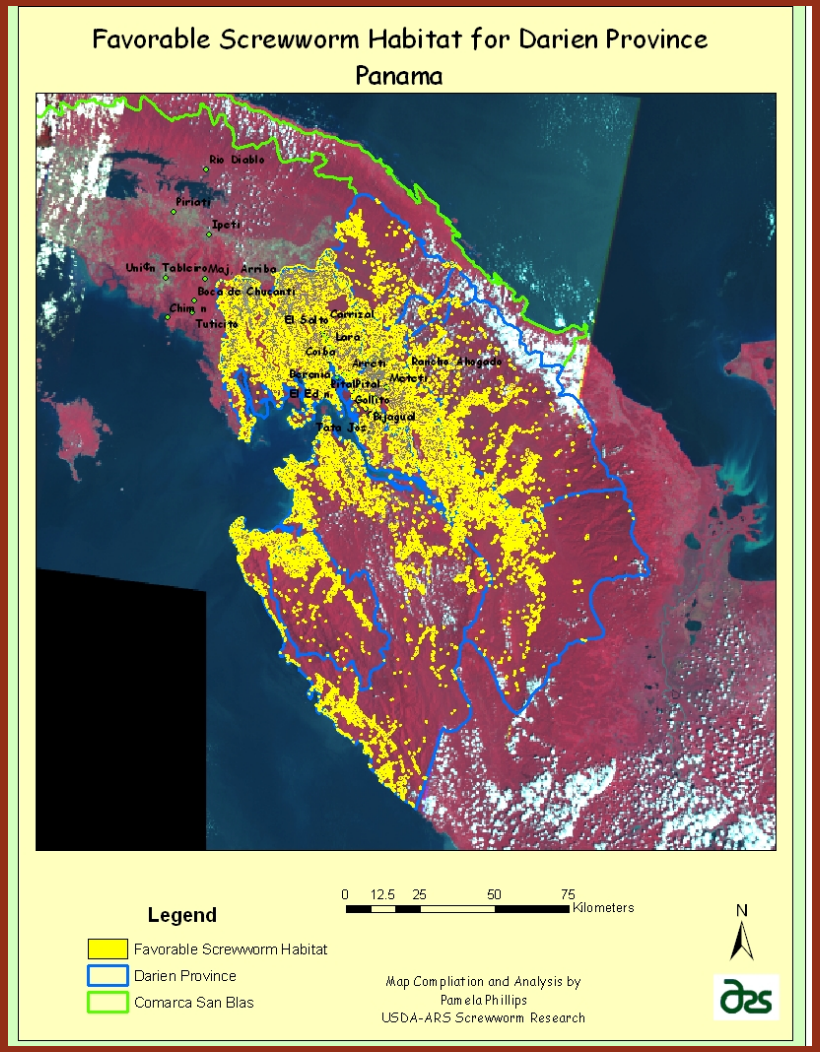
Approach to model and map the spatial variability of host.

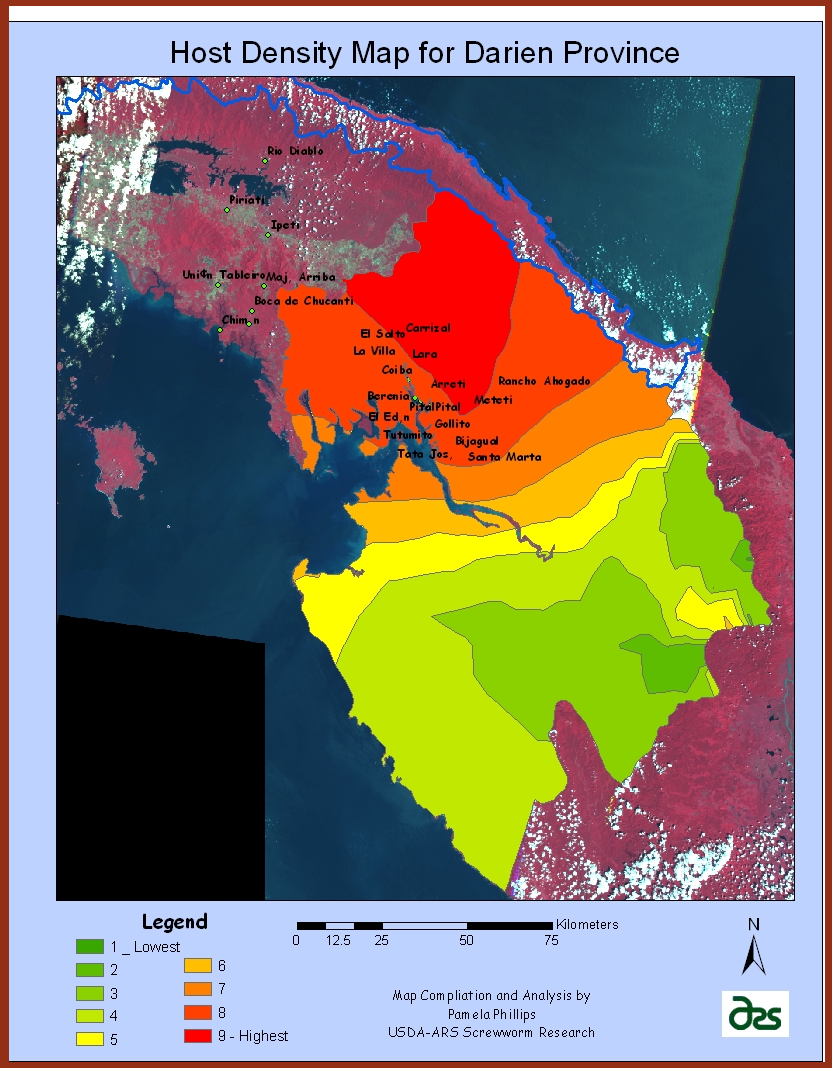



- Used case density points to create Original Kriging (OK).

Approach to model and map the spatial variability of cases.





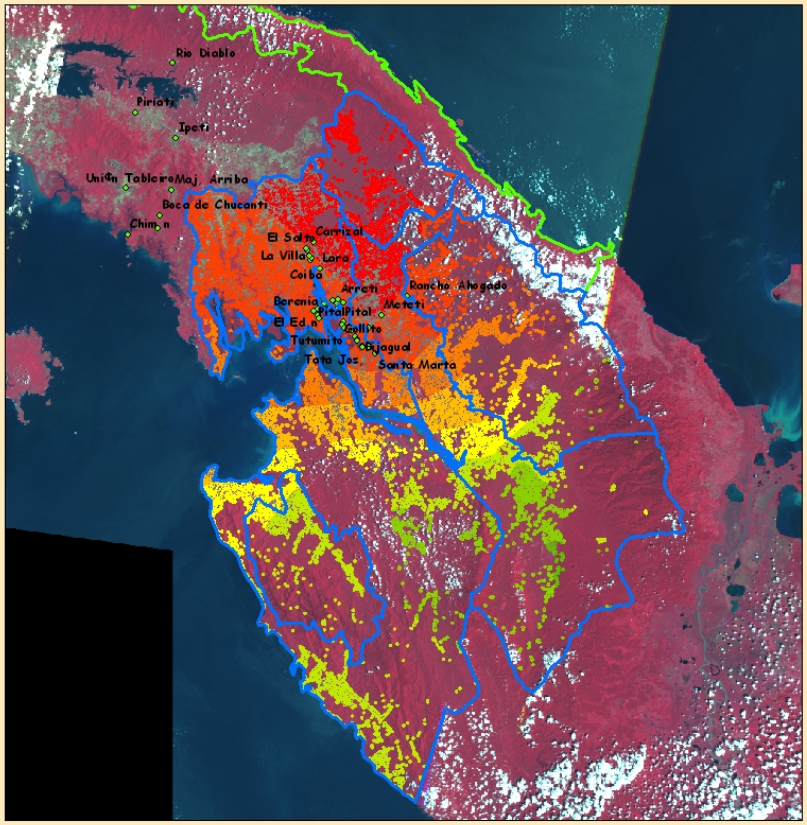




Take Your Favorable Habitats

Combine It With

Where Your Hosts Are

## Calculated Areas of High Host Density with Favorable Habitat




**Legend**

Lowest

Highest

Darien Province

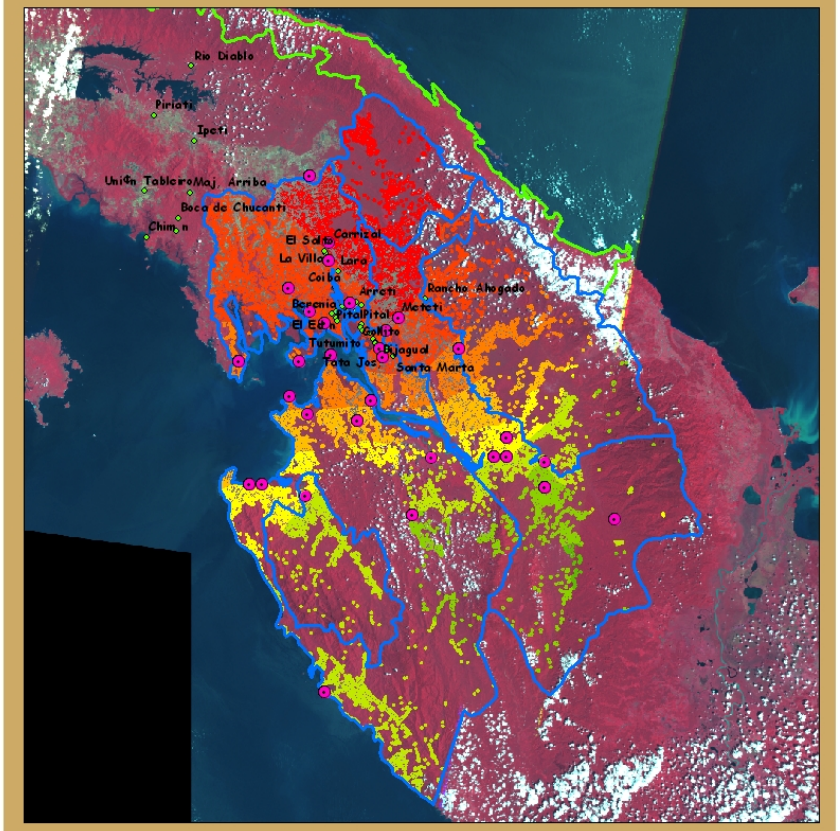
Comarca San Blas

0 10 20 40 60 Kilometers

N

Map Compliation and Analysis by
Pamela Phillips
USDA-ARS Screwworm Research

## Calculated Areas of High Host Density with Favorable Habitat With Case Locations




**Legend**

Lowest

Highest

Darien Province

Comarca San Blas

0 10 20 40 60 Kilometers

N

Map Compliation and Analysis by
Pamela Phillips
USDA-ARS Screwworm Research

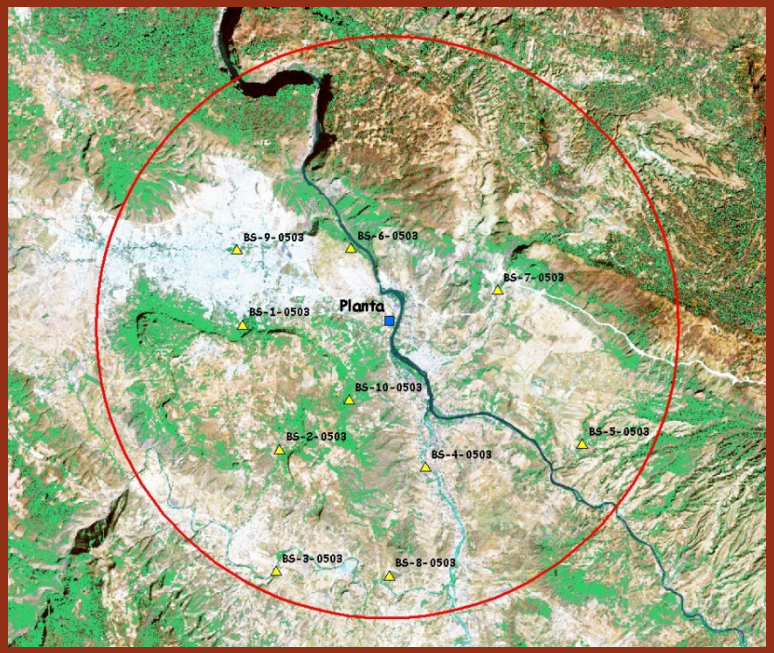
# How Can This Analysis Be Applied to the Screwworm Eradication Program ?

- Want to Save Money?
- Do we need to release the same number of  over the entire Buffer Zone? Safe but is it necessary?
- Program is Successful Because it is Based on Data and Research

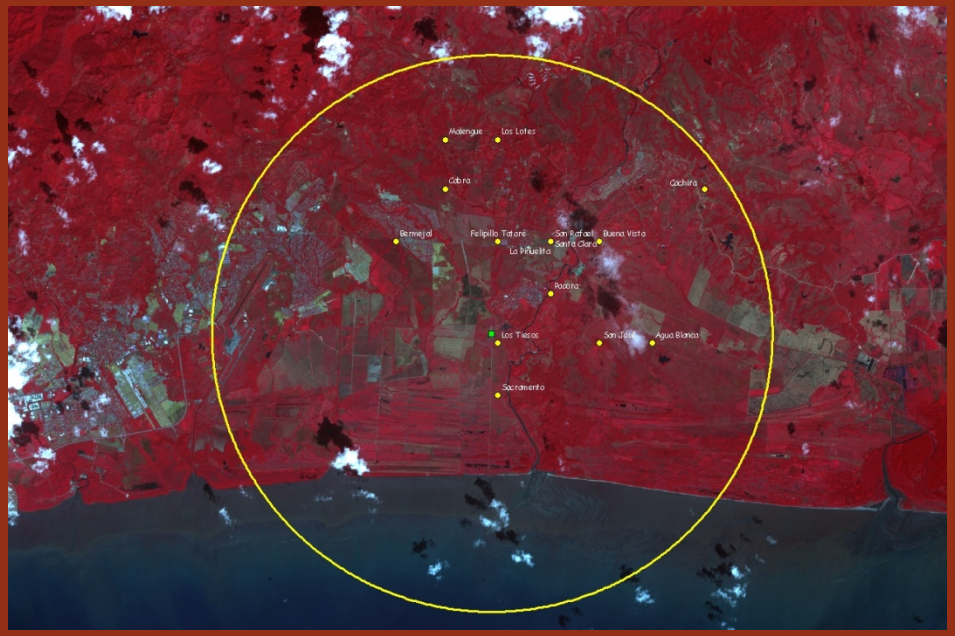
# How is this Applied to the Screwworm Eradication Program -Surveillance

## Trap Placement for Bio-Security of Rearing Facilities

Mexico

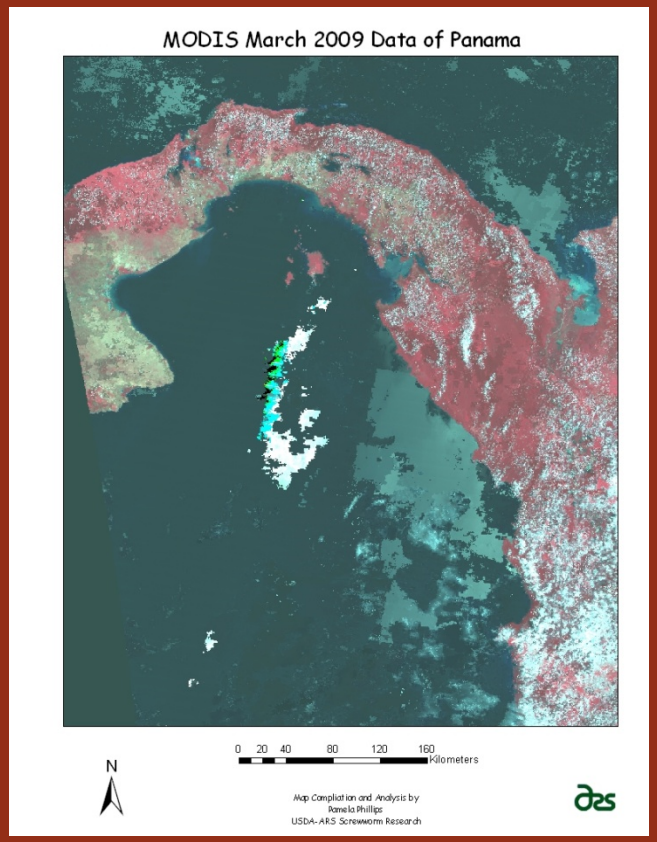



Panama




ARS has selected optimal locations for bio-security trap circuit for Panama

# How is this Applied to the Screwworm Eradication Program Surveillance in Panama

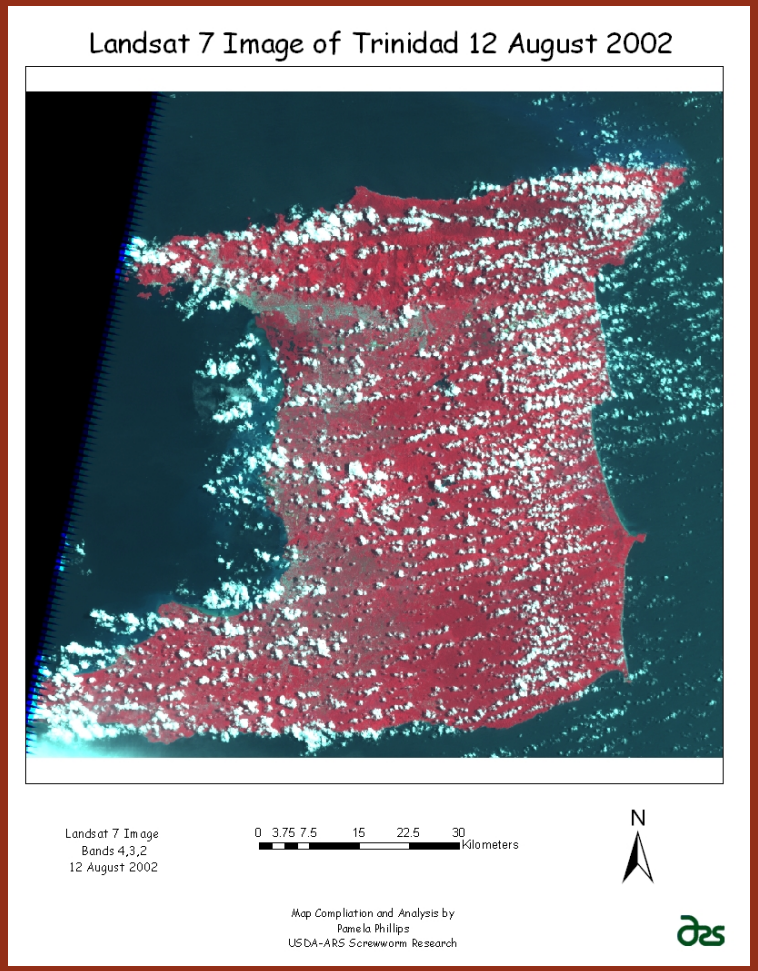


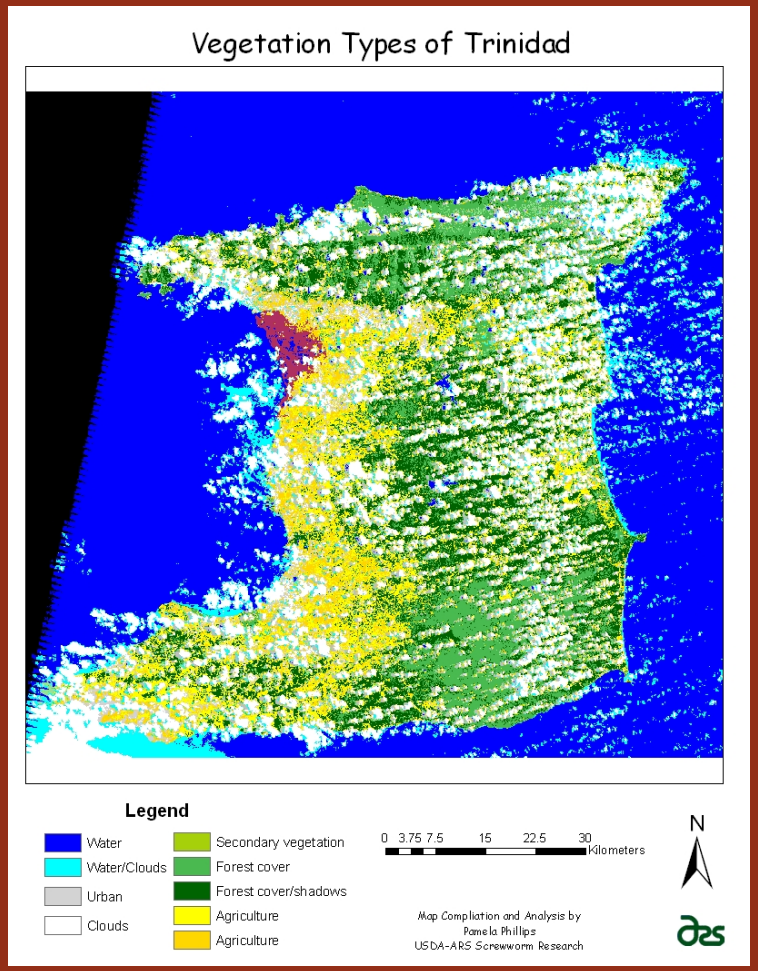

MAP IT

KEEP TRACK

- # of people field surveillance
- Areas with most host/favorable habitat monitored

# How is this Applied to the Male Only Strain?



# Application of Spatial Analysis to Inside the Plant ?

Taking It Inside

# Habitat, Habitat, Habitat

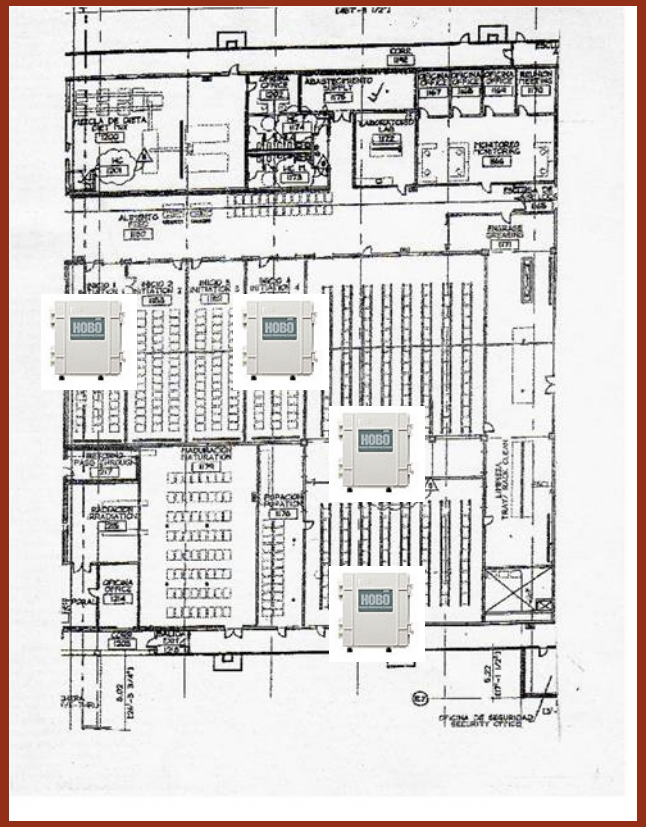
Area of Pupation, 26.5° C, 50% RH

Area of Pupae Maturation
25.5° C, 70 % RH

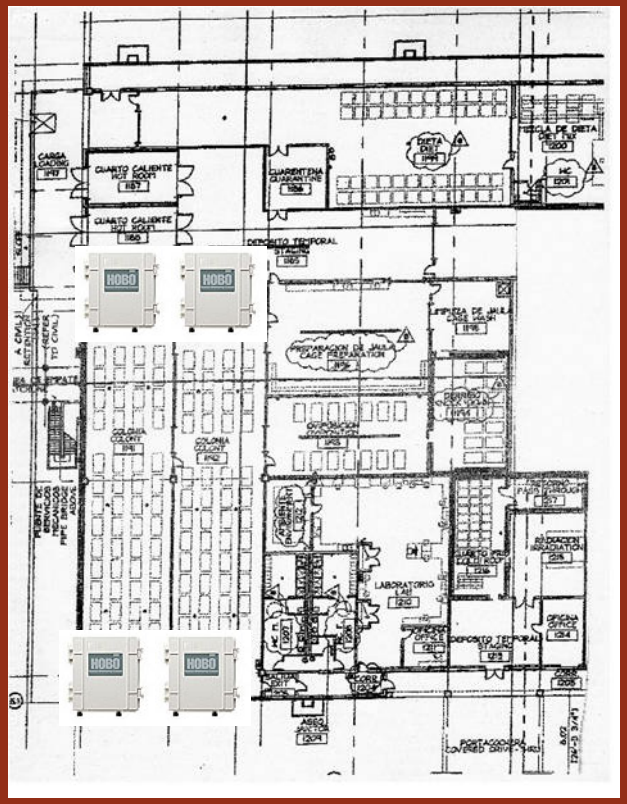
Area of Larval Growth 31° C, 60% RH

# How Can We Make It Better?

Production Floor




Colony Floor



Temp/RH/Air Pressure/$CO_2$ levels

Manage, Organize, Improve Information

# Application of Spatial Analysis to Inside the Plant ?

Production Requirement: 40,000,000 per week <-- ENTER NUMBER OF PUPAE REQUIRED AT DISPERSAL

Input eggs required : 49,333,383 per week

| AREA | Weekly | 4-hour production | Racks in Room | Racks per 4-hours | Room Racks 24-hours | Maximum Rack | Weekly Cycle (hrs) | Maximum production | Utilization of area |
|---|---|---|---|---|---|---|---|---|---|
| Colony | | | | | | 98 | 144 | | |
| Oviposition | | | | | | 14 | 4 | | |
| Knockdown | | | | | | | | | |
| Initiation 1 | 49,333,383 | 1,174,604 | 22.5 | 3.2 | 19.2 | 90 | 28 | 197,769,600 | 24.94% |
| Initiation 2 | 49,333,383 | 1,174,604 | 12.8 | 3.2 | 19.2 | 90 | 16 | 346,096,800 | 14.25% |
| Rearing | 49,333,383 | 1,174,604 | 57.7 | 3.2 | 19.2 | 147 | 72 | 125,620,320 | 39.27% |
| Pupation | 44,400,044 | 1,057,144 | 7.9 | 2.9 | 17.3 | 24 | 20 | 134,265,600 | 33.07% |
| Maturation | 43,956,044 | 1,046,572 | 25.9 | 2.9 | 17.1 | 72 | 132 | 122,059,636 | 36.01% |
| Irradiation | 40,000,000 | 952,381 | | | | | | | |
| Cold Storage | 40,000,000 | 952,381 | | | | | | | |

Racks Per week in Rearing: 135 racks

Diet Mix used: 67,890 liters per week

| DIET MIX INGREDIENTS | LITERS REQUIRED / WEEK | COMPOSITION |
|---|---|---|
| Spray-dried Bovine Blood | 4,073 | 6.0% |
| Milk Substitute | 2,716 | 4.0% |
| Spray-dried egg | 3,394 | 5.0% |
| Gelling agent | 1,222 | 1.8% |
| Formaldehyde | 81 | 0.12% |
| Water | 56,417 | 83.1% |
| | | 100.0% |

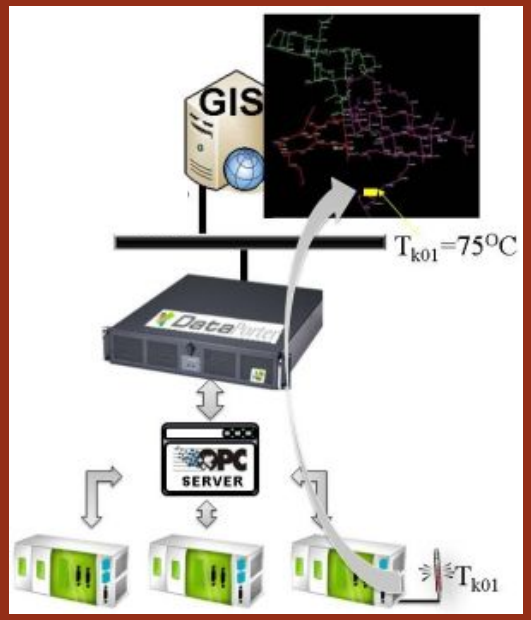
| | EFFICIENCY |
|---|---|
| Initiation 1 | 0.62 |
| Initiation 2 | 0.95 |
| Rearing | 0.90 |
| Pupation | 0.99 |
| Maturation | 0.91 |
| Irraditiation | 1.00 |
| Cold Storage | 1.00 |

NOTE: 6% of Rearing production diverted to maintain colony

| Rack Type | Capacity |
|---|---|
| Cage | |
| Rearing | 366,240 |
| Pupation | 666,000 |
| Maturation | 1,332,000 |

Numbers in light blue cells may be changed

Screwworm Production Algorithm




GIS as a management tool For environments inside Rearing facility

# Application of Spatial Analysis to Fly Dispersal ?

Taking it to Flight

**6,000 Flies per Nautical Mile**

**3,000 Flies/nM$^2$**

**2,273 Flies/M$^2$**

**877 Flies/Km$^2$**

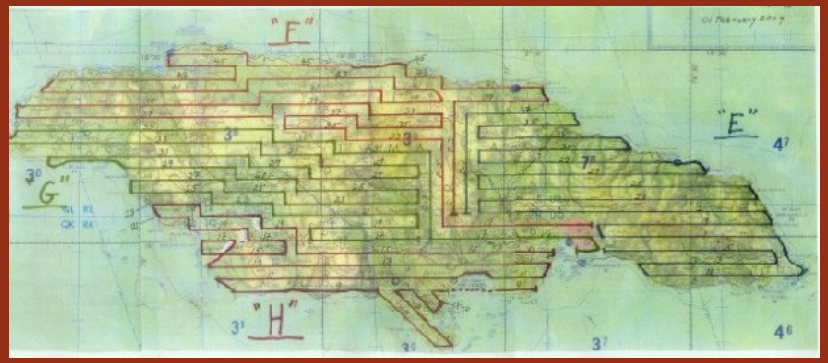
Amount of Sterile Flies released are the same in all habitats

# Ag-Nav For Aerial Dispersal of Sterile Screwworm Flies

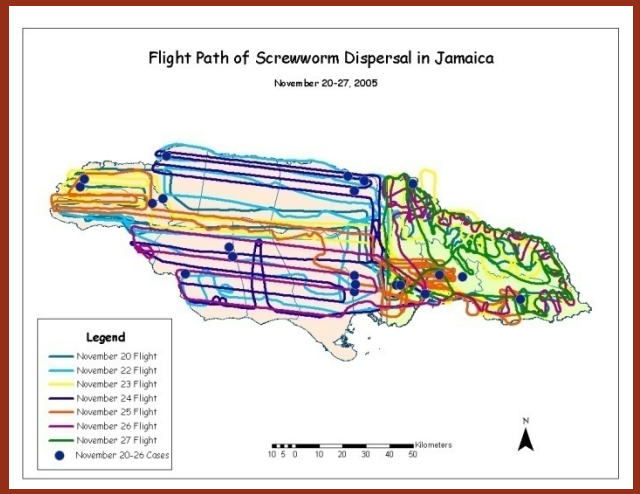
In Jamaica, demonstrated the usefulness of Ag-Nav navigation software/GPS on aerial screwworm dispersal flights. Has proved useful in Panama and will elsewhere.

ARS sees Mapping of Aerial Release of Sterile Flies and Mapping of Habitats and Hosts Integral To current and future eradication programs.

Previous method for tracking dispersal flight lines




Current method for tracking dispersal flights daily along with case data



# Technology Improvements

## Ag-Nav 2

- DGPS navigation system designed by AG-NAV Inc

## FlightMaster™

- A Real time meteorology onboard

Feeds into

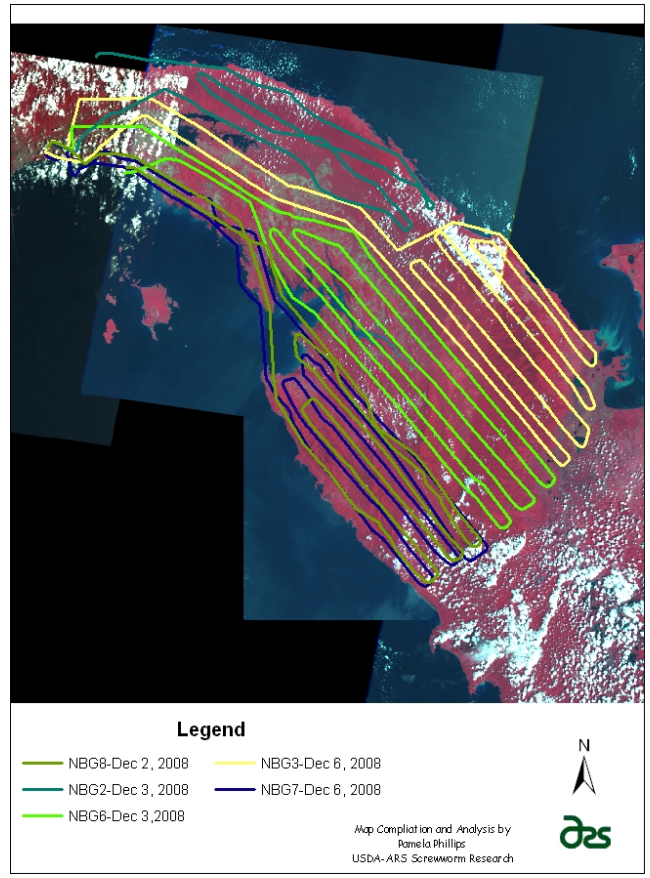
- B Drift Compensation module

Product density, aircraft type
Height of aircraft, wind speed
And direction etc.

- C Integrates A and B into AgNav software and GPS

ARS goes to Canada to learn more about drift model

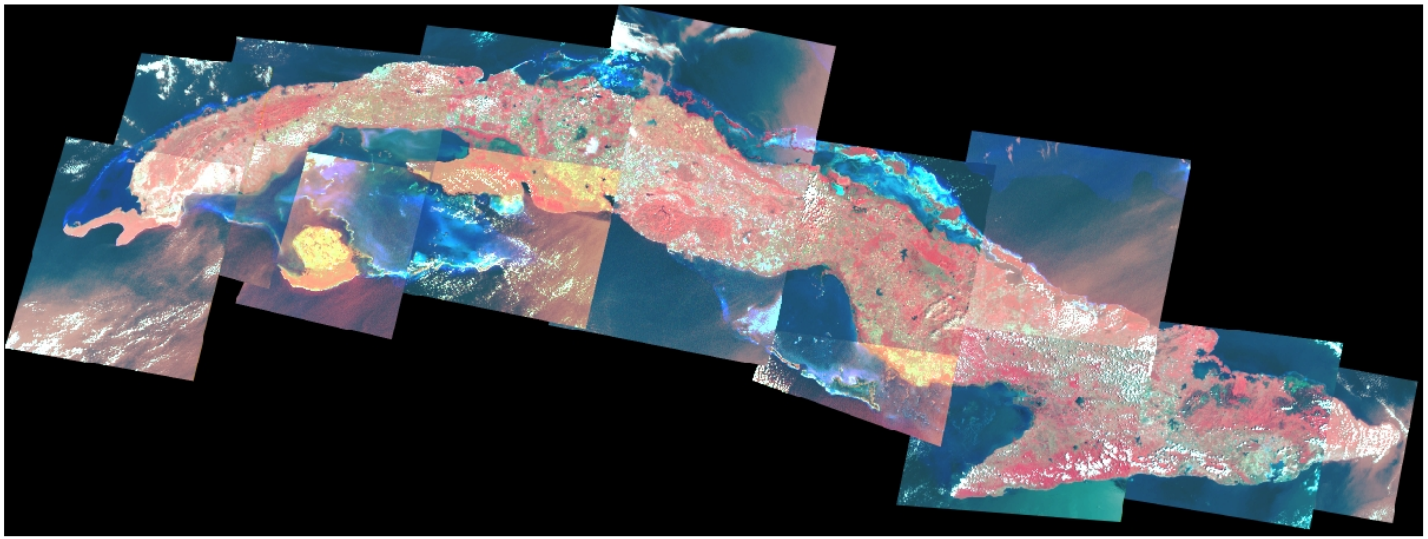
# Release of Sterile Screwworm Flies in the Panama Barrier Zone is Forever




- How can we do this with the least cost and still maintain the integrity of the program?
- Tracking Cases and Mapping Favorable Habitat and Hosts in Columbia will be Important

# Basic Design for any Eradication Program Should Incorporate these Technologies

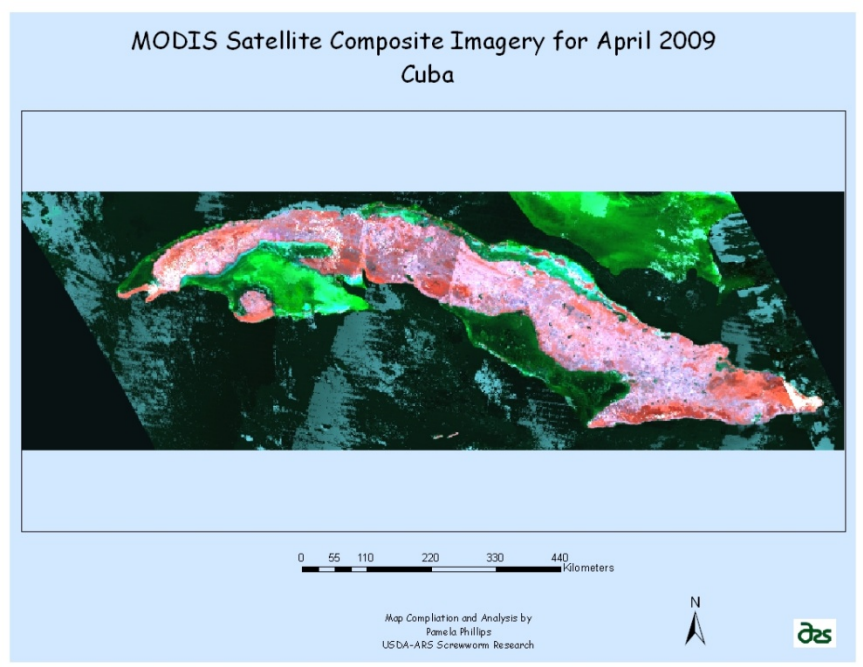
Landsat 7 Image Mosaic of Cuba, 2000-2003

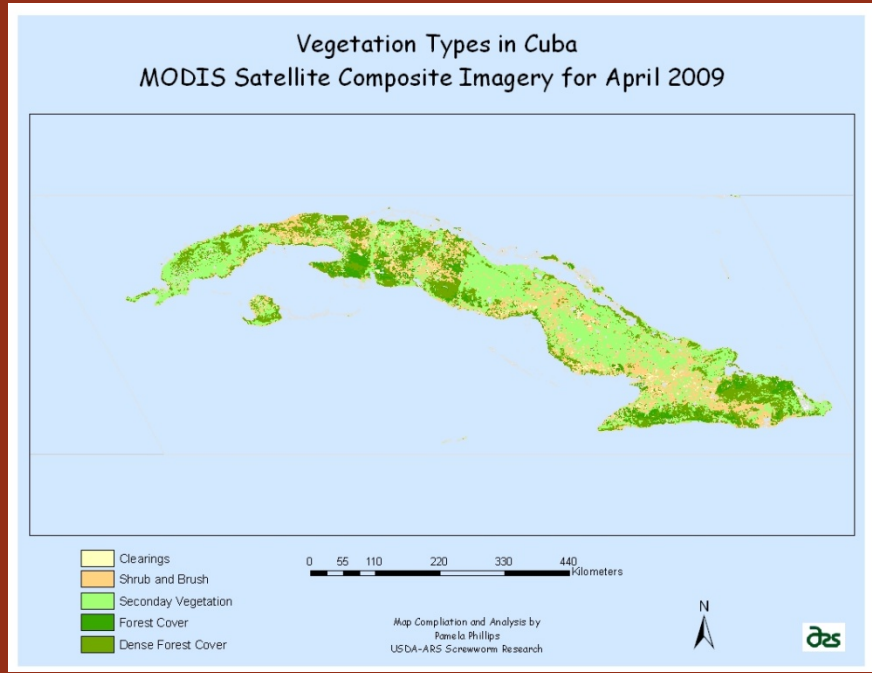


0 40 80 160 240 320 400 Kilometers

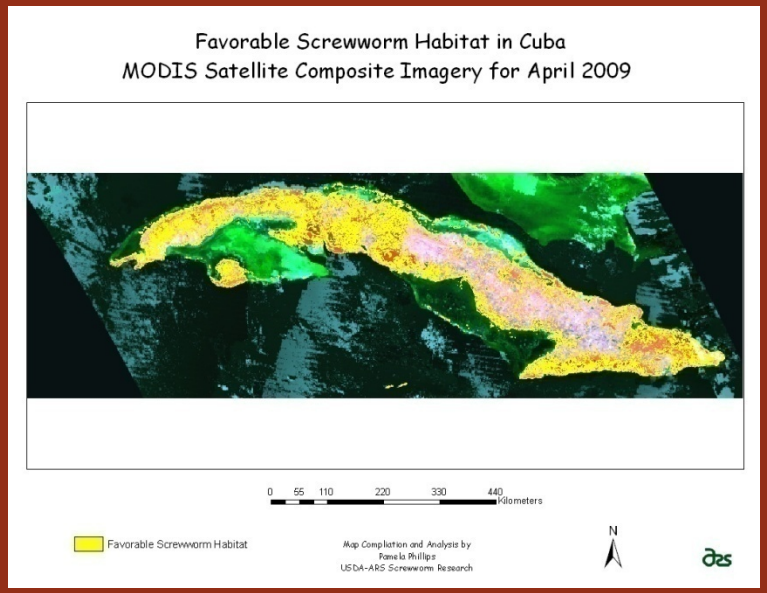
14 Landsat 7 Images will serve as baseline data

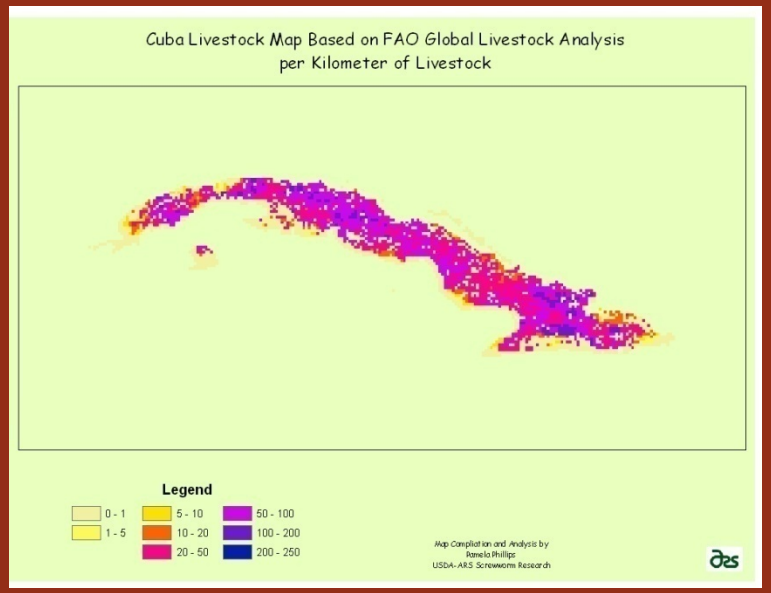
# Moderate Resolution Imaging Spectroradiometer (MODIS)

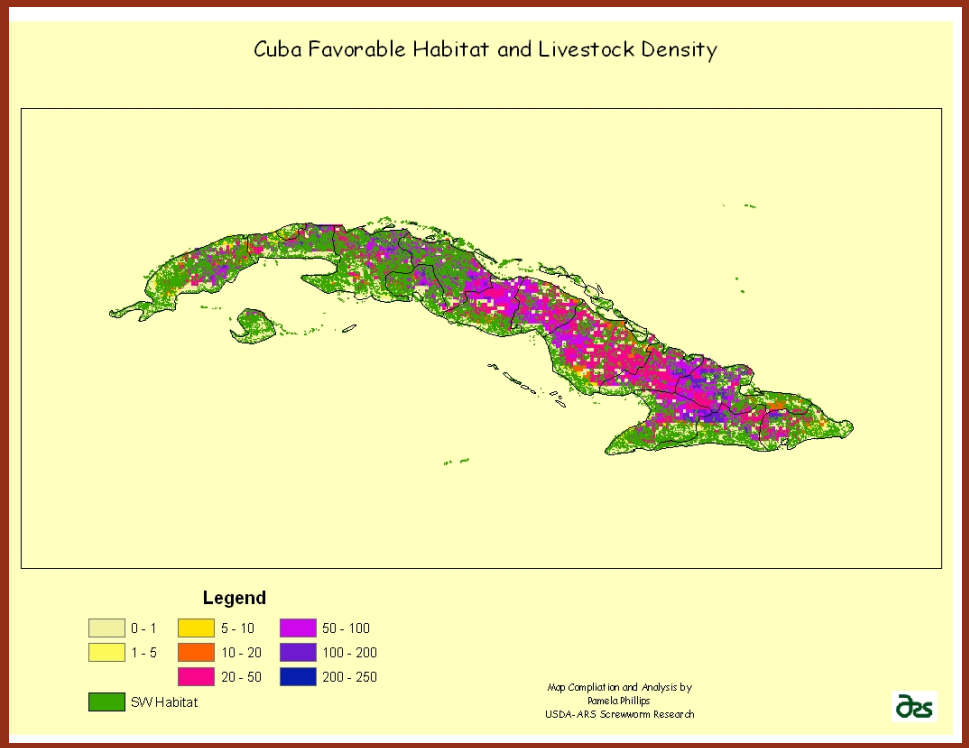


# Combine Favorable Habitat and Hosts






FlightMaster™

An Eradication Program Based on Science
Current Technology Available

# Screwworm Eradication Program

Most successful biological control program in the World

Based on Science and Knowledge

As Budgets Shrink, Technology and Possibilities Expand

# Thank You