# Offshore Biological Control Strategy Applied to Pink Hibiscus Mealybug

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# Biological Control of Invasive Species in the Caribbean Region

- Attack the pest problem abroad prior to invasion
  - "Buys Time" to develop control technology
  - Suppresses exploding pest populations
  - Reduces rate of dispersal between islands and entering Continental U.S.
  - Prolonged invasions reduces potential economic losses

# Classical Biological Control

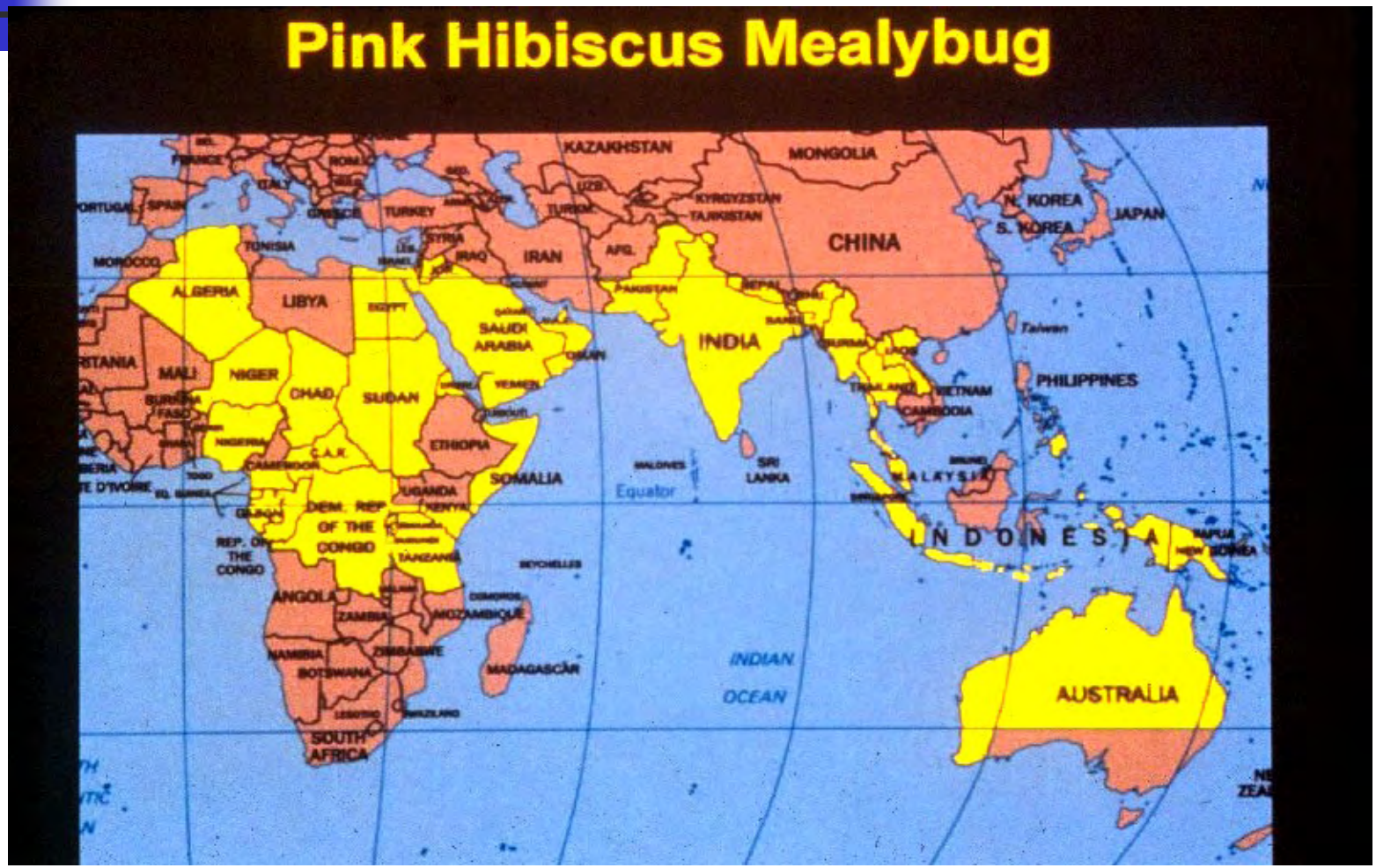
- Importing and releasing exotic natural enemies that become established and self-perpetuating
- Environmentally sound pest control
- Self-sustaining
- Relatively easy to implement
- Cost efficient

# Biological Control of the Pink Hibsucus Mealybug - Caribbean

- Serves as a “Model” for control of an invasive pest species in the Caribbean
- Excellent Caribbean Regional Cooperative Effort
- Cost Sharing
- Biological control technology easily transferred


Pink Hibiscus Mealyug, *Maconellicoccus hirsutus* (Green)

# World Distribution Prior to 1994



# Economic Losses from Pink Hibiscus Mealybug

- **INDIA**: Pest Status - grapes 58-90% losses, rosell or sorrel (Hibiscus sabdariffa) losses up to 75%, heavy infestations on cotton and teak
- **EGYPT**: Cotton damage
- **GRENADA**: IICA est. of economic, social + environmental = US $3,471,900; Crop Losses 1995-97 was US$1.8 million/year Potential Annual Losses = $ 10 mil./year

# Economic Losses (Contin.)

- **TRINIDAD AND TOBAGO**: Potential Losses of $125 million TT Dollars
- **ST. KITTS**: Significant loss of ornamentals, export losses on pumpkins, etc., no sorrel production.
- **U.S. VIRGIN ISLANDS**: Significant Losses to ornamentals (hibiscus) and soursop.

# Risk Assessment of PHM
## Host Range

- Risk Element: HIGH
- PHM is Polyphagous
- Feeds on more than 200 plant genera within 70 plant families

# Pink Hibiscus Mealybug Host Plants

## Fruits

- Papaya
- Sugar-apple
- Golden apple
- Pigeon pea
- Carambola
- Soursop
- Cherry
- Passion fruit
- Avocado
- Mango
- Plum
- Grape
- Citrus
- Breadfruit
- Guava
- Banana

## Ornamental

- Hibiscus
- Croton
- Allamanda
- Anthurium
- Heliconia
- Lantana
- Seagrape
- Bougainvillea
- Oleander
- Ixora
- Ginger lily
- Schefflera
- Ficus

## Vegetable

- Tomato
- Pumpkin
- Okra
- Lettuce
- Beans
- Cucumber
- Peppers
- Dasheen
- Cabbage
- Squash

# Risk Assessment of PHM
## Dispersal Potential

- Risk Element: HIGH
- High reproductive potential

  10 generations/year

  Female Egg Sac >600 eggs
- Highly mobile life stages by wind, animals, man, and machinery

# Risk Assessment of PHM
## Economic Impacts to US

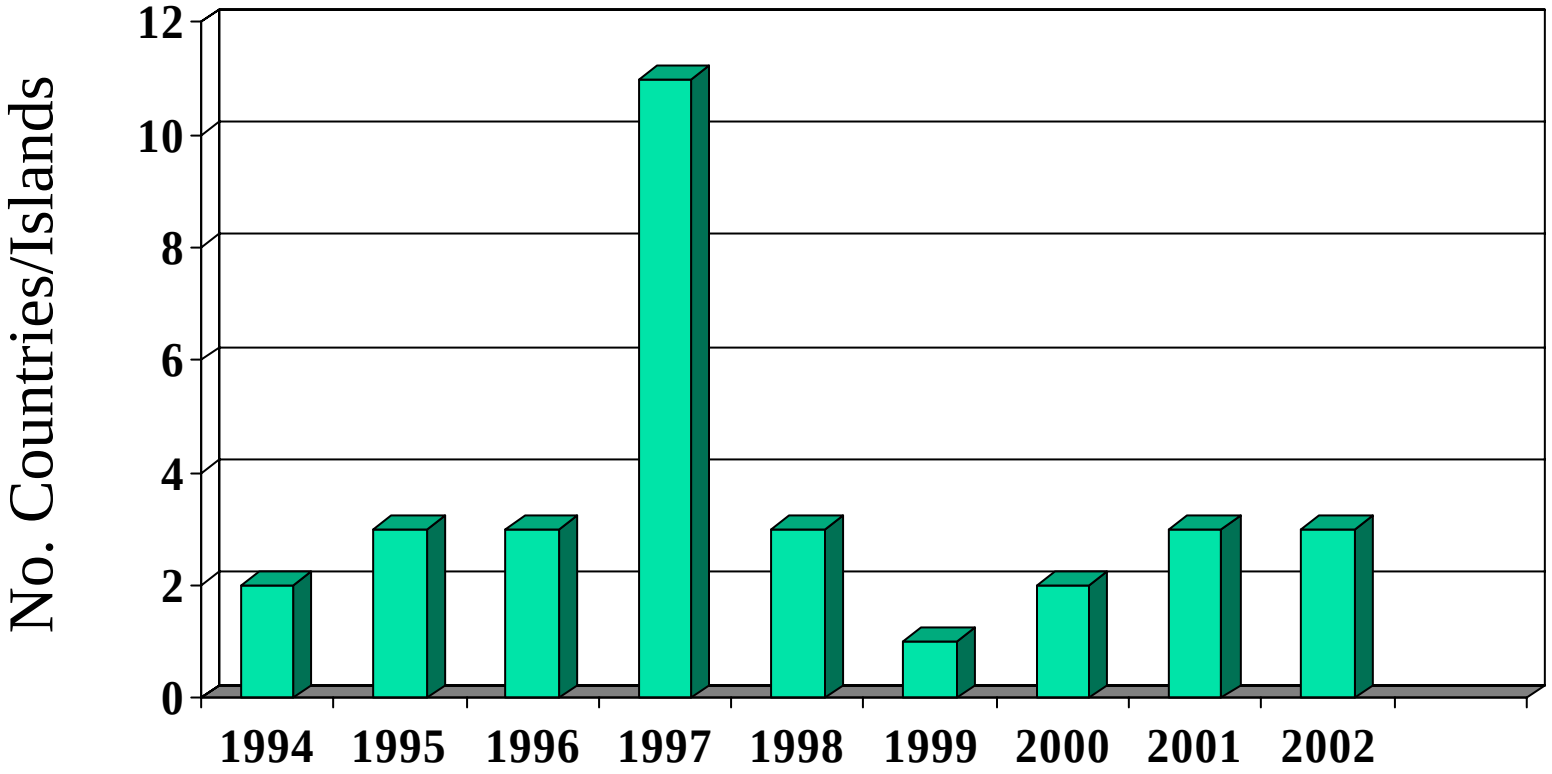
- Risk Element: HIGH
- Reduce Commodity Yield
- Lower Commodity Value
- Result in Loss of Markets
- Potential Economic Losses $2 Billion/year (2003 Dollars)

# Risk Assessment of PHM Environmental Impact

- Risk Element: HIGH
- Damage to agriculture, forestry and horticulture
- Attacks 6 Plant Genera that contain Threatened and Endangered Plant Spp.

  (Florida, Hawaii and Puerto Rico): *Caesalpinia, Colubrina, Curcurbita, Eugenia, Hibiscus and Vigna.*

# Spread of Pink Hibiscus Mealybug in Caribbean



# Spread of Pink Hibiscus Mealybug Throughout Western Hemisphere

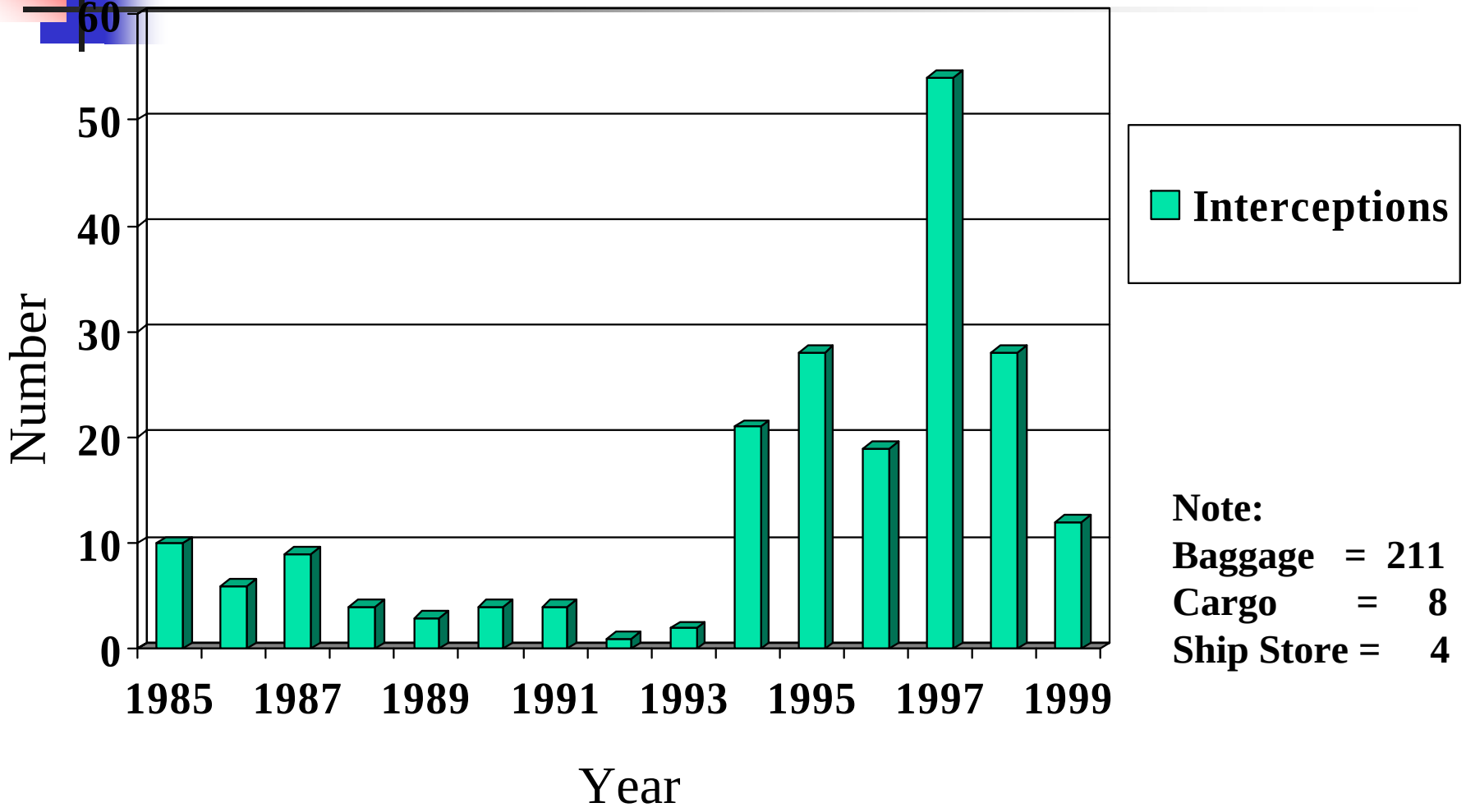
- **1984** - Hawaii
- **1994** - Grenada, Carriacou
- **1995** – Trinidad, St. Kitts and Nevis
- **1996** –Tobago, Aruba, St. Maarten, St. Lucia
- **1997** – St. Eustatius, Curacao, Anguilla, Guyana, British Virgin Islands, St. Vincent, Grenadines, St. Thomas, St. Croix, St. John, Culebra, Vieques
- **1998** – Montserrat, Guadeloupe, Puerto Rico
- **1999** – Martinique, USA (California), Belize, Mexico Venezuela ?
- **2000** – Barbados, Bahamas
- **2001** – Antigua, Dominica, Suriname
- **2002** – Florida (USA), Haiti, Dominican Republic

# Western Hemisphere Countries Infested with Pink Hibiscus Mealybug as of July 2004

# Risk Assessment of PHM
## US Entry Potential Consideration

- Risk Element: HIGH
- PHM Intercepted 813 times (PIN 2003)

# *Maconellicoccus hirsutus* Interceptions at Ports of Entry Into United States From Caribbean

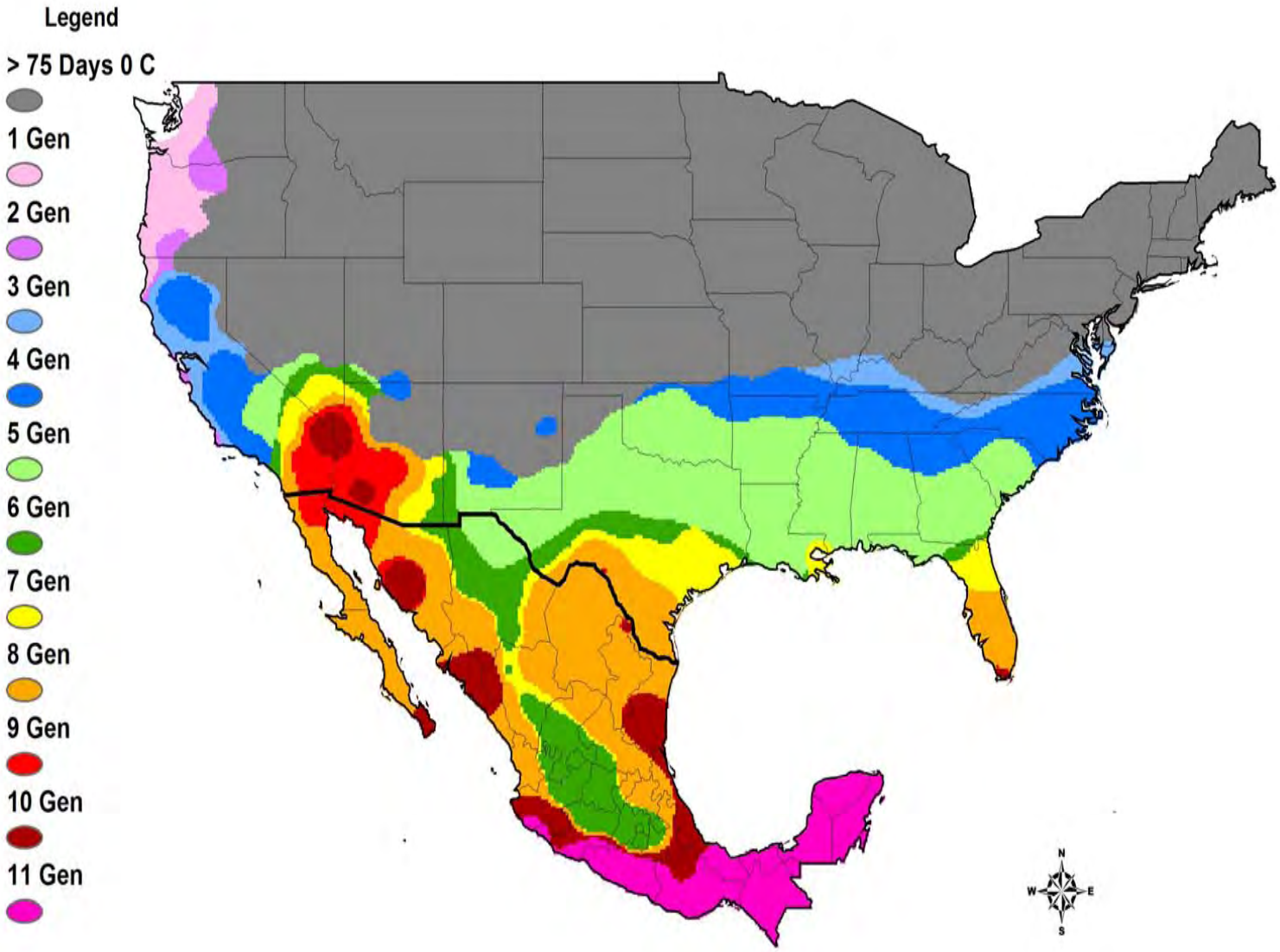


# Risk Assessment of PHM Habitat Suitability In US

- Risk Element: HIGH

- Attacks and survives on hosts in 4 or more plant hardiness zones

Climate Exclusion Map for PHM (75 days/yr with minimum daily Temperature lower than 0 degrees C)

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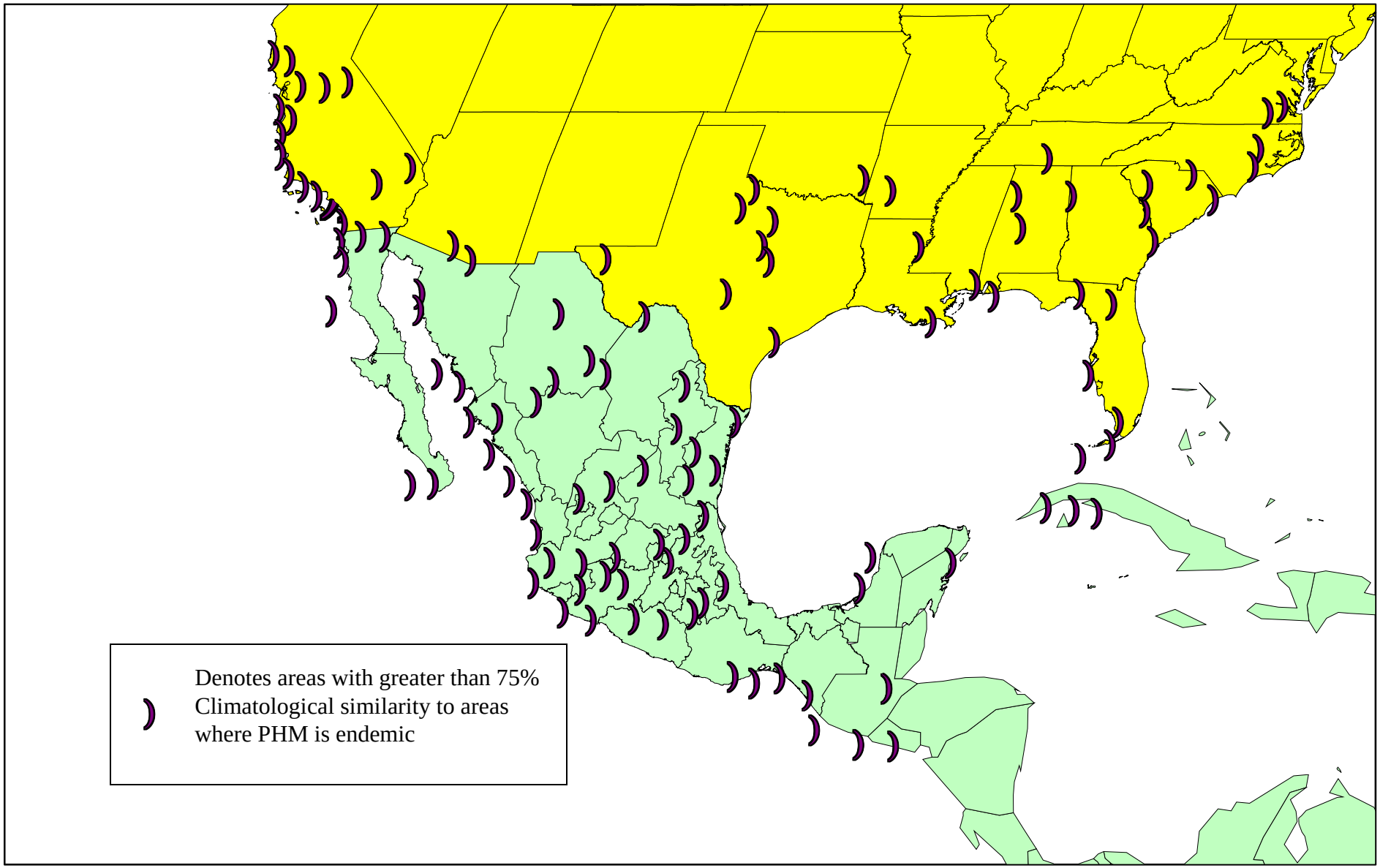
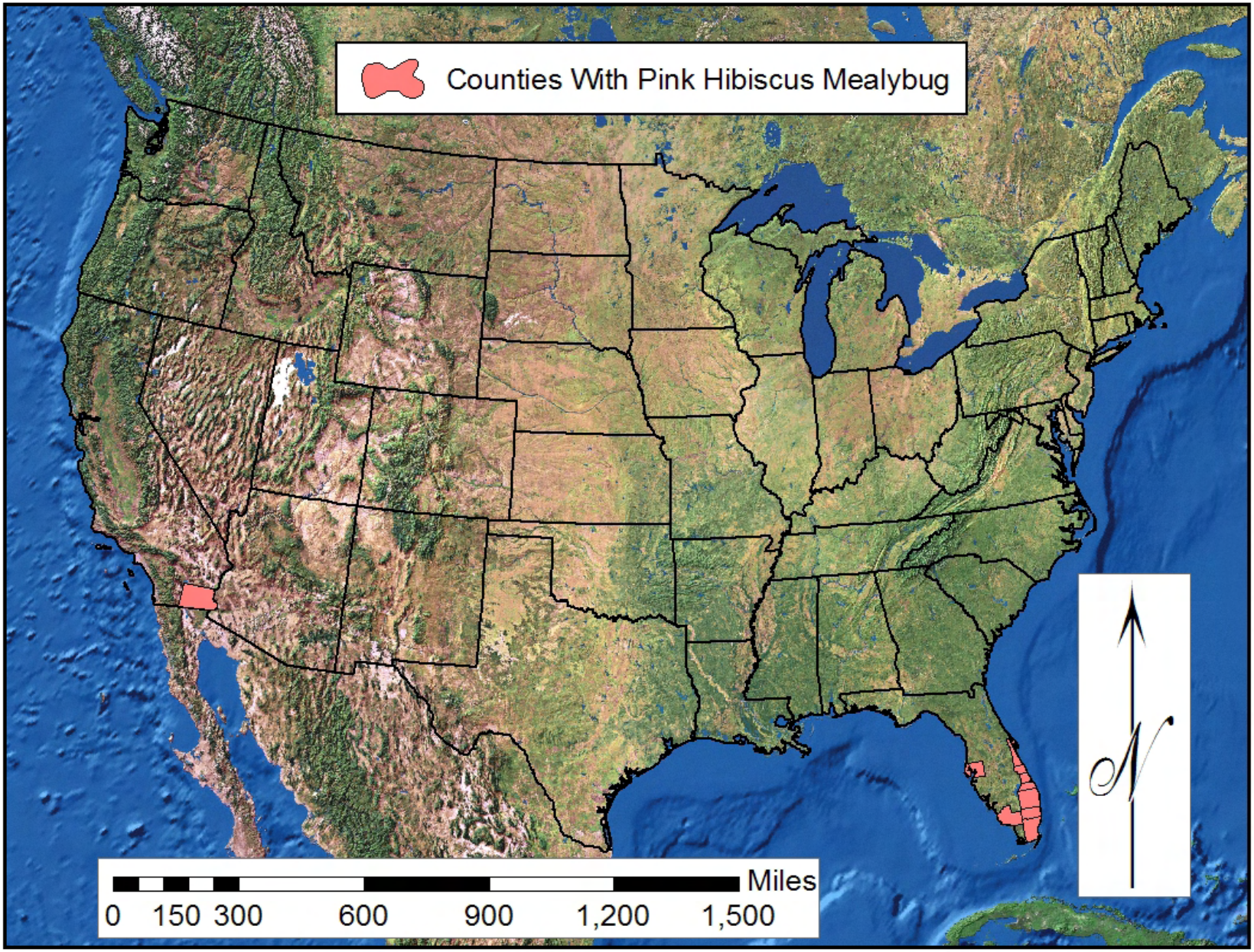



Figure 2. Climex simulation showing PHM potential ecological range

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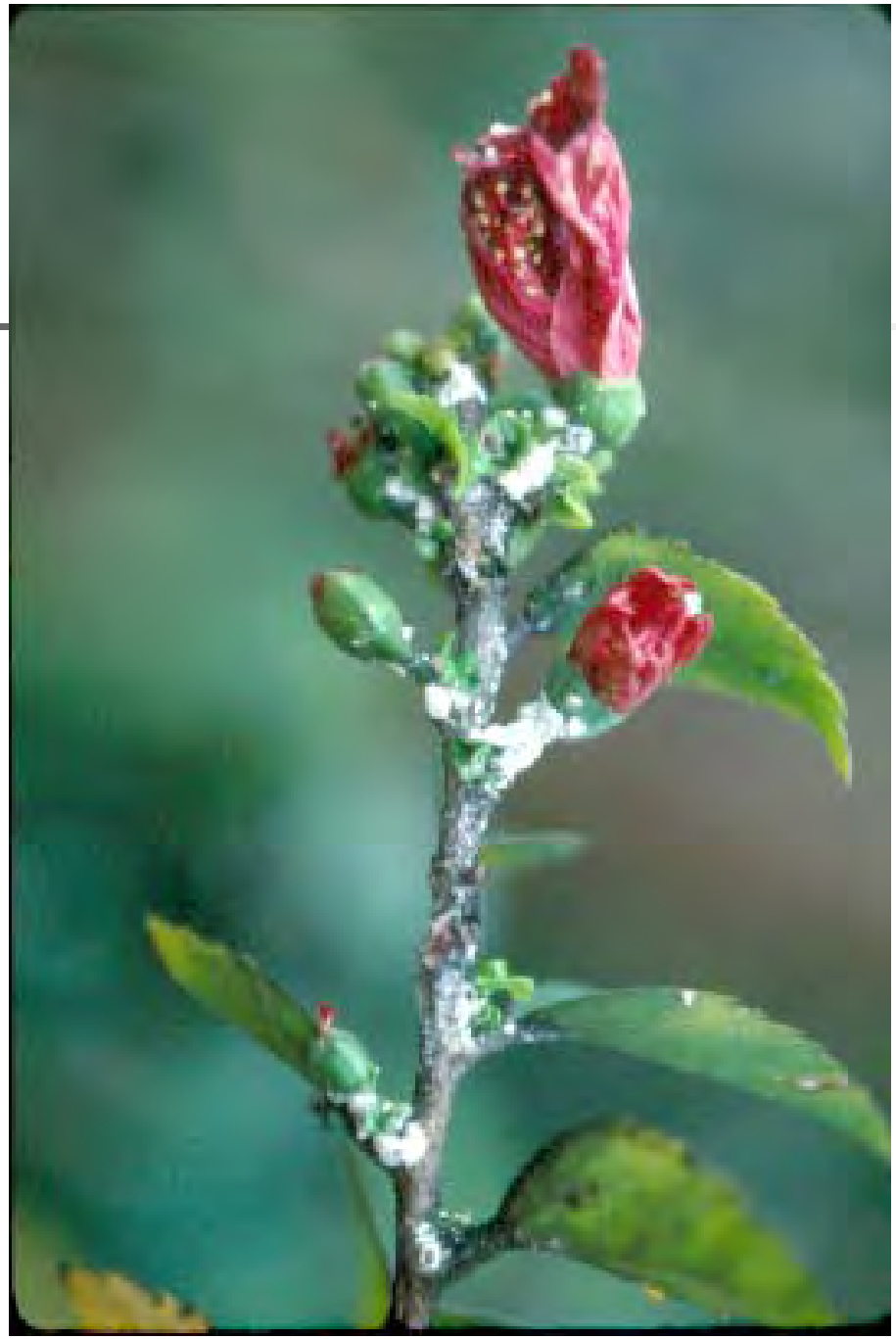
# Damage
# -Pink Hibiscus Mealybug-

- Toxic saliva
- Results in malformation of leaves, fruit and shoot growth
- Stunting of plant growth
- Occasional death of plant
- Shortened internodes = “Bunchy Top”
- Black Sooty Mold



PHM
Infested Hibiscus

PHM
Defoliated Hibiscus

Dead  Hibiscus Shrubs – St Kitts

Healthy Sammon Tree

Dead Sammon Tree – Grenada With PHM Egg Mass

Healthy Soursop Fruit

PHM Infested Soursop Fruit

# Hawaii Infestation
# -Pink Hibiscus Mealybug-

- Since 1983
- **Not** an economically important pest
- Attacked by two primary, internal hymenopterous parasites
- Parasites:
  - 1) *Anagyrus kamali* Moursi
  - 2) *Anagyrus* sp.

# Exotic Parasitoids Introduced

- Quarantine Facility – USDA, ARS, Newark, Delaware
- *Anagyrus kamali*
  - China
  - Hawaii
  - Taiwan
- *Gyranusoidea indica*
  - Egypt
  - Pakistan
  - Australia
- *Allotropa mecrida*
  - Egypt
  - Puerto Rico

# Economic Benefits of Biocontrol Program

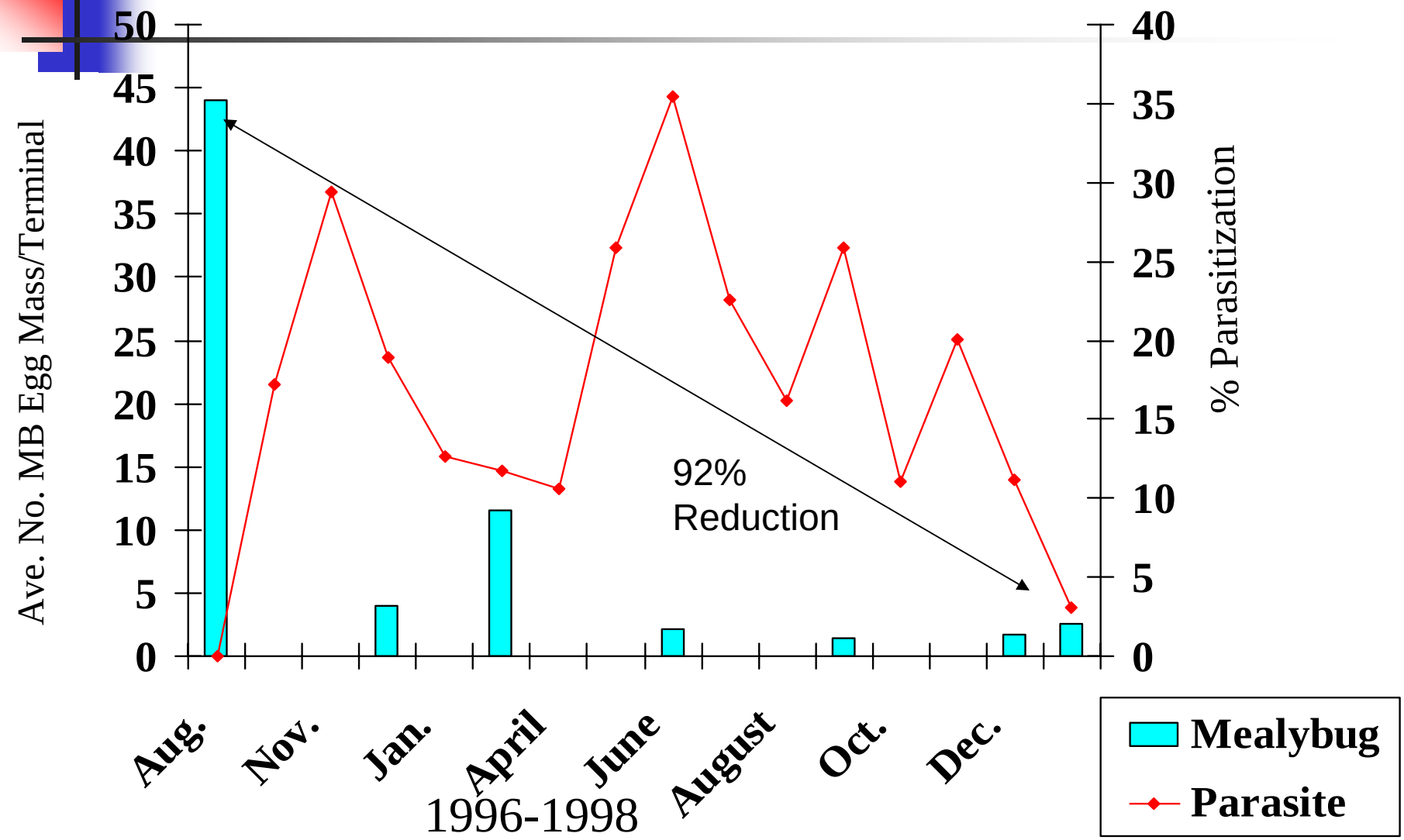
- 750 Million Dollars/Year Loss (1997)
- Estimated cost of Biological Control Technology Development and Transfer= **$500,000**/year for 3 to 5 years
- Expected Economic Benefits to Costs Ratio for a Single Year Exceeds **1500:1**
- Based on 1997 Dollars and value of: Avocado, Citrus, Cotton, Grape, Mango, Ornamentals and Vegetables

*Anagyrus Kamali*

# Technology Transfer of PHM Biological Control Program To:

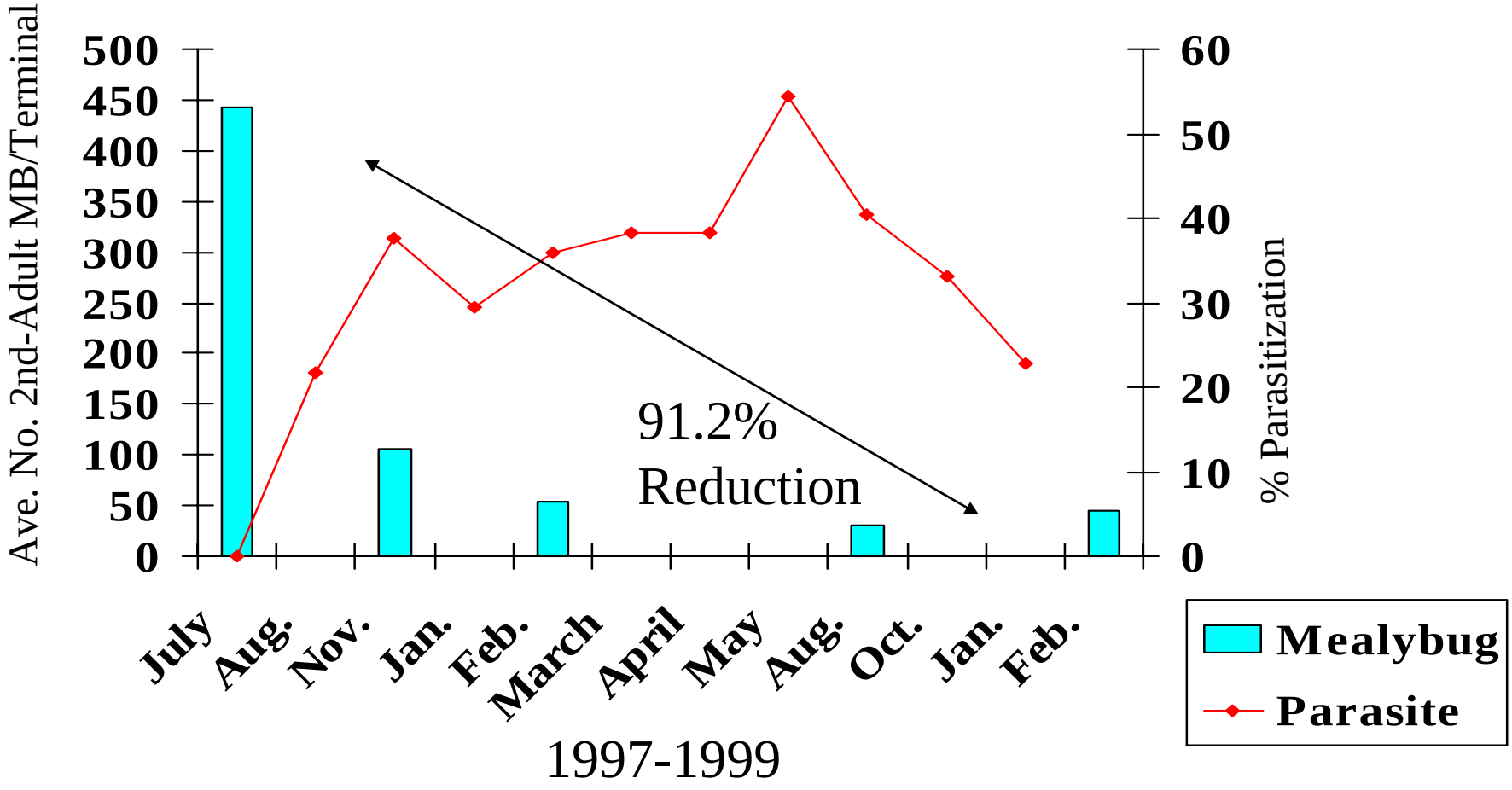
- St. Kits, W.I. - 1996
- US Virgin Islands - 1998
  - St. Thomas
  - St. Croix
  - St. John
- Puerto Rico - 1999
  - Vieques
  - Culebra
- Belize – 1999
- California - 1999
- Bahamas – 2000
- St. Eustatius - 2001
- Haiti – 2002
- Dominican Republic – 2002
- Florida - 2002

# Impact of Parasites on Pink Hibiscus Mealybug – St. Kitts, W.I.



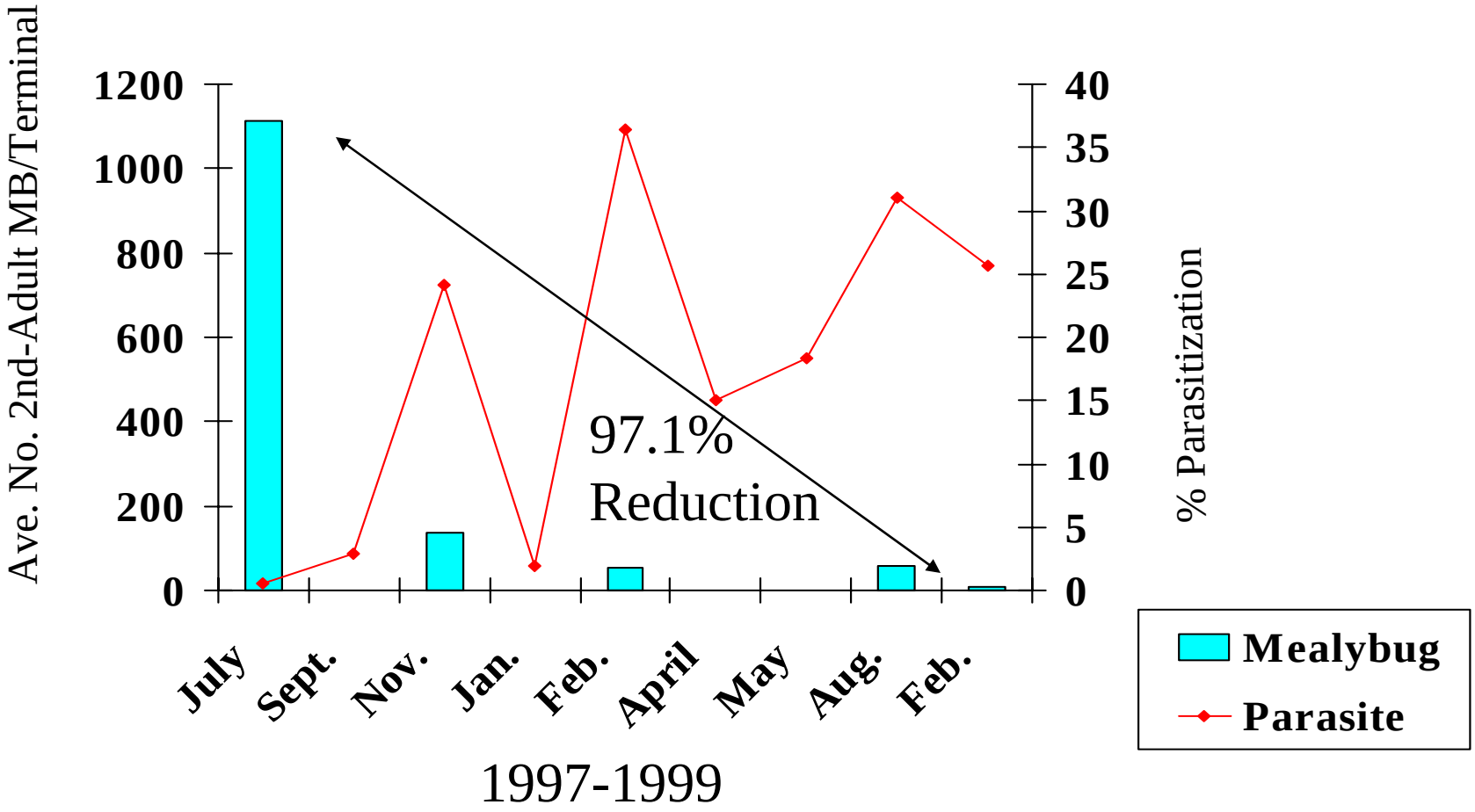
# Impact of Parasites on Pink Hibiscus Mealybug

## St. Thomas, U.S.V.I. (Hibiscus)

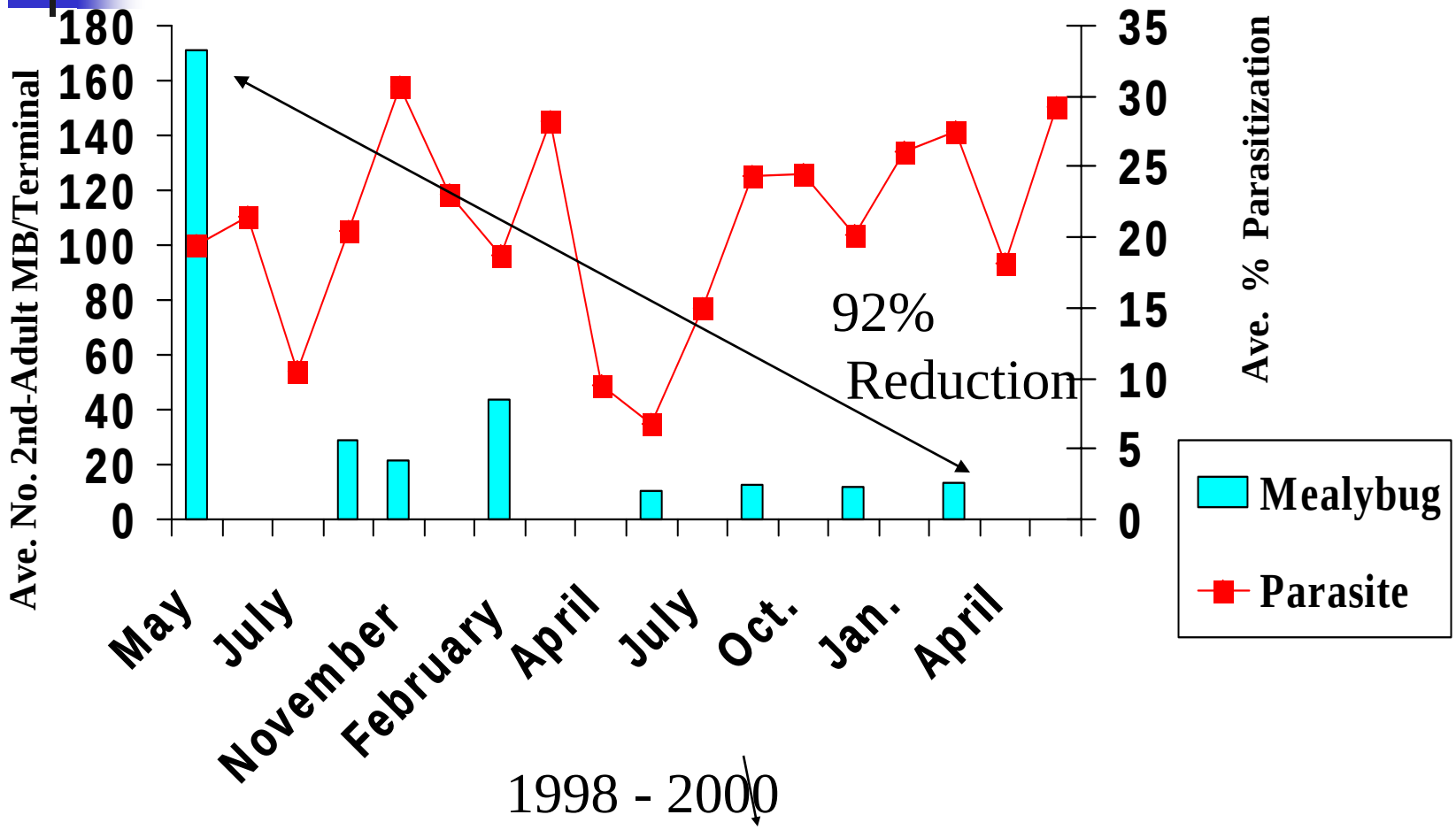


# Impact of Parasites on Pink Hibiscus Mealybug

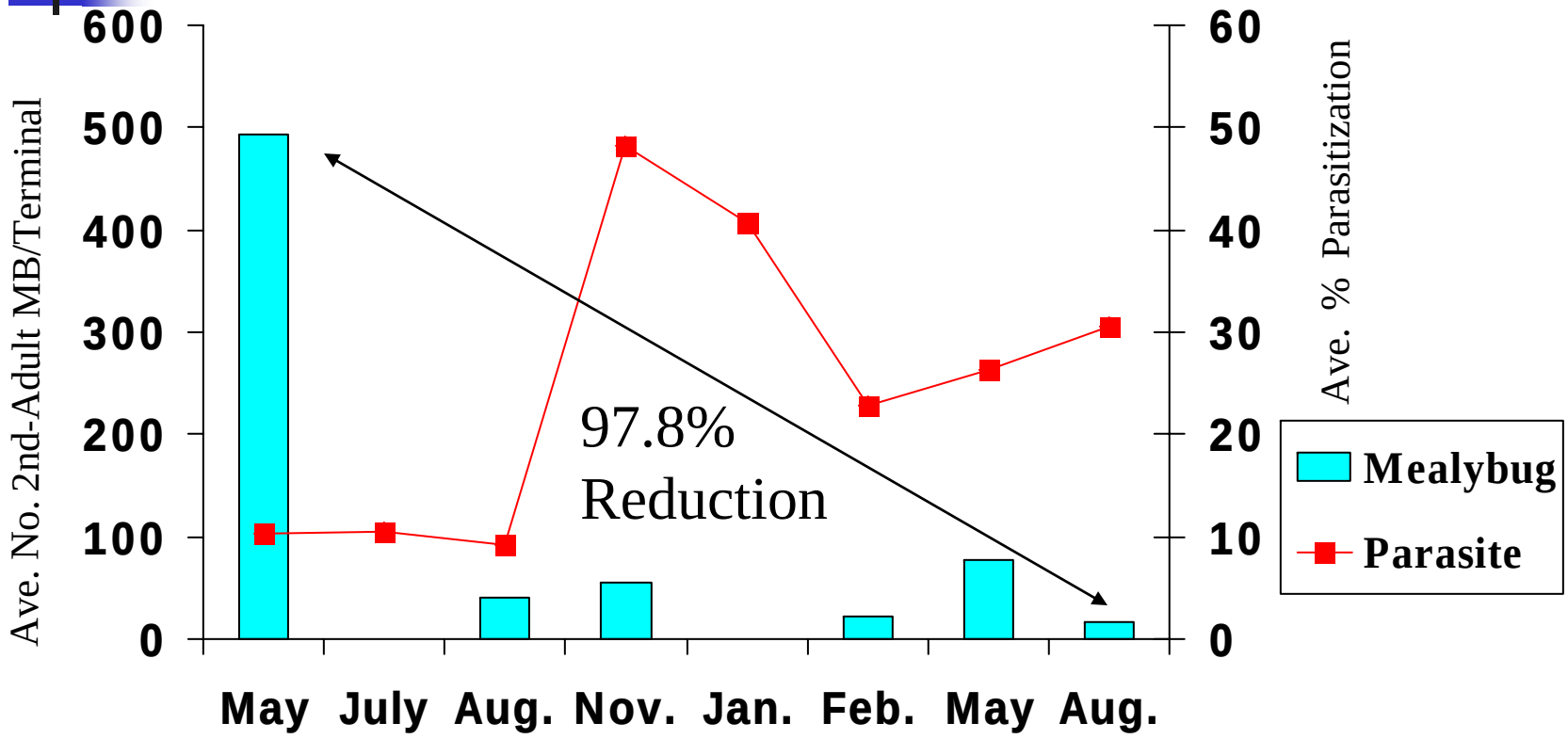
## St. Coix, U.S.V.I. (Hibiscus)



# Impact of Parasites on Pink Hibiscus Mealybug Puerto Rico (Hibiscus)



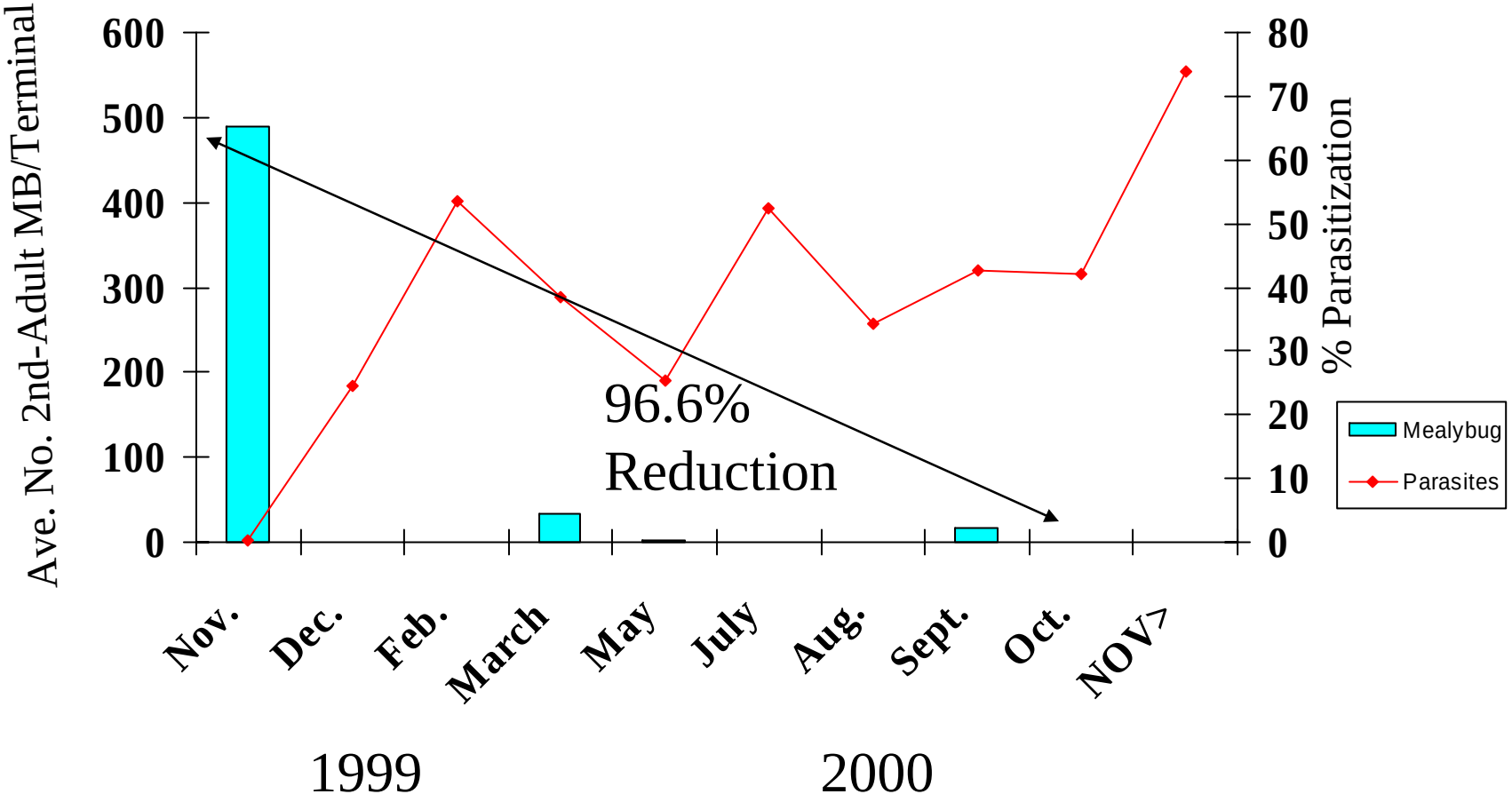
# Impact of Parasites on Pink Hibiscus Mealybug Vieques (Hibiscus)



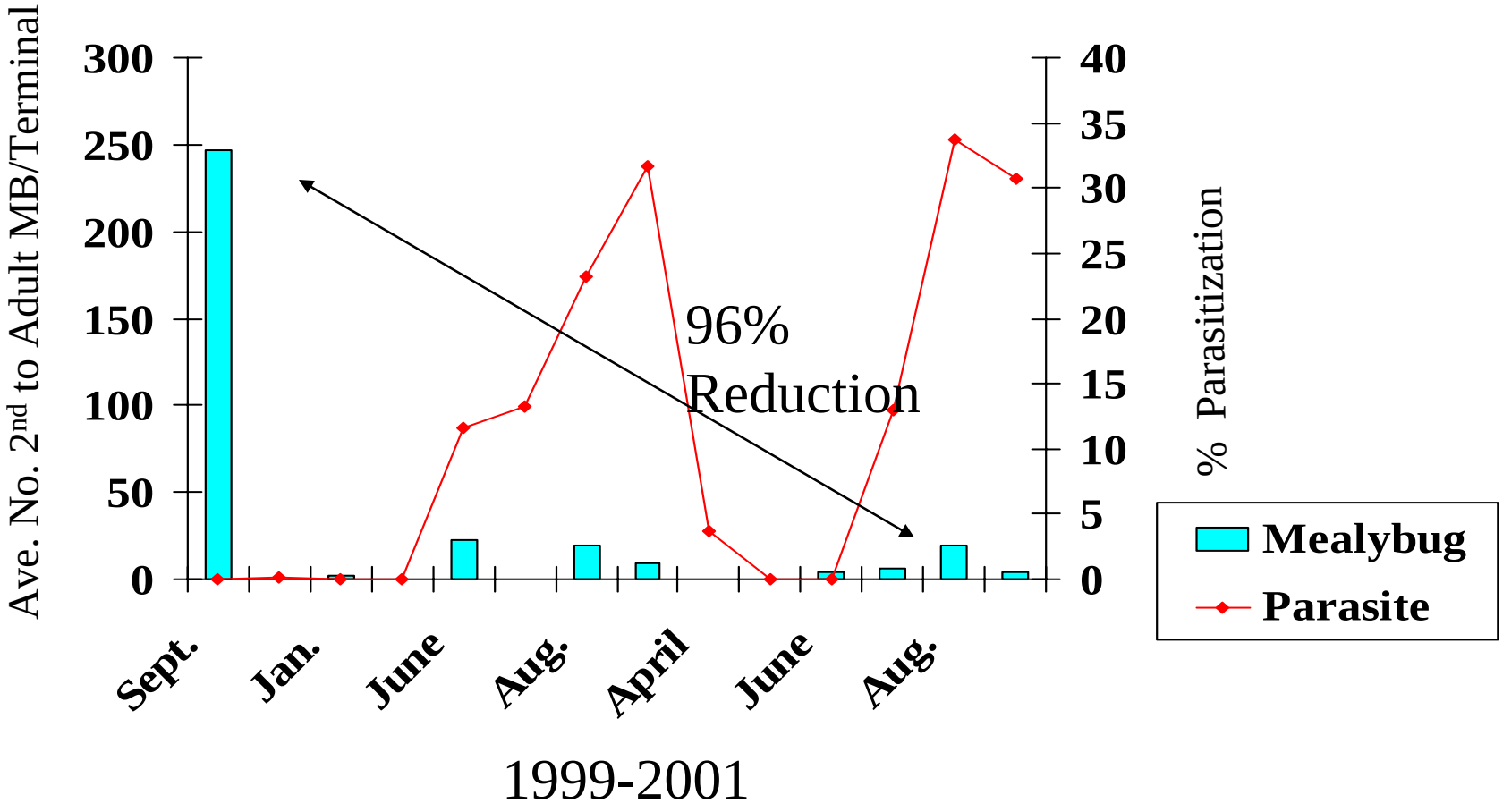

1998 - 1999

# Impact of Parasites on Pink Hibiscus Mealybug

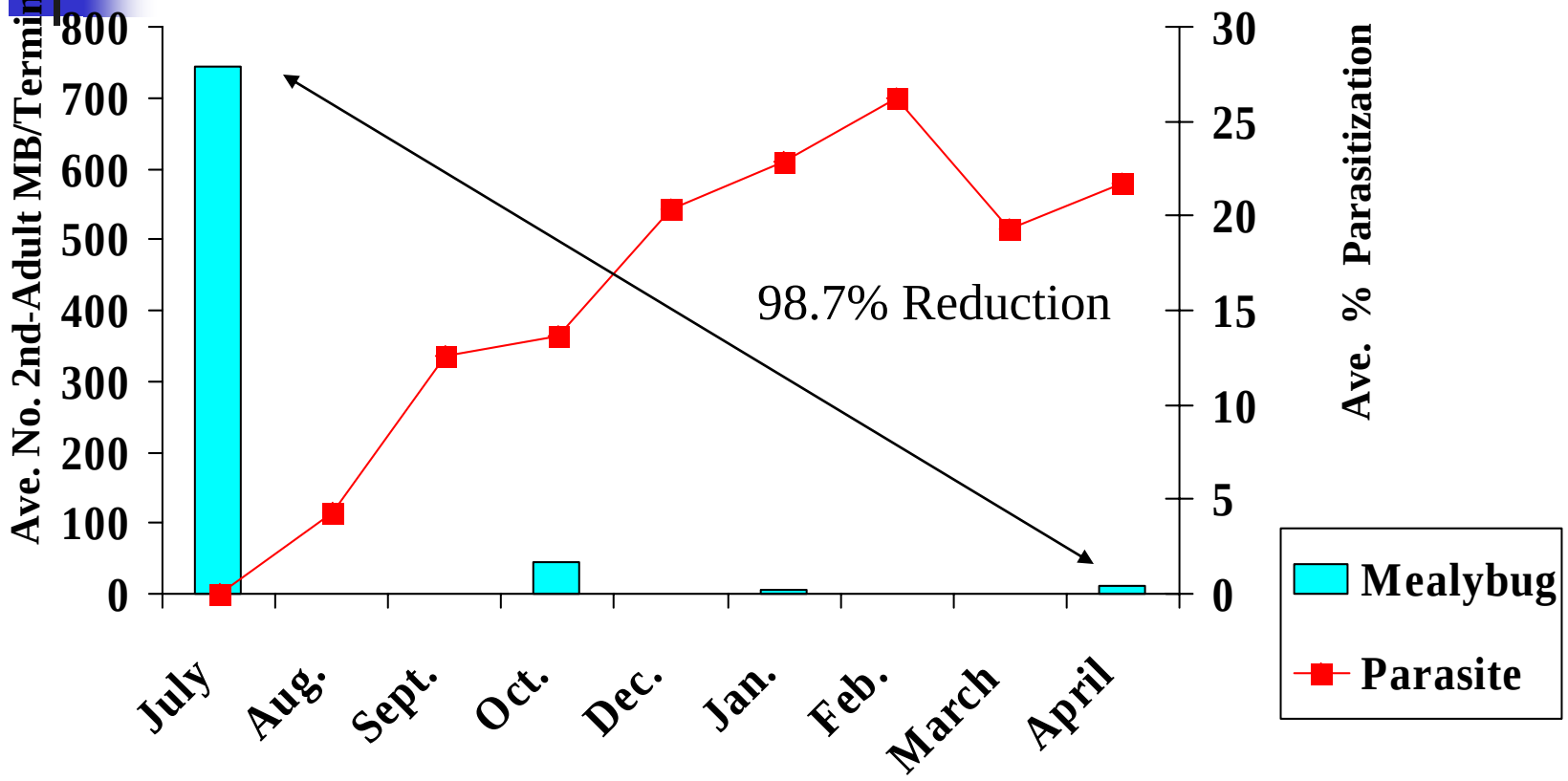
## Belize - Hibiscus



# Pink Hibiscus Mealybug in Imperial County, California (Mulberry)

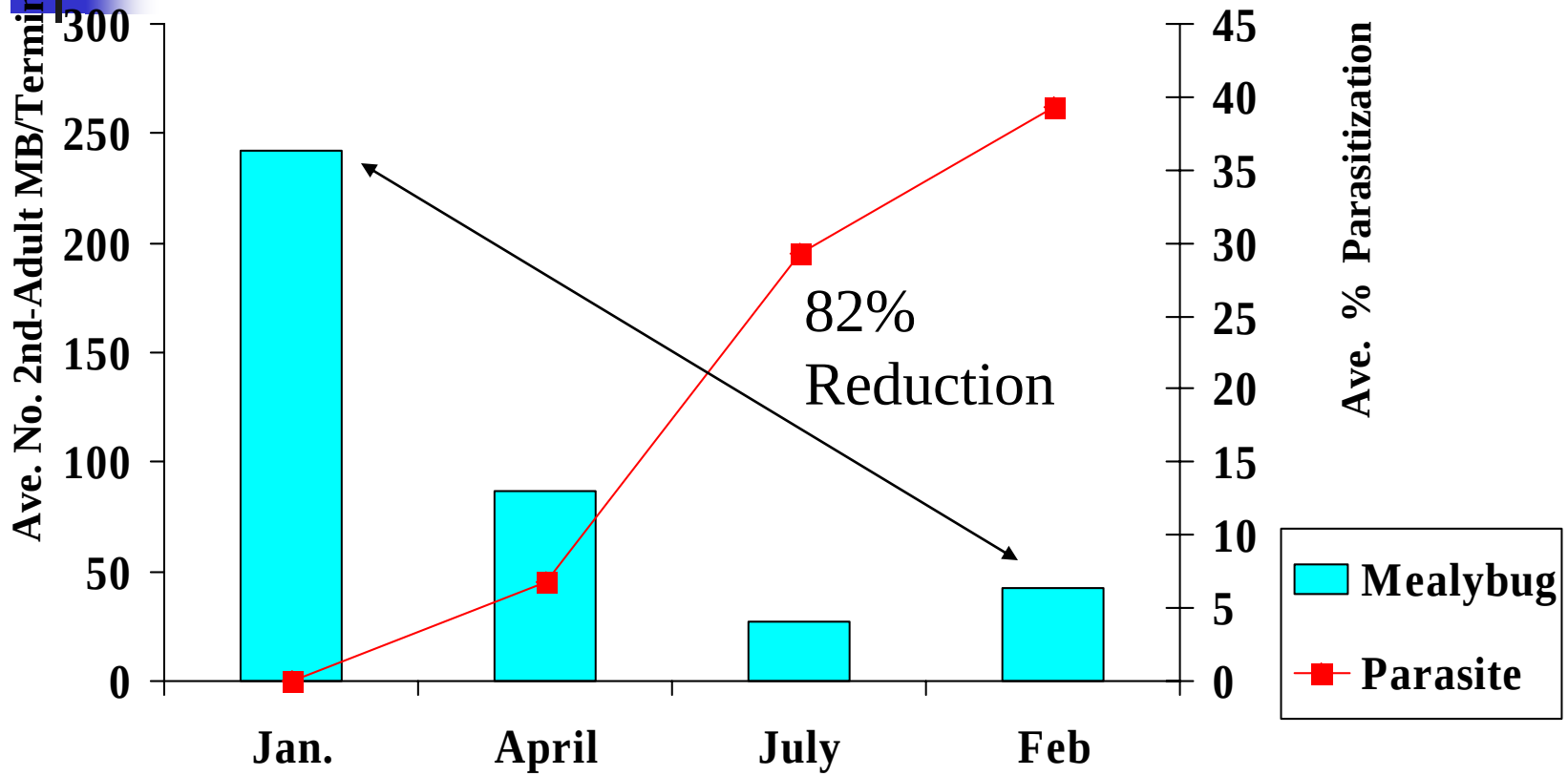


# Impact of Parasites on Pink Hibiscus Mealybug - Florida (Hibiscus)



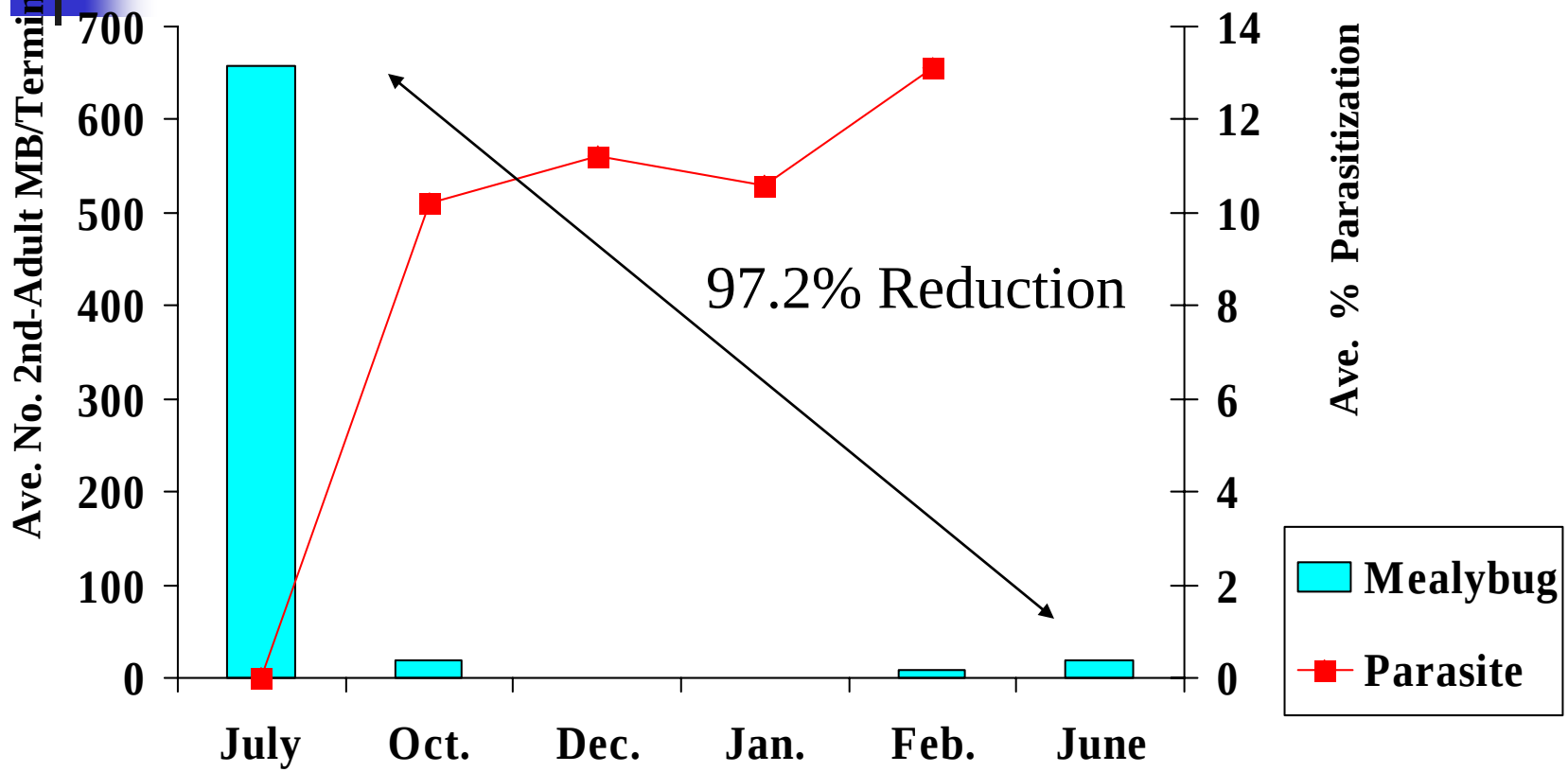

2002 - 2003

# Impact of Parasites on Pink Hibiscus Mealybug - Nassau, New Providence, Bahamas (Hibiscus)



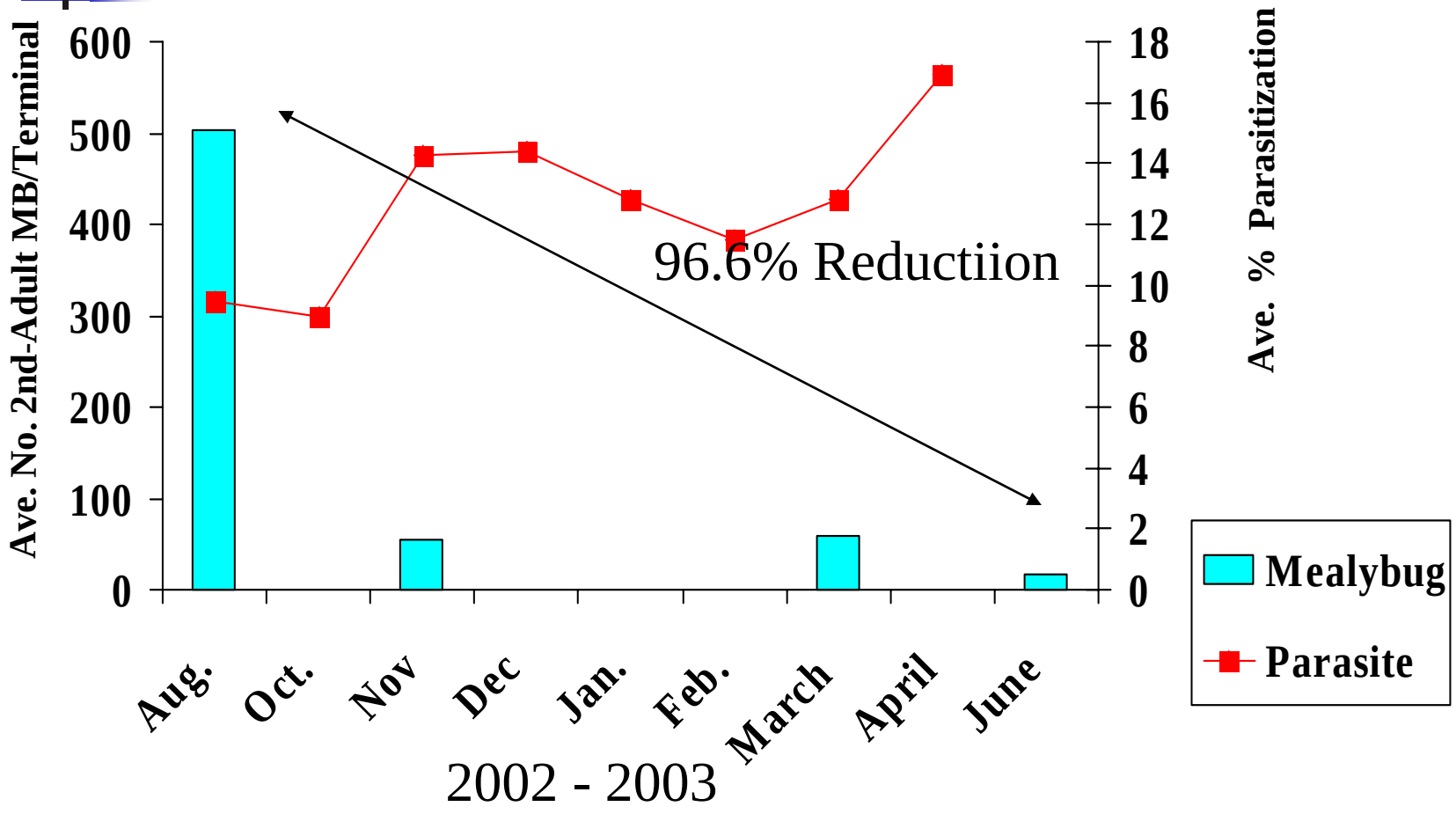

2001-2002

# Impact of Parasites on Pink Hibiscus Mealybug - Haiti (Hibiscus)




2002 - 2003

# Impact of Parasites on Pink Hibiscus Mealybug – Dominican Republic (Hibiscus)



# Level of PHM Population Density Reduction by Parasitoids

**Hibiscus**

- St. Kitts = 91.6 %
- US Virgin Islands
  St. Thomas = 91.2%
  St. Croix = 97.1%
- Puerto Rico = 92%
- Culebra = 96.5%
- Vieques = 97.8%
- Belize = 96.6%
- California
  Mulberry = 96%
  Carob = 93%
- Bahamas = 82%
  (1 year)
- Florida = 98.7%
- Haiti = 97.2%
- Doinican Republic = 96.6%

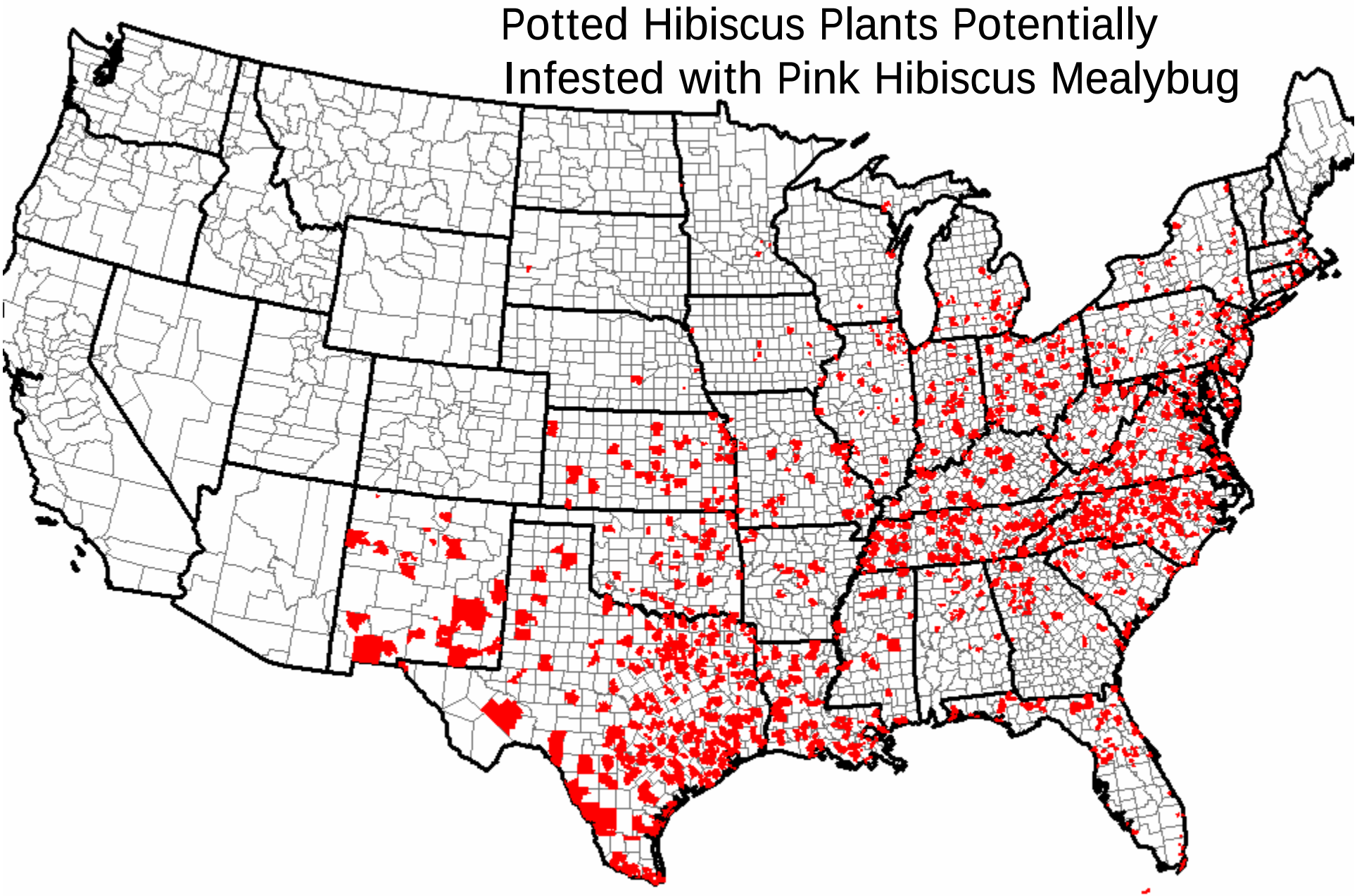
# Potential Spead of PHM in United States in 2005

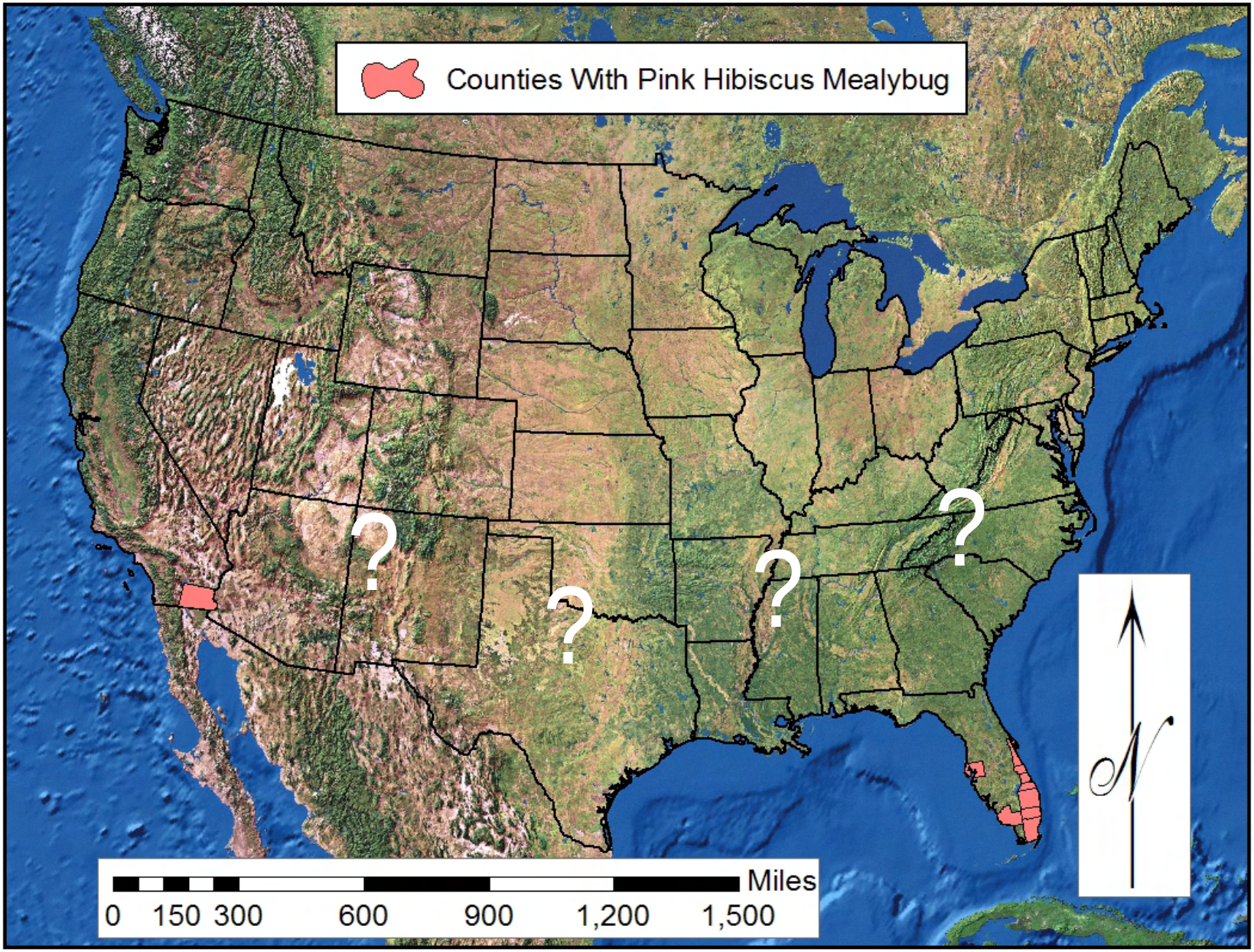
- Florida Nursery Shipped 900,000 potted hibiscus plants to 36 States from January to July 2005
- 11 of 17 States Climatically suitable for PHM
- Shipments were found to be partly infested with PHM in Late July 2005

# Potential Spead of PHM in United States in 2005

- Shipments made to Garden Centers of Major Establishments
- PHM recovered from Garden Centers in Louisiana, North Carolina and Kansas.

Homestead, Florida Shipments from January through July 2004



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