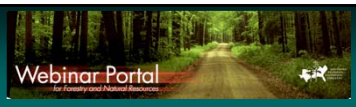
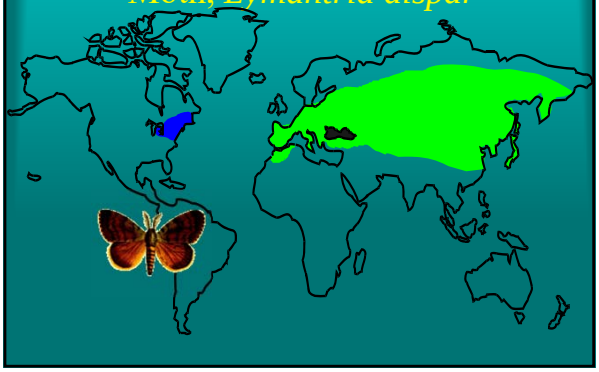


Gypsy Moth Biology, Ecology, Management, and Implications for the Southeastern U.S.

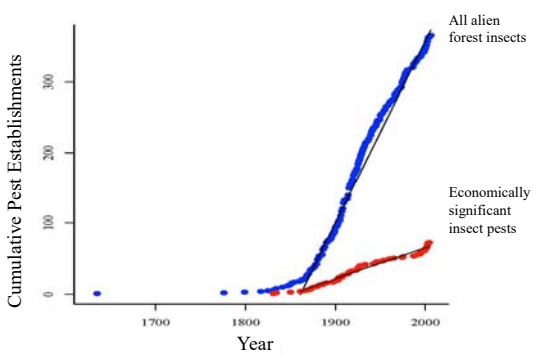
Andrew Liebhold
US Forest Service Northern Research Station, Morgantown, WV

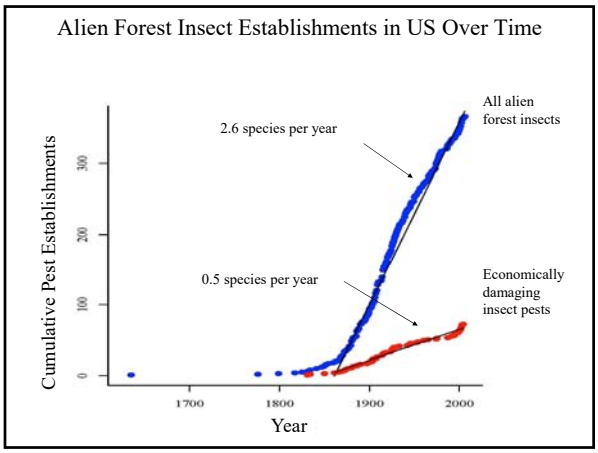
Mar 23, 2016 1:00 pm US/Eastern

World Distribution of the Gypsy Moth, *Lymantria dispar*

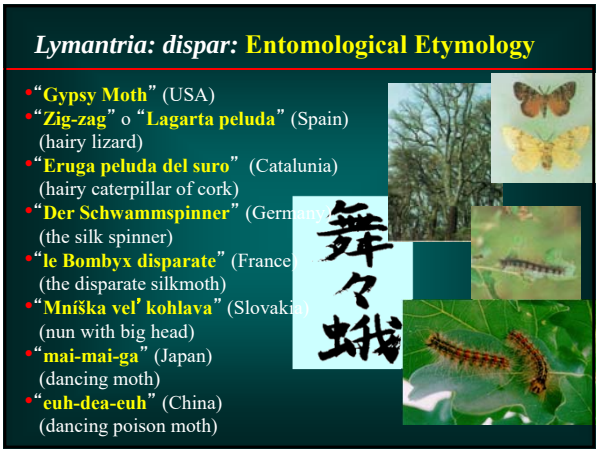


Alien Forest Insect Establishments in US Over Time

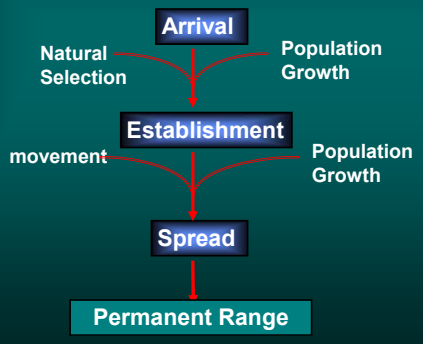



Alien Forest Insect Establishments in US Over Time
Cumulative Pest Establishments
0
100
200
300
1700
1800
1900
2000
Year
2.6 species per year
0.5 species per year
All alien forest insects
Economically damaging insect pests


Gypsy Moth Outbreaks

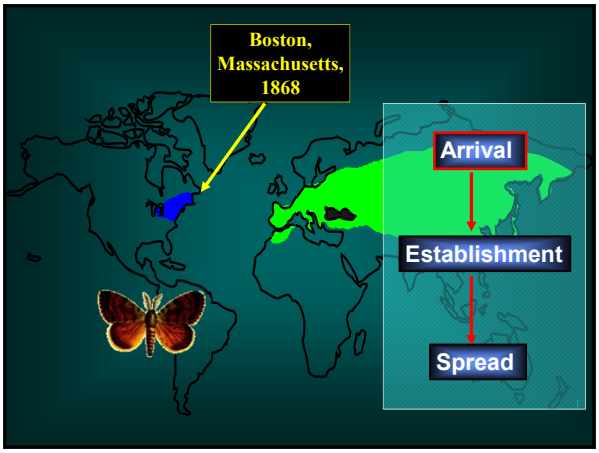

Lymantria: dispar: Entomological Etymology
"Gypsy Moth" (USA)
"Zig-zag" o "Lagarta peluda" (Spain)
(hairy lizard)
"Eruga peluda del suro" (Catalunia)
(hairy caterpillar of cork)
"Der Schwammspinner" (Germany)
(the silk spinner)
"le Bombyx disparate" (France)
(the disparate silkmoth)
"Mníška vel' kohlava" (Slovakia)
(nun with big head)
"mai-mai-ga" (Japan)
(dancing moth)
"euh-dea-euh" (China)
(dancing poison moth)
舞々蛾

Three Phases of Biological Invasions:



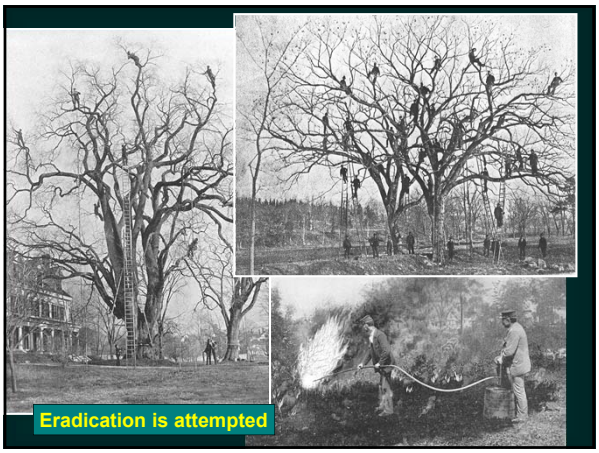
Management of Biological Invasions

Phase	Action
Arrival	Quarantine, Inspection
Establishment	Surveillance, Eradication
Spread	Barrier Zones, etc
Permanent Range	Biological Control, Silviculture

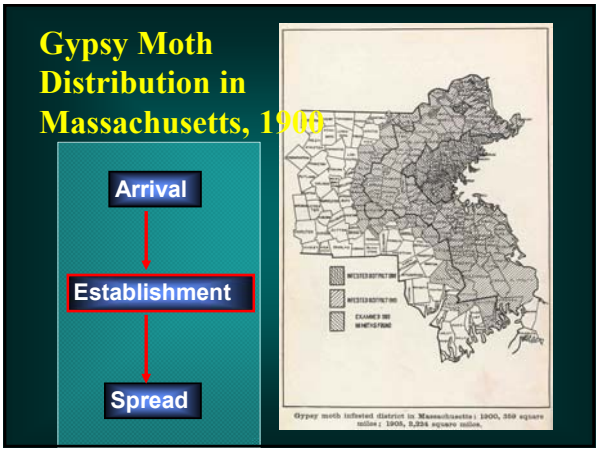


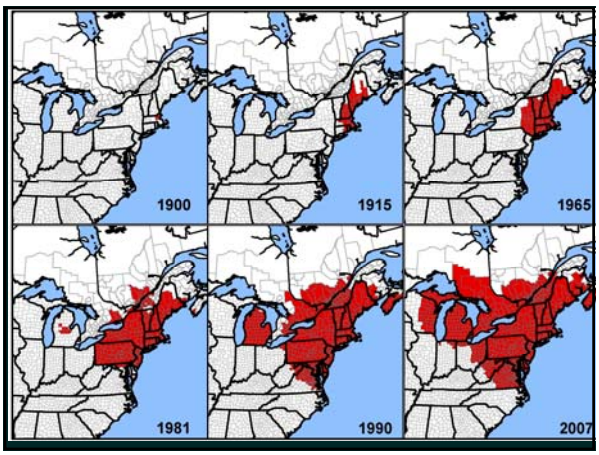
Étienne Léopold Trouvelot, 1827 - 1895

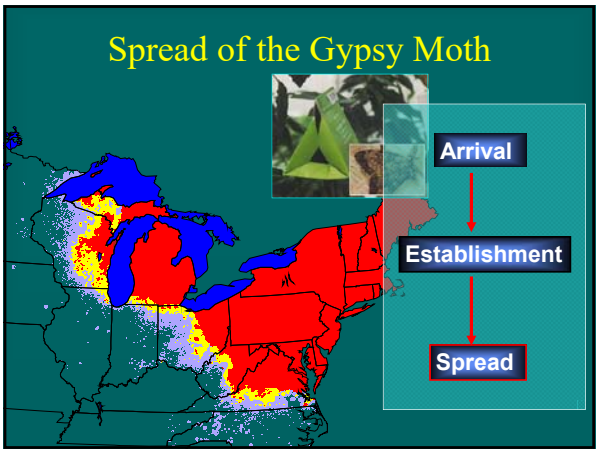
Forbush EH, Fernald CH (1896) The gypsy moth, *Porthetria dispar* (Linn). Wright and Potter, Boston

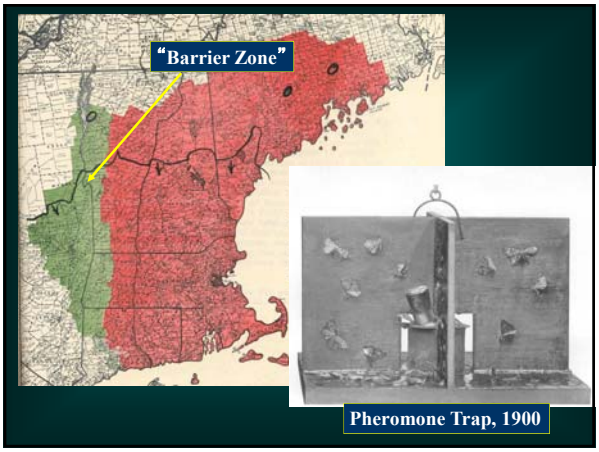


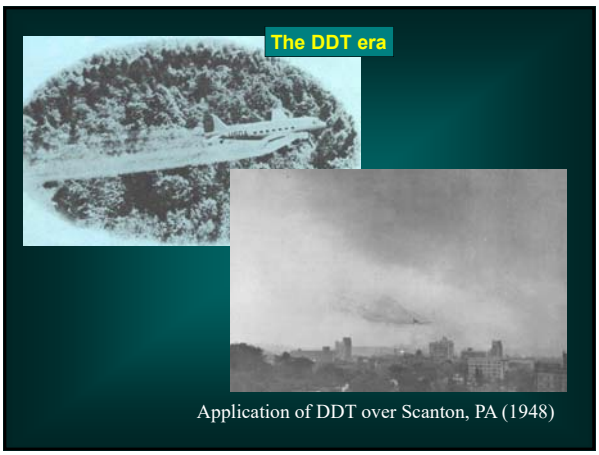
Gypsy Moth Distribution in Massachusetts, 1906

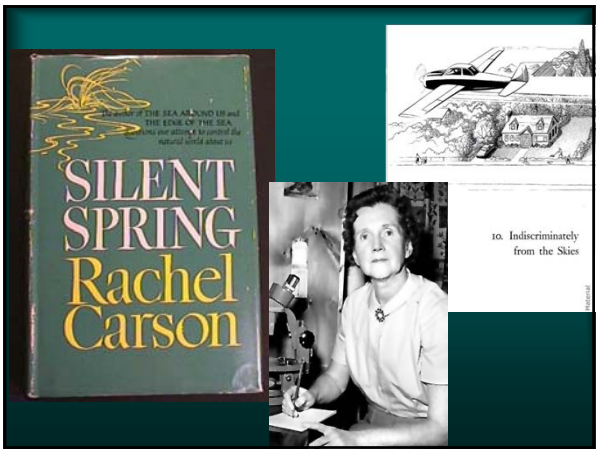





Spread of the Gypsy Moth
Arrival
Establishment
Spread


"Barrier Zone"
Pheromone Trap, 1900

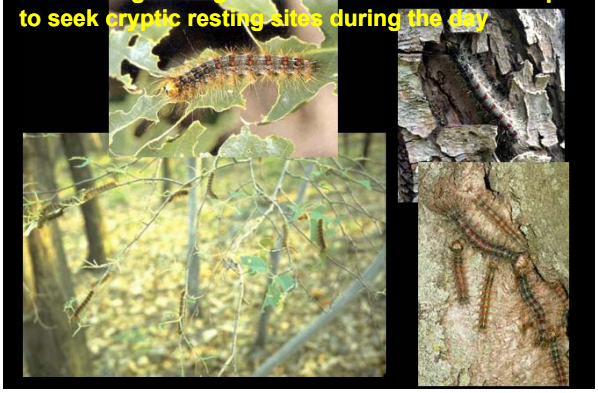

The DDT era
Application of DDT over Scanton, PA (1948)


SILENT
SPRING
Rachel
Carson
10. Indiscriminately
from the Skies


Gypsy moth egg masses are laid in late summer
and present all winter
old
new

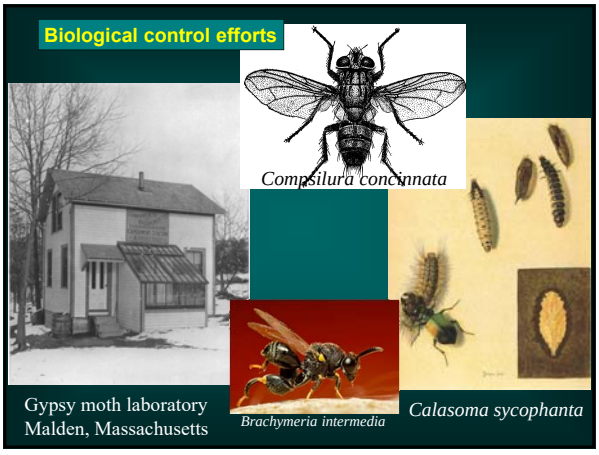

In spring, first instars hatch from egg masses, climb
trees, spin down on silk threads and begin feeding

Gypsy moths have 5-6 larval instars. Late instars feed during the night and crawl down from canopies to seek cryptic resting sites during the day



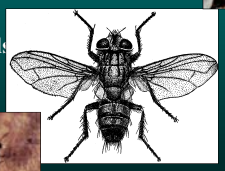
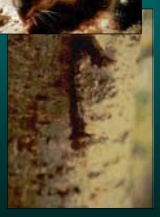
Larvae pupate at resting sites. Pupal period lasts ~10 days. Adults eclose, mate and oviposit typically all at the larval resting sites

Biological control efforts

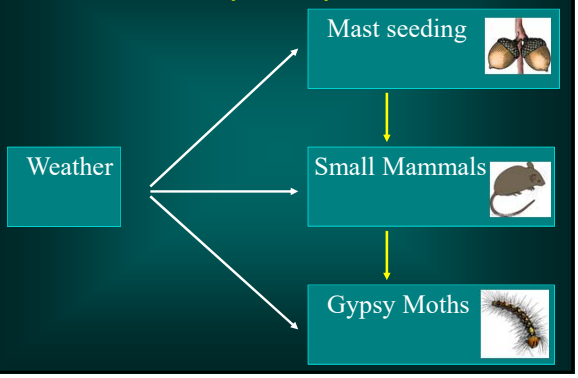


Factors affecting gypsy moth dynamics

- **Generalist predators**
- **Pathogens**
- **Induced host defenses**
- **Parasitoids**

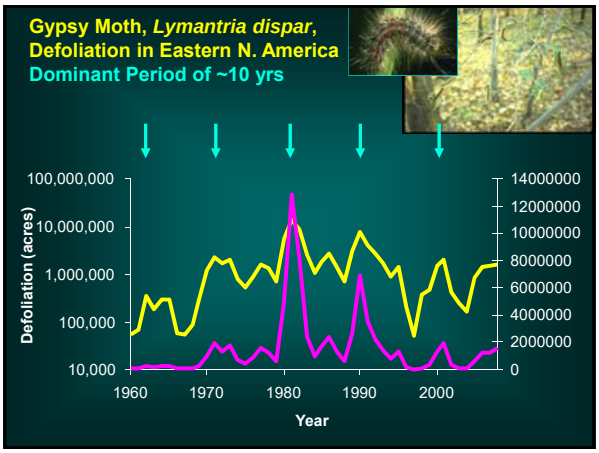

Trophic influences on *Lymantria dispar* Spatial Synchrony

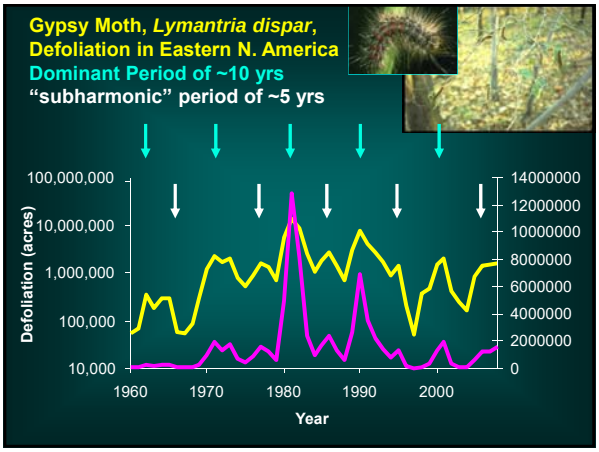


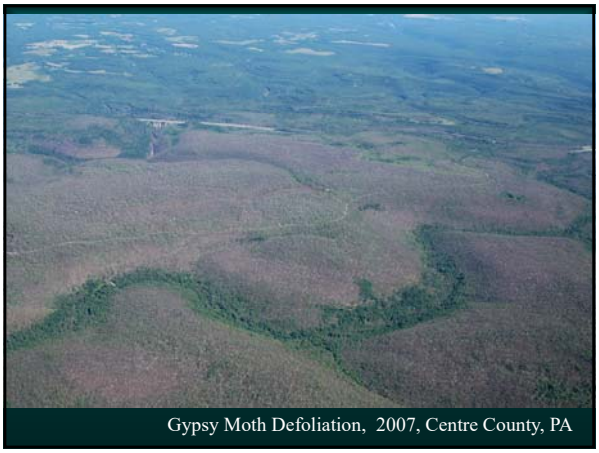
Gypsy Moth Pathogens

- Virus*: L. dispar* nucleopolyhedrovirus
- Fungus: *Entomophaga maimaiga*,








Gypsy Moth Defoliation, 2007, Centre County, PA

Host Preferences

Favored (Susceptible)

Oaks	Aspens	Basswood	Willows
Apple	White Birch	Larch	Sweetgum
Gray Birch	Hawthorns	Witch-hazel	Serviceberry

Also Eaten (Resistant)

Beech	Maples	Cherry	Pines
Hemlock	Spruces	Chestnut	Hickories
Butternut	Walnut	Cottonwood	Yellow Birch

Not Eaten (Immune)

Ashes	Cedars	Locusts	Yellow-Poplar
Junipers	Sycamore	Balsam Fir	Horsechestnut
Dogwood	Azaleas	Laurels	Rhododendrons

Defoliated Oaks

Yellow Poplar, No Defoliation

Stand Susceptibility

- Probability of defoliation by the gypsy moth given that it is present

Stand Vulnerability

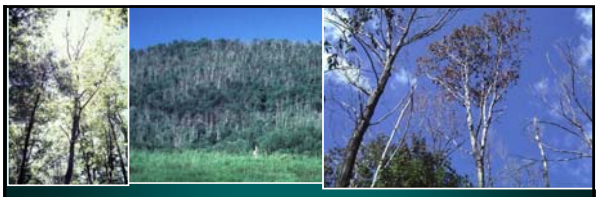
- Probability of damage given that defoliation has occurred

Stand Susceptibility

Percent Preferred Species	Susceptibility Category
0 – 20	Low
20 – 50	Moderate
50 – 80	High
80 - 100	Very High

Typical defoliation of ridge tops in Central Pennsylvania

"Catastrophic" tree mortality



Determinants of Tree Mortality Levels Associated with Gypsy Moth Outbreaks

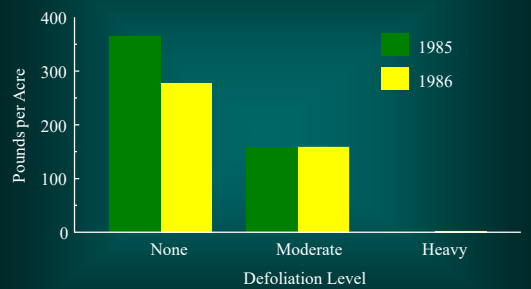
- Intensity and frequency (no. years) of defoliation
- Abiotic influences (drought, late frost, etc)
- Crown condition, crown position
- Secondary agents

Secondary agents associated with gypsy moth outbreaks

Shoestring root rot, *Armillaria mellea*

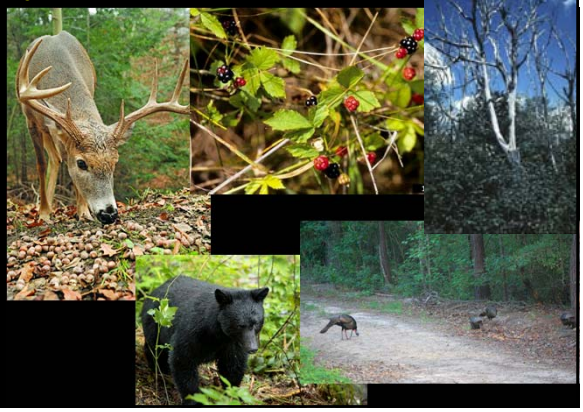
Twolined chestnut borer, Agrilus bilineatus

Effect of Gypsy Moth Defoliation Level on Sound Acorn Biomass Production



McConnell, S. P. (1988). Effects of gypsy moth defoliation on acorn production and viability, litterfall, and litter layer depth and biomass in north-central Virginia and western Maryland. MS Thesis, Virginia Tech University

Negative effects on hard mast but positive effects on soft mast

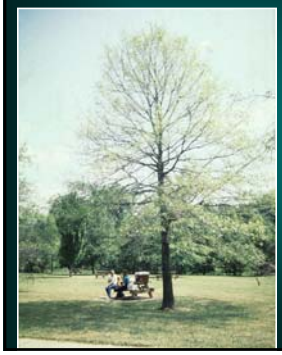


Impacts of Gypsy Moth Outbreaks

- Market values – Timber
  - Tree Growth and Yield
  - Tree Mortality
- Non- market values
  - Wildlife
  - Nutrient cycling, stream water, public water usage
  - Recreation
  - Residential Nuisance and aesthetics

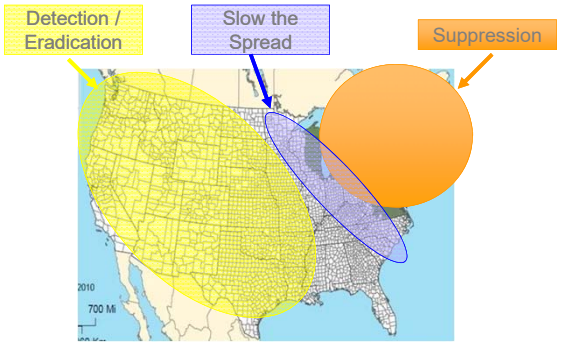
Defoliation results in nitrogen leaching in streams and may trigger microbial blooms in lakes

Visual Impacts of Defoliation on Recreational Values

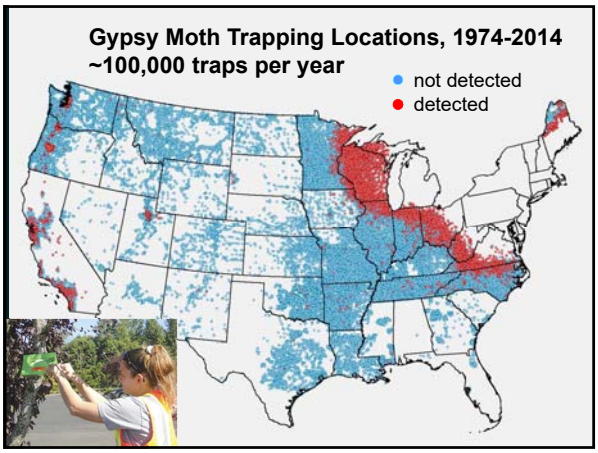


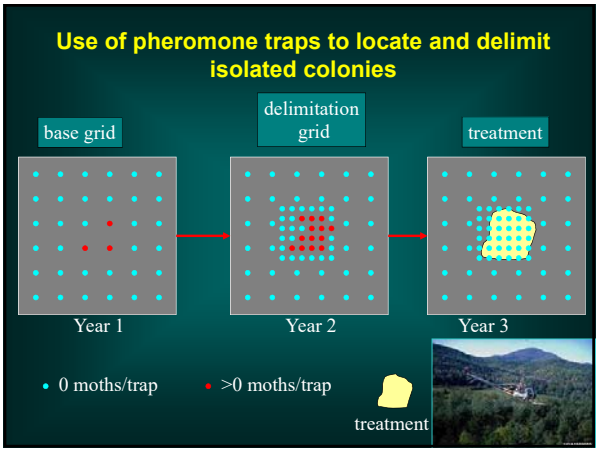
Nuisance and aesthetic impacts on homeowners

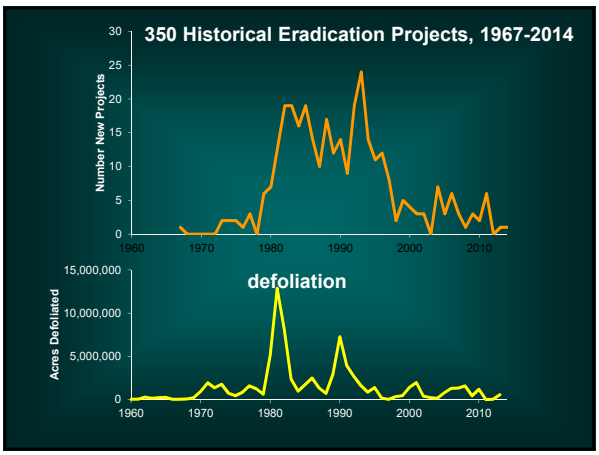
Gypsy Moth Management



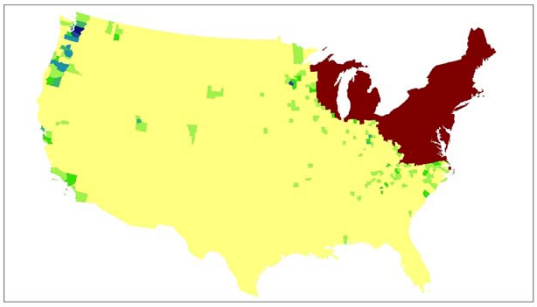
Gypsy Moth Egg Masses Accidentally Transported During Household Moves


Gypsy Moth Trapping Locations, 1974-2014
~100,000 traps per year
not detected
detected


Use of pheromone traps to locate and delimit isolated colonies
base grid
delimitation grid
treatment
Year 1
Year 2
Year 3
0 moths/trap
>0 moths/trap
treatment

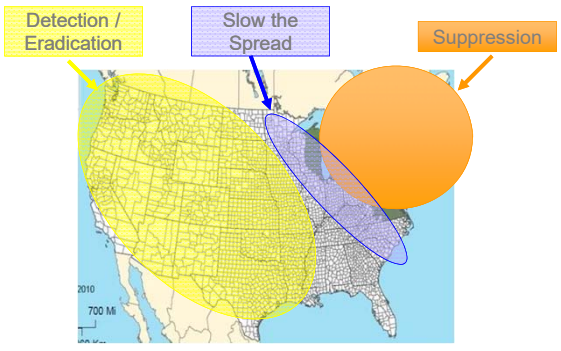

350 Historical Eradication Projects, 1967-2014
Number New Projects
defoliation
Acres Defoliated

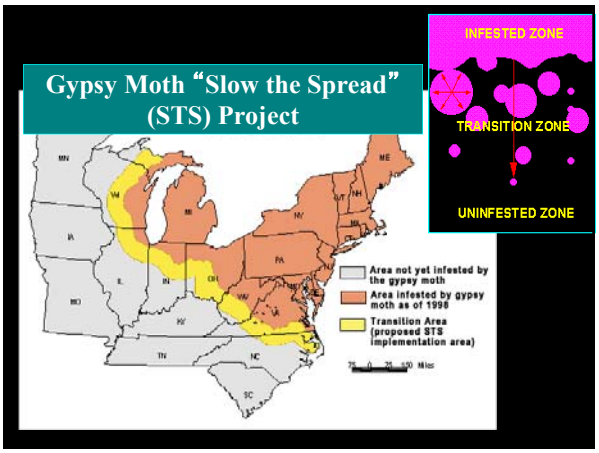
Numbers of Eradication Projects per County, 1967-2014

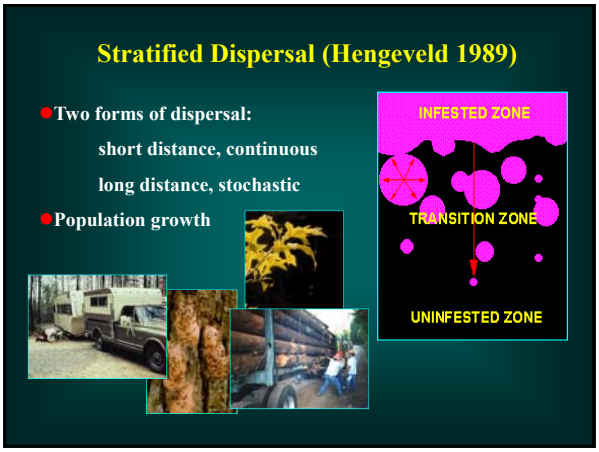


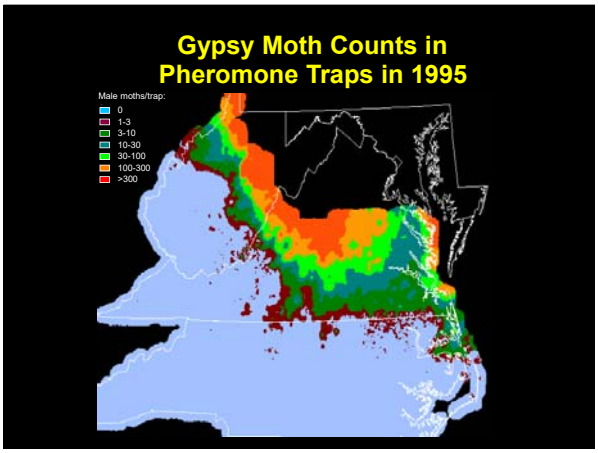
Gypsy Moth Traps are Very Sensitive

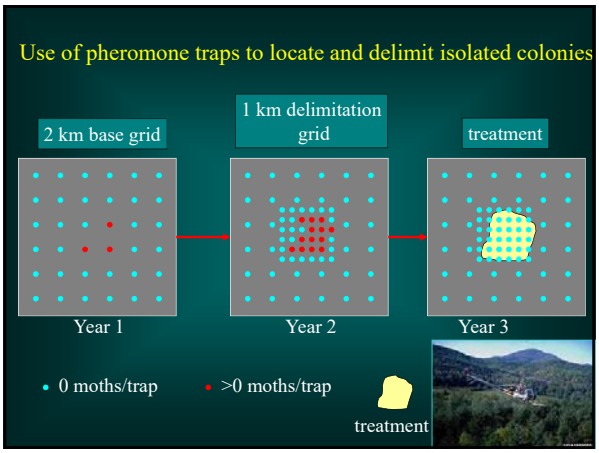
Gypsy Moth Management



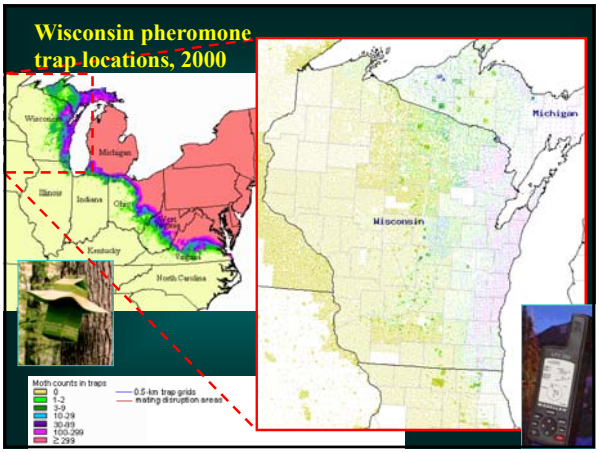

Gypsy Moth "Slow the Spread" (STS) Project
INFESTED ZONE
TRANSITION ZONE
UNINFESTED ZONE
Area not yet infested by the gypsy moth
Area infested by gypsy moth as of 1998
Transition Area (proposed STS implementation area)

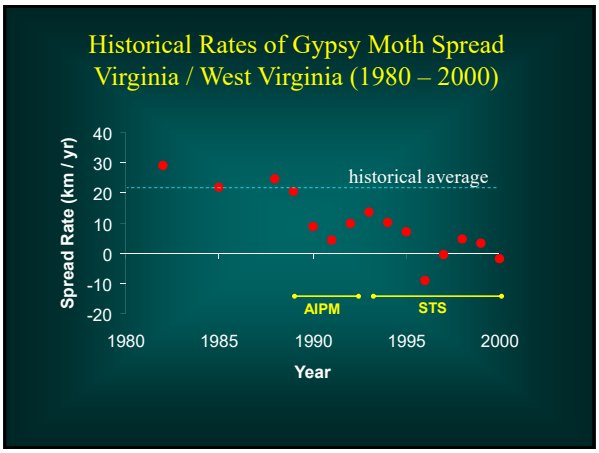

Stratified Dispersal (Hengeveld 1989)
Two forms of dispersal:
short distance, continuous
long distance, stochastic
Population growth
INFESTED ZONE
TRANSITION ZONE
UNINFESTED ZONE

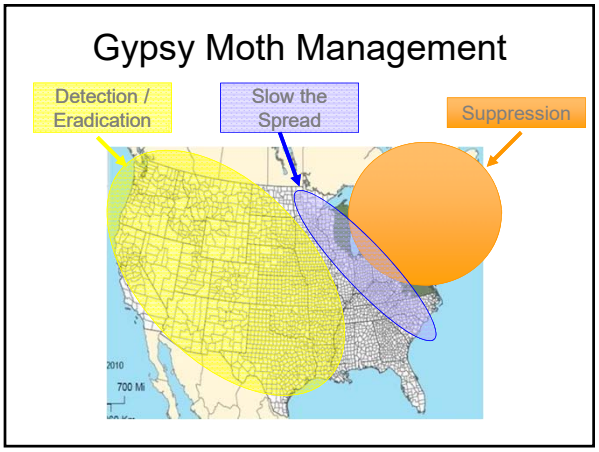

Gypsy Moth Counts in Pheromone Traps in 1995
Male moths/trap:
0
1-3
3-10
10-30
30-100
100-300
>300

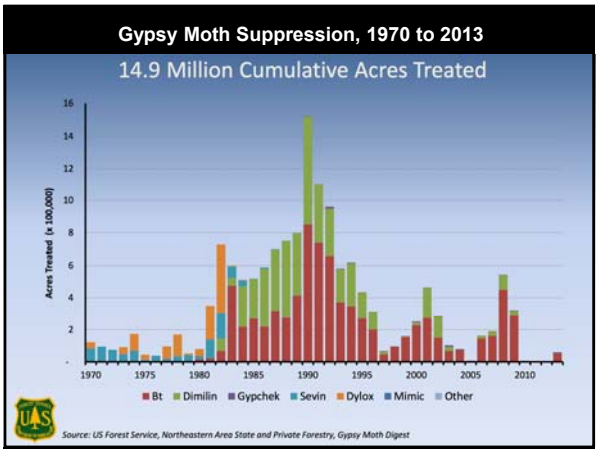

Use of pheromone traps to locate and delimit isolated colonies
2 km base grid
1 km delimitation grid
treatment
Year 1
Year 2
Year 3
0 moths/trap
>0 moths/trap
treatment


DISRUPT® II
GYPSY MOTH
MATING DISRUPTANT
Population Suppressant
KEEP OUT OF REACH OF CHILDREN
CAUTION
Mating Disruption
2L

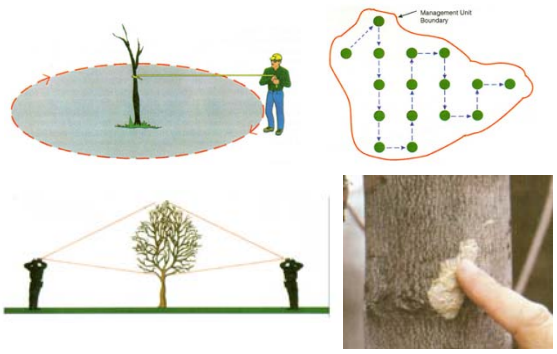

Wisconsin pheromone trap locations, 2000
Michigan
Wisconsin
Illinois
Indiana
Kentucky
North Carolina
Moth counts in traps
0
1-2
3-9
10-29
30-99
100-299
≥ 299
0.5-km trap grids
mating disruption areas


Historical Rates of Gypsy Moth Spread
Virginia / West Virginia (1980 – 2000)
Spread Rate (km / yr)
40
30
20
10
0
-10
-20
historical average
AIPM
STS
1980
1985
1990
1995
2000
Year

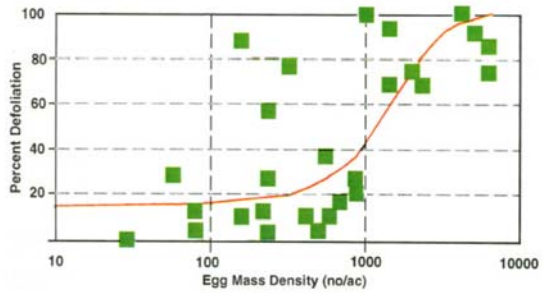

Gypsy Moth Management
Detection / Eradication
Slow the Spread
Suppression
2010
700 Mi

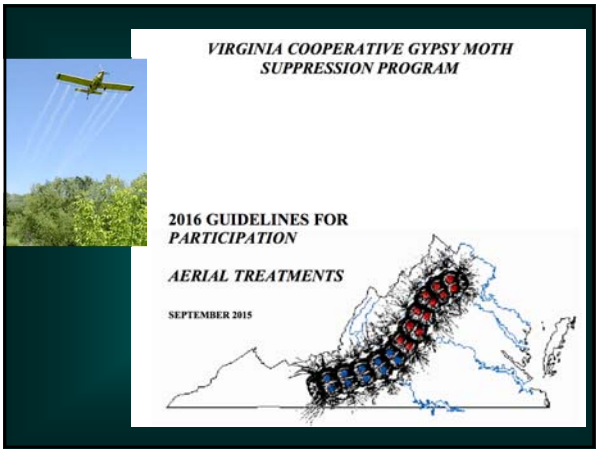

Gypsy Moth Suppression, 1970 to 2013
14.9 Million Cumulative Acres Treated
Acres Treated (x 100,000)
16
14
12
10
8
6
4
2
-
1970
1975
1980
1985
1990
1995
2000
2005
2010
Bt
Dimilin
Gypchek
Sevin
Dylox
Mimic
Other
Source: US Forest Service, Northeastern Area State and Private Forestry, Gypsy Moth Digest

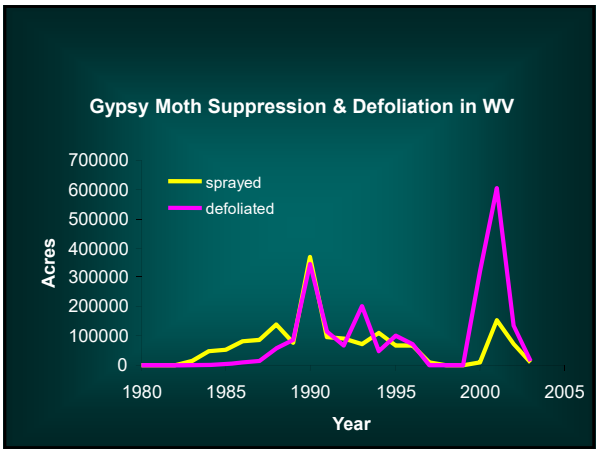
1/40th acre plots for counting gypsy moth egg masses



Action Thresholds for Predicted Stand Defoliation



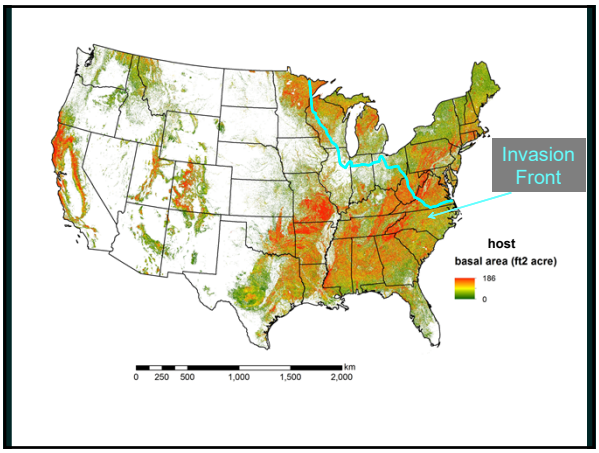




Defoliation Suppression

Silvicultural Treatments to Minimize Impacts of Gypsy Moth

- **Reduction of Stand Susceptibility**
  Thin to reduce component of oaks and other preferred hosts
- **Reduction of Stand Vulnerability**
  Thin to remove low vigor trees
- **Salvage**
  Harvest dead and dying trees following an outbreak


Invasion Front
host
basal area (ft2 acre)
186
0
0 250 500 1,000 1,500 2,000
km