NEW YORK STATE | Department of Environmental Conservation

Gypsy Moth Egg Mass Sampling

How to quantify potential defoliation for the following year

Naja Kraus
Forest Health Scientist
Bureau of Invasive Species and Ecosystem Health
Division of Lands and Forests
October 21, 2020

Planning

Choose area, management threshold, learn methodology, when to sample

Learn Method for Egg Mass Sampling in NY

- Field Protocol for Sampling Gypsy Moth Egg Masses

  - Based on USDA Forest Service Publication

  - Sequential sampling plans for estimating gypsy moth egg mass density (Fleischer et. al. 1992)

- Objective: to determine if gypsy moth population numbers in sampled stands fall above or below chosen management threshold

Sequential sampling method

- A sequential sampling plan helps to allocate labor

  - balance number of samples to increase precision with cost of taking additional samples

- Site sample may vary from 4 to 9 plots

- Very low and very high populations require the least sampling

- More sampling is required in areas close to management thresholds

- Different tables for forested and urban/suburban habitats (>1 house per 10 acres)

Figure 6.—Generic sequential sampling plan.
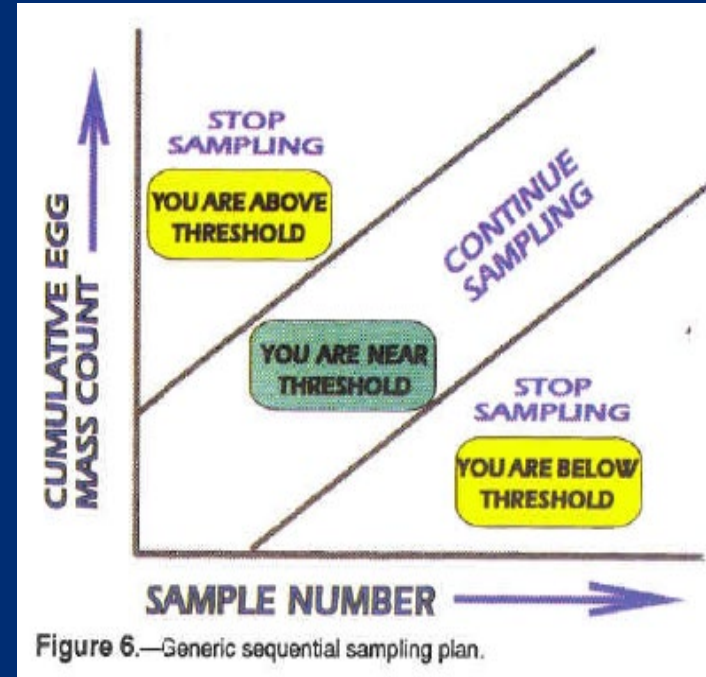
Choose Survey Area

Identify area of concern
- Geographical boundaries
- Ownership
- Ecosystem
- Areas of Special Concern
  - Previously defoliated
  - Poor site quality
- Personal Choice

UGA0758040

Choose Management Objective

USDA Forest Service (Liebhold et al 1994)

Management Objective	Egg Mass Threshold
To prevent noticeable caterpillars	250 egg masses/acre
To prevent noticeable defoliation (>30% defoliation) or growth loss (>40% defoliation)	500 egg masses/acre
To prevent likely mortality (> 60% defoliation)	1000 egg masses/acre

NEW YORK STATE | Department of Environmental Conservation

When to sample

- September to mid-April (egg masses present)
- After trees drop their leaves
- Before snow covers the eggs on the ground
- Before new egg masses start to look weathered like old egg masses
- It is easier to see egg masses with good light and under dry conditions
  - Best in good weather conditions when the sky is clear & sun is overhead
  - Try to avoid poor weather conditions with dim lighting, long shadows, precipitation and wet bark.

NEW YORK STATE | Department of Environmental Conservation

Egg Mass Sampling

Setting up your plots

NEW YORK STATE | Department of Environmental Conservation

Choosing Plot Center

- Plot should lie within a forested area
- Contain susceptible host species
- Be more than 100 feet from the forest edge
- 1st plot center
    - Generated random coordinates
    - Or walk 130 ft (40 m, 2 chains) perpendicular from the nearest road or trail in the area you wish to sample.
- Additional plots
    - Walk 100 ft (30 m, 1½ chains) in direction noted on random direction table.
    - If the direction takes you out of the desired forest type then use the next direction noted in the table instead.

130 feet

100 feet

NEW YORK STATE | Department of Environmental Conservation
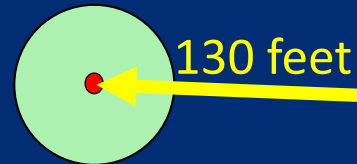
Random Direction Table

Random Direction Table[1]

The first plot should be chosen by walking 130 ft (40 m, 2 chains) perpendicular from the nearest road in the area you wish to sample. If random coordinates were generated for sampling then that should be your first plot location. For the next plot, locate today's date on the table below and walk 100 ft (30 m, 1½ chains) in the direction noted and place a flag there as plot center. Today's date is the starting point; continue down the table to choose the walking direction for each additional plot sampled. If the direction takes you out of the desired forest type (i.e. into a conifer stand, cliff edge, road or swamp) then use the next direction instead.

Date	Direction		Date	Direction		Date	Direction		Date	Direction
1	NE		15	SE		25	E		-	N
2	SE		16	NE		26	SE		-	SW
3	N		17	E		27	NE		-	W
4	NW		18	N		28	SE		-	NW
5	SW		19	NW		29	NE		-	SW
6	S		20	N		30	E		-	W
7	S		21	W		31	N		-	SE
8	SE		22	S		-	N		-	S
9	SW		23	W		-	SW		-	E
10	W		24	W		-	W		-	S
11	S					-	SW			
12	E		Return to 1 for additional directions			-	NW		Return to 25 for additional directions	
13	E					-	NW			
14	NE					-	NE			
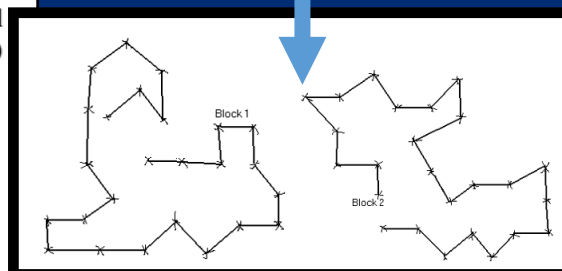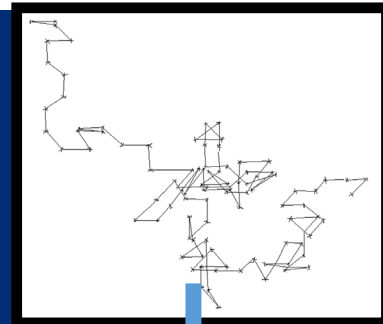
Semi-random Cardinal Path

Developed by Scott Costa, University of VT, Entomology Research Lab

NEW YORK STATE | Department of Environmental Conservation

Layout your plot

- 18.6 ft (5.7 m) radius circular plot

- Plot area = 1/40 acre (0.01 ha)

- Set up flags at center and 4 cardinal directions
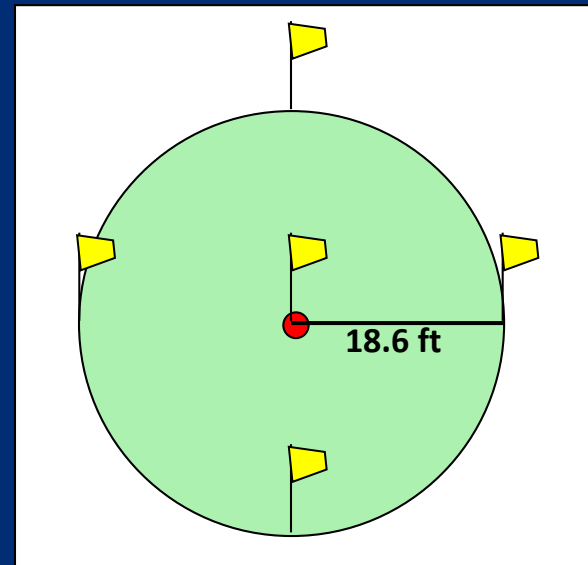
Equipment

Bare essentials & helpful extras

Gather Survey Equipment

- Binoculars or spotting scope & tripod
- Data collector or paper data sheets with clipboard & pencil
- Sequential sampling table(s), random direction table & sampling protocol
- GPS, compass & site map
- 18.6 ft. (5.7 m) tape/string
- 5 bright color stake flags
- Small ruler to measure egg masses

NEW YORK STATE Department of Environmental Conservation
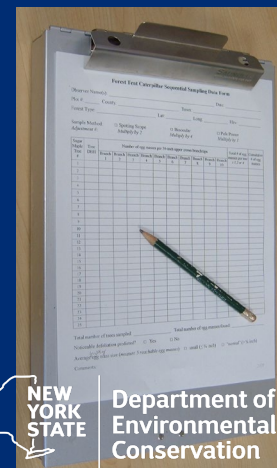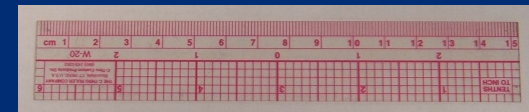
Survey Equipment - Helpful Extras

- Tally counters
- Plastic ground cloth (using binoculars)
- Camp chair (using spotting scope)
- For Safety:
  - First aid kit
  - Cell phone or radio
  - Orange vest
  - Hardhat

NEW YORK STATE | Department of Environmental Conservation

How to Count Egg Masses

All egg masses within each circular plot must be counted

NEW YORK STATE | Department of Environmental Conservation

Egg Masses

- Eggs laid in late summer

  - Female covers eggs with abdominal hairs

  - Size depends on health of female

    ~ 25 mm long for healthy egg mass

    ~ 600-700 eggs per egg mass

- Usually deposited in a slightly sheltered location (NOT necessarily host trees)

- Embryos develop within 4-6 weeks to fully formed pharate larvae & overwinter in this stage

- CAUTION: Some people have allergic respiratory and skin reactions to gypsy moth parts

New vs. Old Egg Masses

New Egg Masses	Old Egg Masses
Firm to touch (feel hard and full)	Soft to touch (feel soft & spongy)
Usually darker beige, buff colored	Usually dull or bleached coloration
Opaque to dark-colored eggs	Clearer eggs (no larvae inside)
No holes or small parasitoid exit holes present	Exit holes present

NEW YORK STATE | Department of Environmental Conservation

Counting Egg Masses- below 6 feet

- 1st count all egg masses on the ground & below 6 ft. on trees

  - Count old & new <u>separately</u>

  - May be helpful to separate into quadrants

  - Examine all objects on the ground (i.e. on fallen branches or rocks).

  - You may need to move objects so all surfaces can be seen.

18.6 ft

NEW YORK STATE | Department of Environmental Conservation
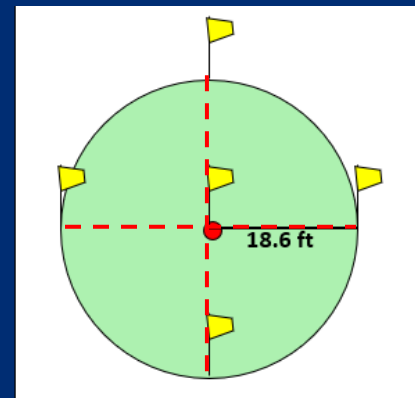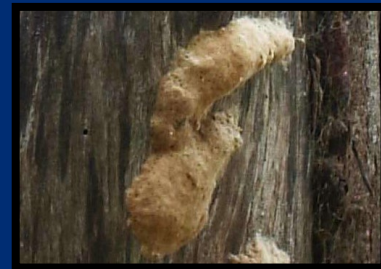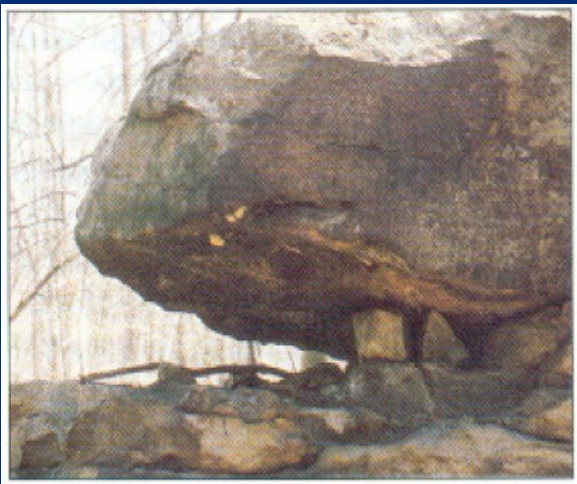
Eggs can be found

almost anywhere

Counting Egg Masses- above 6 feet

- 2nd count all egg masses above 6 feet

  - Count old & new <u>combined</u>

  - Use binoculars or spotting scope

  - Count only egg masses on portions of trees within plot circle

  - Count up to 50 then estimate in groups of 25

  - View trees from multiple vantage points

    - (bigger trees = more vantage points)

  - Egg masses may be on trunks or under branches

  - Avoid double counting

NEW YORK STATE | Department of Environmental Conservation

What data to collect

& lots of Calculations!

Gypsy Moth Sequential Sampling Data Form

Observer Name(s): ___NAJA KRAUS_____ Date: _____11/15/2005_____

Site #: __1__ County: _____WARREN_____ Town: _____THURMAN_____

Forest Type: __MIXED HARDWOODS__ GPS coordinates*: __18 589475E___ , __4823612N___ Elev: __1300 feet__
* DEC uses UTM NAD 83

Management Threshold (egg masses/acre): □ 250 □ 500 ☑ 1000

Habitat: ☑ continually forested □ urban/suburban (≥ 1 house per 10 acres)
(minimum: 4 plots, maximum: 10 plots) (minimum: 6 or 7 plots, maximum: 15, 22 or 25 plots)

| Plot (1/40 -acre) | Actual egg mass counts | | | Formulas to estimate % new | | Total # of new egg masses per plot (F) | Cumulative # of egg masses [sum of egg masses found at all plots] |
| | Egg masses on ground and lower portion of trunks | | All egg masses in Crown (C) | % new egg masses (D) | # of new crown egg masses (E) | | |
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1							
2							
3							
4							
5							
25							

Total # of egg masses found: _____ Total # of plots sampled: _____ Average # of egg masses/acre: [(total # egg masses/total # plots)*40] _____

Above management threshold? □ Yes □ No □ Undetermined

Average egg mass length (*measure 5 typical egg masses*): □ small □ average □ large
(< 20 mm) (20-30 mm) (> 30 mm)
_____ _____ _____ _____ _____

Comments:

Data Sheet (1) Basic Site Information

NEW YORK STATE | Department of Environmental Conservation

Gypsy Moth Sequential Sampling Data Form

Observer Name(s): ___NAJA KRAUS_____   Date: _____11/15/2005____

Site #: ___1___   County: _____WARREN_____   Town: _____THURMAN_____

Forest Type: __MIXED HARDWOODS__ GPS coordinates*: __18 589475E__ , __4823612N__   Elev: __1300 feet__
*DEC uses UTM NAD 83

Management Threshold (egg masses/acre):   ☐ 250   ☐ 500   ☑ 1000

Habitat: ☑ continually forested   ☐ urban/suburban (≥ 1 house per 10 acres)
                (minimum: 4 plots, maximum: 10 plots)   (minimum: 6 or 7 plots, maximum: 15, 22 or 25 plots)

Plot (1/40-acre)	Actual egg mass counts			Formulas to estimate % new		Total # of new egg masses per plot (F)	Cumulative # of egg masses [sum of egg masses found at all plots]
	Egg masses on ground and lower portion of trunks		All egg masses in Crown (C)	% new egg masses (D)	# of new crown egg masses (E)		
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28				
2							
3							
4							
5							
	⇩		⇩		⇩		⇩
25							

Total # of egg masses found: [____]   Total # of plots sampled: [____]   Average # of egg masses/acre: [____]
                                                                        [(total # egg masses/total # plots)*40]

Above management threshold?   ☐ Yes   ☐ No   ☐ Undetermined

Average egg mass length (*measure 5 typical egg masses*):   ☐ small   ☐ average   ☐ large
_____ _____ _____ _____ _____   (< 20 mm)   (20-30 mm)   (> 30 mm)

Comments:

Calculations (1)

- Determine % of new egg masses
  - Divide number of <u>new</u> ground egg masses by number of <u>all</u> (new & old) ground egg masses

Plot (1/40 -acre)	Actual egg mass counts			Formulas to estimate % new		Total # of new egg masses per plot (F)	Cumulative # of egg masses [sum of egg masses found at all plots]
	Egg masses on ground and lower portion of trunks		All egg masses in Crown (C)	% new egg masses (D)	# of new crown egg masses (E)		
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	19/(19+8) = 0.70			

- *If there are no egg masses in the understory you will need to go outside the plot to find egg masses to determine this percentage. Do not use these counts for the total egg mass count.*
- *If there are no egg masses in the understory outside the plot you will need to carefully count only NEW egg masses in the crown.*

NEW YORK STATE | Department of Environmental Conservation

Calculations (2)

- Determine % of new egg masses in the crown
  - Multiply number of all crown egg masses with % new egg masses (from ground count)

Plot (1/40 -acre)	Actual egg mass counts			Formulas to estimate % new		Total # of new egg masses per plot (F)	Cumulative # of egg masses [sum of egg masses found at all plots]
	Egg masses on ground and lower portion of trunks		All egg masses in Crown (C)	% new egg masses (D)	# of new crown egg masses (E)		
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	19/(19+8) = 0.70	28 * 0.70 = 20		

Department of Environmental Conservation

Calculations (3)

- Determine total number of new egg masses

    - Sum new ground egg masses & new crown egg masses

Plot (1/40 -acre)	Actual egg mass counts			Formulas to estimate % new		Total # of new egg masses per plot (F)	Cumulative # of egg masses [sum of egg masses found at all plots]
	Egg masses on ground and lower portion of trunks		All egg masses in Crown (C)	% new egg masses (D)	# of new crown egg masses (E)		
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	19/(19+8) = 0.70	28 * 0.70 = 20	19 + 20 = 39	39
2							

Gypsy Moth Sequential Sampling Data Form

Observer Name(s): __NAJA KRAUS__   Date: __11/15/2005__

Site #: __1__ County: __WARREN__   Town: __THURMAN__

Forest Type: __MIXED HARDWOODS__ GPS coordinates*: __18 589475E__ , __4823612N__ Elev: __1300 feet__
* DEC uses UTM NAD 83

Management Threshold (egg masses/acre):   □ 250   □ 500   ☑ 1000

Habitat: ☑ continually forested   □ urban/suburban (≥ 1 house per 10 acres)
(minimum: 4 plots, maximum: 10 plots)   (minimum: 6 or 7 plots, maximum: 15, 22 or 25 plots)

| Plot (1/40 -acre) | Actual egg mass counts | | | Formulas to estimate % new | | Total # of new egg masses per plot (F) | Cumulative # of egg masses [sum of egg masses found at all plots] |
| | Egg masses on ground and lower portion of trunks | | All egg masses in Crown (C) | % new egg masses (D) | # of new crown egg masses (E) | | |
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	0.70	20	39	39
2	8	24	30	0.75	23	47	86
3	4	20	25	0.83	21	41	127
4	7	21	20	0.75	15	36	163
5							
25							

Total # of egg masses found: [   ]   Total # of plots sampled: [   ]   Average # of egg masses/acre: [   ]
[(total # egg masses/total # plots)*40]

Above management threshold?   □ Yes   □ No   □ Undetermined

Consult Sequential Sampling Table

- Consult sequential sampling table to determine if the stand falls above or below the chosen threshold.

- Continue sampling additional plots until a result is determined.

Figure 6.—Generic sequential sampling plan.

Sequential sampling table
for Gypsy Moth egg masses at three management thresholds in continuously forested eastern hardwoods

Management Threshold (egg masses/acre)	# of plots (1/40 acre) sampled	Total number of new egg masses counted		
		Below threshold STOP sampling	Continue sampling	Above threshold STOP sampling
250 egg masses/acre "Noticeable Caterpillars"	4	< 7	7 – 42	> 42
	5	< 13	13 – 48	> 48
	6	< 19	19 – 54	> 54
	7	< 25	25 – 60	> 60
	8	< 31	31 – 66	> 66
	9	< 37	37 -73	> 73
500 egg masses/acre "Noticeable Defoliation"	4	< 16	16 – 81	> 81
	5	< 28	28 – 94	> 94
	6	< 40	40 – 106	> 106
	7	< 53	53 – 118	> 118
	8	< 65	65 – 130	> 130
	9	< 77	77 – 143	> 143
1000 egg masses/acre "Likely Mortality"	4	< 19	19 – 178	> 178
	5	< 44	44 -202	> 202
	6	< 68	68 – 227	> 227
	7	< 93	93 – 252	> 252
	8	< 117	117 – 276	> 276
	9	< 142	142 - 301	> 301

Sample guide showing minimum numbers of plots (1/40 acre) that must be examined in an egg mass survey to permit site classification with respect to expected gypsy moth defoliation.

NEW YORK STATE | Department of Environmental Conservation

Gypsy Moth Sequential Sampling Data Form

Observer Name(s): __NAJA KRAUS__ Date: __11/15/2005__

Site #: __1__ County: __WARREN__ Town: __THURMAN__

Forest Type: __MIXED HARDWOODS__ GPS coordinates*: __18 589475E__ , __4823612N__ Elev: __1300 feet__
* DEC uses UTM NAD 83

Management Threshold (egg masses/acre): ☐ 250 ☐ 500 ☑ 1000

Habitat: ☑ continually forested ☐ urban/suburban (≥ 1 house per 10 acres)
(minimum: 4 plots, maximum: 10 plots) (minimum: 6 or 7 plots, maximum: 15, 22 or 25 plots)

Plot (1/40 -acre)	Actual egg mass counts			Formulas to estimate % new		Total # of new egg masses per plot (F)	Cumulative # of egg masses [sum of egg masses found at all plots]
	Egg masses on ground and lower portion of trunks		All egg masses in Crown (C)	% new egg masses (D)	# of new crown egg masses (E)		
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	0.70	20	39	39
2	8	24	30	0.75	23	47	86
3	4	20	25	0.83	21	41	127
4	7	21	20	0.75	15	36	163
5	6	22	31	0.79	24	46	209
	⇩	⇩	⇩	⇩	⇩	⇩	⇩
25							

Total # of egg masses found: [ ] Total # of plots sampled: [ ] Average # of egg masses/acre: [ ]
[(total # egg masses/total # plots)*40]

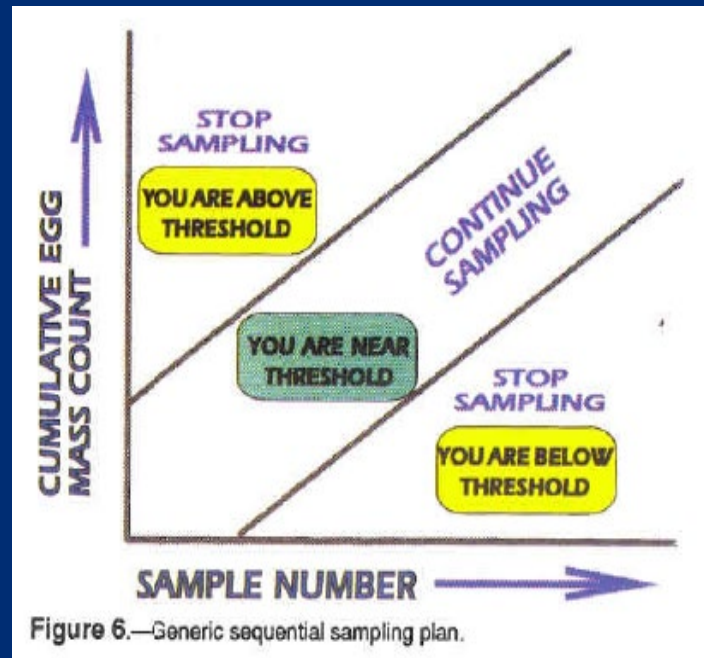Above management threshold? ☐ Yes ☐ No ☐ Undetermined

Average egg mass length (*measure 5 typical egg masses*): ☐ small ☐ average ☐ large
_____ _____ _____ _____ _____ (< 20 mm) (20-30 mm) (> 30 mm)

Comments:

Data Sheet (5)
Sample 1 more plot, sum total # of new egg masses & check sequential sampling table

NEW YORK STATE | Department of Environmental Conservation

Sequential sampling table
for Gypsy Moth egg masses at three management thresholds in continuously forested eastern hardwoods

Management Threshold (egg masses/acre)	# of plots (1/40 acre) sampled	Total number of new egg masses counted		
		Below threshold STOP sampling	Continue sampling	Above threshold STOP sampling
250 egg masses/acre "Noticeable Caterpillars"	4	< 7	7 – 42	> 42
	5	< 13	13 – 48	> 48
	6	< 19	19 – 54	> 54
	7	< 25	25 – 60	> 60
	8	< 31	31 – 66	> 66
	9	< 37	37 -73	> 73
500 egg masses/acre "Noticeable Defoliation"	4	< 16	16 – 81	> 81
	5	< 28	28 – 94	> 94
	6	< 40	40 – 106	> 106
	7	< 53	53 – 118	> 118
	8	< 65	65 – 130	> 130
	9	< 77	77 – 143	> 143
1000 egg masses/acre "Likely Mortality"	4	< 19	19 – 178	> 178
	5	< 44	44 -202	> 202
	6	< 68	68 – 227	> 227
	7	< 93	93 – 252	> 252
	8	< 117	117 – 276	> 276
	9	< 142	142 - 301	> 301

Sample guide showing minimum numbers of plots (1/40 acre) that must be examined in an egg mass survey to permit site classification with respect to expected gypsy moth defoliation.

NEW YORK STATE | Department of Environmental Conservation

Gypsy Moth Sequential Sampling Data Form

Observer Name(s): ___NAJA KRAUS_____ Date: ___11/15/2005___

Site #: __1__ County: ___WARREN_____ Town: ___THURMAN_____

Forest Type: _MIXED HARDWOODS_ GPS coordinates*: _18 589475E_ , _4823612N_ Elev: _1300 feet_
* DEC uses UTM NAD 83

Management Threshold (egg masses/acre): ☐ 250   ☐ 500   ☑ 1000

Habitat: ☑ continually forested   ☐ urban/suburban (≥ 1 house per 10 acres)
(minimum: 4 plots, maximum: 10 plots)   (minimum: 6 or 7 plots, maximum: 15, 22 or 25 plots)

| Plot (1/40 -acre) | Actual egg mass counts | | | Formulas to estimate % new | | Total # of new egg masses per plot (F) | Cumulative # of egg masses [sum of egg masses found at all plots] |
| | Egg masses on ground and lower portion of trunks | | All egg masses in Crown (C) | % new egg masses (D) | # of new crown egg masses (E) | | |
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	0.70	20	39	39
2	8	24	30	0.75	23	47	86
3	4	20	25	0.83	21	41	127
4	7	21	20	0.75	15	36	163
5	6	22	31	0.79	24	46	209
	⇓		⇓		⇓		⇓
25							

Total # of egg masses found: __209__   Total # of plots sampled: __5__   Average # of egg masses/acre: [(total # egg masses/total # plots)*40] __1672__

Above management threshold? ☑ Yes   ☐ No   ☐ Undetermined

Average egg mass length (*measure 5 typical egg masses*): ☐ small (< 20 mm)   ☐ average (20-30 mm)   ☐ large (> 30 mm)

_____ _____ _____ _____ _____

Comments:

Data Sheet (6)
total # of egg masses, # of plots, average # of egg masses/acre, above mgmt. threshold?

Egg Mass Size

- Measure the length of 5 egg masses

- Determine if the average length is
  - ➤ < 20 mm (small)
  - ➤ 20 – 30 mm (normal)
  - ➤ > 30 mm (large)

- Small egg masses may indicate decreasing population
- Large egg masses may indicate increasing population

NEW YORK STATE | Department of Environmental Conservation

Gypsy Moth Sequential Sampling Data Form

Observer Name(s): _____NAJA KRAUS_____ Date: _____11/15/2005_____

Site #: ___1___ County: _____WARREN_____ Town: _____THURMAN_____

Forest Type: __MIXED HARDWOODS__ GPS coordinates*: __18 589475E__, __4823612N__ Elev: __1300 feet__
* DEC uses UTM NAD 83

Management Threshold (egg masses/acre): ☐ 250 ☐ 500 ☑ 1000

Habitat: ☑ continually forested ☐ urban/suburban (≥ 1 house per 10 acres)
(minimum: 4 plots, maximum: 10 plots) (minimum: 6 or 7 plots, maximum: 15, 22 or 25 plots)

| Plot (1/40-acre) | Actual egg mass counts | | | Formulas to estimate % new | | Total # of new egg masses per plot (F) | Cumulative # of egg masses [sum of egg masses found at all plots] |
| | Egg masses on ground and lower portion of trunks | | All egg masses in Crown (C) | % new egg masses (D) | # of new crown egg masses (E) | | |
	Old (A)	New (B)		B/(B+A)	C * D	B+E	F+F+F….
1	8	19	28	0.70	20	39	39
2	8	24	30	0.75	23	47	86
3	4	20	25	0.83	21	41	127
4	7	21	20	0.75	15	36	163
5	6	22	31	0.79	24	46	209
	⇩		⇩		⇩		⇩
25							

Total # of egg masses found: [209] Total # of plots sampled: [5] Average # of egg masses/acre: [(total # egg masses/total # plots)*40] [1672]
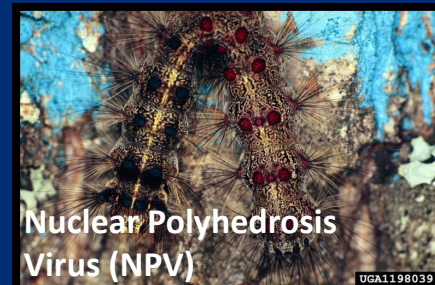
Above management threshold? ☑ Yes ☐ No ☐ Undetermined

Average egg mass length (*measure 5 typical egg masses*): ☐ small (< 20 mm) ☐ average (20-30 mm) ☑ large (> 30 mm)
__29__ __34__ __33__ __31__ __33__

Comments: THIS SITE WAS MODERATELY DEFOLIATED IN 2004.

Data Sheet (7)
Egg mass size

NEW YORK STATE | Department of Environmental Conservation

Qualifiers

- This is not a 100% accurate method

- Weather, low spring temperatures, parasites, pathogens and other factors may cause significant egg and larval mortality

- Other factors to consider
  - levels of defoliation from previous years
  - number of years of previous defoliation (heavy defoliation rarely occurs more than 2 years in a row)
  - extent of defoliation in adjacent areas
  - length of egg masses
  - percentage of old vs. new egg masses

Nuclear Polyhedrosis Virus (NPV)

UGA1198039

Entomophaga maimaiga fungus

NEW YORK STATE | Department of Environmental Conservation

UGA2253091

Submit your data

- Please email or mail your egg mass sampling results to NYSDEC Forest Health so that your data can contribute to our understanding of gypsy moth population levels throughout New York State.

  NYSDEC   Telephone: 518-402-9425
  Div. of Lands & Forests   Fax: 518-402-9028
  Forest Health   Email: foresthealth@dec.ny.gov
  625 Broadway
  Albany, NY 12233-4253

- An outcome where no defoliation is predicted is also of interest to us.

- Contact your local NYSDEC foresters or the NYSDEC Forest Health staff if you have any questions about this protocol.

- Thank you for your interest in our state forests!

NEW YORK STATE | Department of Environmental Conservation

Thank You

- Naja Kraus
- Forest Health Scientist
- 21 South Putt Corners Rd.
- New Paltz NY 12561
- naja.kraus@dec.ny.gov
- 845-256-3001

For more gypsy moth information:

https://www.dec.ny.gov/animals/83118.html

Go to DEC website & search gypsy moth

Connect with us:
Facebook: www.facebook.com/NYSDEC
Twitter: twitter.com/NYSDEC
Flickr: www.flickr.com/photos/nysdec

NEW YORK STATE | Department of Environmental Conservation