Indiana Gypsy Moth Survey—A History

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Introduction

Since gypsy moth's, *Lymantria dispar L.*, (Lepidoptera, Lymantriidae), escape from a botanist in Medford Massachusetts in 1869, this forest defolitor has gradually spread west. Currently, the defoliation to timberlands of the United States occurs northward from western Pennsylvania, northeastern West Virginia, northern Virginia, Maryland, and Delaware through the New England states to Canada (6). While the gypsy moth caterpillars were eating their way through 14 states and over 52 million acres of forest land, man has unknowingly aided gypsy moth in their spread to other states (2). Currently, man and his vehicles have introduced gypsy moth to all states east of the Mississippi River and to several states west of the Mississippi including all west coast states. Realizing that gypsy moth would be introduced to noninfested states as man moved and travelled, the United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) began cooperative surveys to detect gypsy moth in these states. The cooperative gypsy moth survey in Indiana began in 1972, and this paper presents a history of the survey from 1972 through 1984.

Methods and Materials

The gypsy moth survey uses the gypsy moth pheromone trap. This trap is a delta trap (tent-like) approximately 9.4″ x 4.0″ x 4.0″. The trap is made of plastic coated paperboard with two internal sides covered with Tack-Trap and the third side used to attach the pheromone bait. The traps are orange, tan or green in color. The trap will hold 15-20 male moths (3).

The gypsy moth pheromone is called disparlure. Between 1972 and 1980, the racemic form of the pheromone was used. Starting in 1981, the improved 'plus' form of the pheromone has been used. The racemic form came in a green plastic dispenser approximately 1″ x 1″. The 'plus' form is dispensed from a tan plastic dispenser 1″ x 1/8″. The pheromone is released at a constant rate over the trapping period (3).

The gypsy moth survey begins with a detection survey, and then, if a male moth is trapped, a delimitation survey is conducted the following year. If more than one moth is caught in one trap or when several traps in one localized area have one or more moths, an egg mass survey is conducted in the fall of the survey year. One additional part of the gypsy moth survey is mass trapping. Mass trapping is used to follow-up aerial spray programs and in areas where patterns of male moth catches indicate an infestation has started but no other life stage has been found.

In the detection survey, traps are placed according to two grid systems—one trap per three square miles (one trap every 1.7 mile) and one trap per 25 square mile (one trap every 5 mile, 5 mile grid). The USDA, APHIS uses the one trap per three square mile grid, and the Division of Entomology uses the one trap per 25 square mile grid. The grid system is rotated in each county each year to prevent surveying the same area each year and to achieve a complete survey of all land area after three years.

In some years, APHIS has intensified the detection survey to one trap per one square mile in some areas of the counties that they survey.

In addition to the grid system of the detection survey, traps are placed in special sites such as campgrounds, interstate rest areas, motels, truck stops, national campers association meetings, nature preserves, classified forests, federal installations, universities, and homes of people newly moved into Indiana from the northeast.

The delimitation survey is conducted at a greater density of traps per square mile. Generally, 25 traps per square mile is used; however 32 or 81 traps per square mile may be used. The nine square mile area around the trap that caught a gypsy moth is trapped at the above density. An additional 16 square mile area surrounding the nine square mile area may be trapped at nine traps per square mile (5). When several gypsy moths are detected in close proximity to each other, the delimitation grid patterns will be modified and combined to efficiently delimit all catches of the gypsy moth. When only one moth is caught in a county, the nine square mile area may be reduced to a four square mile area at 25 traps per square mile with the detected moth at the center of the four square mile area.

The egg mass survey is a general survey of all the area around the point where a gypsy moth was trapped. Personnel of the USDA, APHIS and the Division of Entomology search the environment for egg masses. They also contact people in the areas trying to locate anyone who may have moved there from the generally infested area of the northeastern United States. If egg masses are found, they are destroyed, and the area is defined as an infestation and will be placed in a control program the following year.

Mass trapping is conducted on a grid system of three traps per acre (1920 traps per square mile) or one trap every 120 feet. It is confined to small areas because of the quantity of traps needed.

In the cooperative survey, the USDA, APHIS selected certain counties each year to survey, and the Division of Entomology surveyed all remaining counties. From 1972 through 1980, APHIS would survey 1/3 of the counties in the state. The selection of the counties was rotated each year so that after three years, APHIS had surveyed all counties of the state once, and the Division of Entomology has surveyed all counties once. Since 1981, APHIS has surveyed the counties where gypsy moth has been trapped the previous year, and the Division of Entomology has surveyed all remaining counties. In 1984, the survey changed to target the placement of the traps in areas where gypsy moth had a high probability of being introduced. In 1984, APHIS surveyed all counties where gypsy moth was detected in 1983 and the counties with major metropolitan areas. The Division of Entomology surveyed all remaining counties targeting the traps into the cities.

Personnel involved in the gypsy moth survey are given maps showing the grid system indicating where traps are to be placed. The traps are placed as close as possible to the grid point on the map. The traps are placed on the sides of trees, posts, or poles. The location of each trap is recorded on a trap record form by trap number, county, township, range, section number, city or other name for the trap location such as the name of the campground. Directions to the trap are recorded, and a sketch map is drawn on the trap record form to help locate the trap.

The traps are placed across the state during June with all traps to be in place by the first of July. Traps in the detection survey, generally, are not checked during the survey. However, traps in delimitation surveys are periodically checked, and traps in a mass trapping survey are checked regularly. All traps are removed during August, and the number of gypsy moths and their location are reported to the USDA, APHIS and the Division of Entomology. All moths found for the first time in a county are

submitted to the USDA to be confirmed for official record of first find. The locations of moths are plotted on maps to observe the distribution of the gypsy moth. These maps aid in identifying the start of infestations and in the planning for the following year's survey.

Results of the survey are summarized annually and reported to the USDA, APHIS and Forest Service, the Indiana Department of Natural Resources, Divisions of Entomology and Forestry, and the National Gypsy Moth Management Board. The report is also published in the Indiana Pest Informer, a newsletter on forest insect and diseases.

Results

Since 1972, the gypsy moth survey has placed 72,168 traps in the state (Table 1). Personnel of the USDA, APHIS have placed 52,211 traps, and personnel of the Division of Entomology have placed 19,166 traps. An additional 791 traps have been placed by members of the National Campers and Hikers Association.

TABLE 1. The number of gypsy moth traps set in Indiana by year and cooperators.

	Cooperators			
Year	Federal	State	Other[1]	Total
1972	883	1640		2523
1973	1622	[2]	51	1673
1974	2031	849	94	2974
1975	1602	1193		2795
1976	1413	1919	36	3368
1977	3991	1355		5346
1978	3465	1233		4698
1979	4902	1257		6159
1980	5371	1227	200	6798
1981	4678	1819	300	6797
1982	3827	2313		6140
1983	9063	1209		10272
1984	9363	3152	110	12625
Total	52211	19166	791	72168

[1]Primarily set by the National Campers and Hikers Association.
[2]Records unavailable.

The number of traps placed in the state started to increase in the late 70s. This increase was in response to the increased introduction of gypsy moth in Indiana from the increasing population of gypsy moth in the northeastern United States during this time (Table 1) (6). During 1979-1982, the number of traps placed in the state was at a constant level over 6,000. Then in 1983 and 1984, the number of traps placed almost doubled. This increase in traps placed was due to the use of mass trapping in areas where a gypsy moth infestation had been found, to increased intensity of the grid system in some counties of the state, and to the increased use of delimitation trapping around the increased number of gypsy moth catches of 1982 and 1983 (Table 2).

During the thirteen years of the survey, traps have been placed in every county of the state, except for five years. In 1972, 1973, 1978, 1981, and 1984, traps were not placed in 1, 3, 4, 2, and 1 counties, respectively.

1973 was the first year gypsy moth was found in Indiana. One male moth was found in Lake County (Table 2). Surveys in 1974 and 1975 did not catch gypsy moths; thus, the first find of gypsy moth was a 'hitchhiker.'

TABLE 2. The number of gypsy moth males trapped in Indiana by year and county.

Year	County	Number of moths
1973	Lake	1
1977	Whitley	1
1980	1. Allen	1
	2. Elkhart	2
	3. Franklin	1
	4. Hendricks	1
	5. Vigo	4
	6. Wayne	1
		10
1981	1. Allen	2
	2. Bartholomew*	1
	3. Boone*	1
	4. Elkhart	20
	5. Lake	1
	6. LaPorte*	1
	7. Tippecanoe*	2
	8. Vigo	32
	9. Wayne	4
		64
1982	1. Allen	5
	2. Bartholomew	14
	3. Blackford*	1
	4. Brown*	1
	5. Elkhart	372
	6. Fulton*	1
	7. Hancock*	2
	8. Hendricks	2
	9. Jefferson*	1
	10. Johnson*	20
	11. Kosciusko*	1
	12. LaPorte	4
	13. Marion*	11
	14. Monroe*	1
	15. Montgomery*	1
	16. Morgan*	2
	17. Noble*	1
	18. Putnam*	1
	19. St. Joseph*	21
	20. Tippecanoe	8
	21. Wayne	3
		473
1983	1. Allen	1
	2. Bartholomew	7
	3. Elkhart	29
	4. Greene*	1
	5. Hamilton*	2
	6. Hendricks	1
	7. LaGrange*	1
	8. Lake	1
	9. LaPorte	1
	10. Marion	35
	11. Monroe	1
	12. St. Joseph	11
		91

TABLE 2.—Continued

Year	County	Number of moths
1984	1. Allen	11
	2. Decatur*	1
	3. DeKalb*	1
	4. Elkhart	13
	5. Fulton	1
	6. Hamilton	1
	7. Jackson*	1
	8. Johnson	4
	9. Kosciusko	4
	10. LaGrange	3
	11. Lake	8
	12. Marion	14
	13. Marshall*	2
	14. Monroe	1
	15. Orange*	1
	16. St. Joseph	23
	17. Wabash*	1
	18. Wayne	1
	19. Whitley	1
		92

*New county record for that year.

The second gypsy moth was caught in 1977 in Whitley county. Again, this moth was a 'hitchhiker' and no infestation developed.

1980 was the first year when more than one moth was found and more than one county had gypsy moth (Table 2). Since 1980 when 10 moths from 6 counties were found, gypsy moth has been found in Indiana every year. In 1981, 64 moths were found in 9 counties with 4 of the counties being new county records. In 1982, 473 moths were found in 21 counties with 14 of the counties being new county records. In 1983, 91 moths were trapped in 12 counties with 3 counties being new county records. And in 1984, 92 moths were found in 19 counties with 7 new county records (Table 2, Figure 1).

The survey has trapped 732 male moths from 35 different counties since 1972 (Table 3, Figure 2). Most of these gypsy moth catches have been one moth in one trap in one location. These single catches are 'hitchhikers' that did not develop into infestations. And, yearly survey records indicate 13 counties are more likely to have gypsy moth introduced and trapped from them. These counties are Allen, Elkhart, Hamilton, Hendricks, LaGrange, Lake, LaPorte, Marion, Monroe, St. Joseph, Tippecanoe, Vigo, and Wayne (Table 2 & 3). The major metropolitan areas of the state occur in or next to these counties, and this is one reason why these counties are prone to gypsy moth introduction.

The survey has detected and located six infestations. This number may increase after the 1984 multiple-catches of gypsy moth are delimited to determine if an infestation has started (Table 3).

The first infestation was found in Vigo county in 1981. The 1980 survey found 4 moths in a subdivision called Krislynn Woods near Tecumseh. In 1981, the survey trapped 31 moths in this areas. Egg mass surveys in 1981 found 63 egg masses around one home in the subdivision. Residents of this home had moved there from an infested area of New Jersey.

Also in 1981 a second infestation was found in Elkhart county in the city of

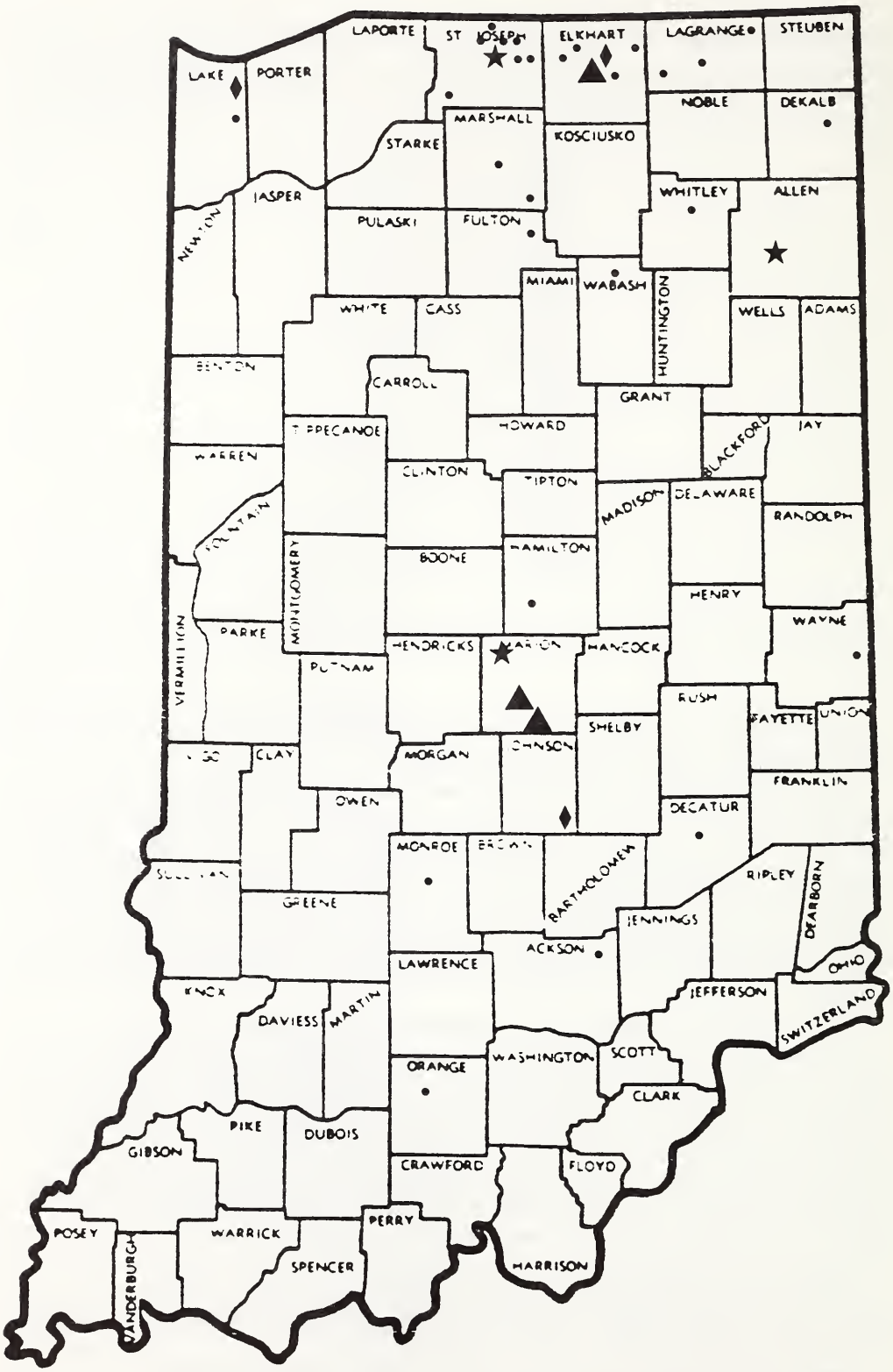

FIGURE 1. Locations where gypsy moth was trapped in 1984.

Goshen. Surveys in 1980 found 2 moths in Elkhart county. In 1981, 20 moths were found with 18 moths being found in Goshen. Surveys in 1982 found 372 moths and 80 egg masses.

TABLE 3. List of counties where gypsy moth males have been trapped including total moths trapped, year first trapped, number of consecutive years trapped and number of infestations.

County	Total moths	First year	Consecutive Years	Number Infestations
1. Allen	20	1980	5	
2. Bartholomew	19	1981	3	1
3. Blackford	1	1982		
4. Boone	1	1981		
5. Brown	1	1982		
6. Decatur	1	1984		
7. DeKalb	1	1984		
8. Elkhart	436	1980	5	1
9. Franklin	1	1980		
10. Fulton	2	1982		
11. Greene	1	1983		
12. Hamilton	3	1983	2	
13. Hancock	2	1982		
14. Hendricks	4	1980	2	
15. Jackson	1	1984		
16. Jefferson	1	1982		
17. Johnson	22	1982		1
18. Kosciusko	5	1982		
19. LaGrange	4	1983	2	
20. Lake	11	1973	2	
21. LaPorte	6	1981	3	
22. Marion	60	1982	3	2
23. Marshall	2	1984		
24. Monroe	3	1982	3	
25. Montgomery	1	1982		
26. Morgan	2	1982		
27. Noble	1	1982		
28. Orange	1	1984		
29. Putnam	1	1982		
30. St. Joseph	55	1982	3	
31. Tippecanoe	10	1981	2	
32. Vigo	36	1980	2	1
33. Wabash	1	1984		
34. Wayne	9	1980	3	
35. Whitley	2	1977		
	732			

TABLE 4: Explanation of symbols for figure 1.

•	One male moth in one trap in one location.
▲	More than one trap containing one male moth in one location.
⧫	Multiple male moths in one trap in one location.
★	One or more of the following in one location—one male moth per trap and multiple male moths per trap.

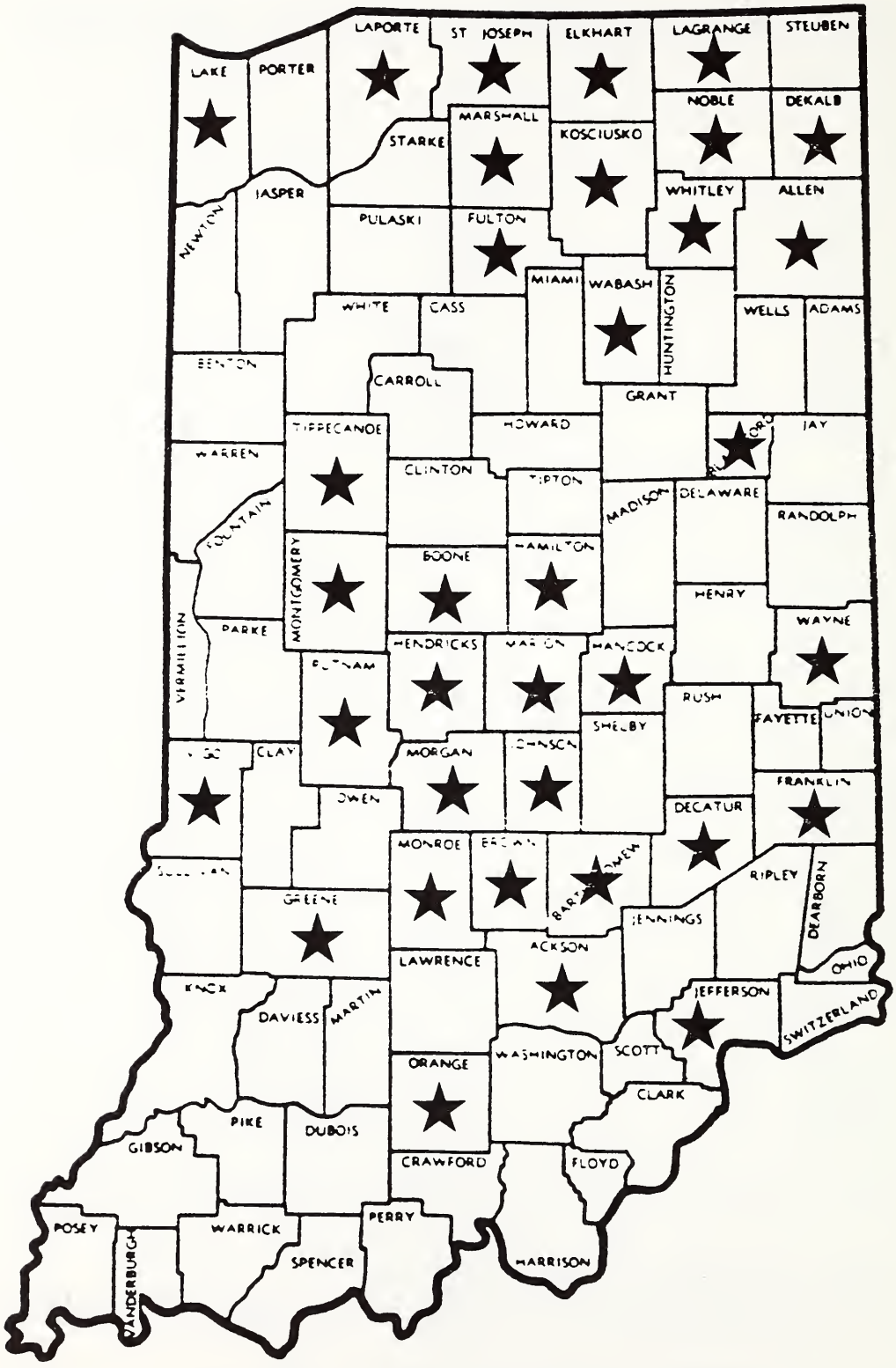

FIGURE 2. Counties where gypsy moth has been trapped since the survey began in 1972.

The infestation in Bartholomew county was in the city of Columbus. One moth was caught in 1981. In 1982, 14 moths were caught in the same area. Egg mass surveys in 1982 found 5 old egg masses on a boat trailer belonging to a family who had recently

moved to Columbus from Connecticut. No viable egg masses were found, and with mass trapping this infestation has died-out (Table 2).

The infestation in Johnson county (Table 3) was found in Camp Atterbury at a national meeting of the Campers and Hikers Association. This infestation was mostly 'hitchhiking' moths, and the infestation died-out from mass trapping and ground sprays.

The two infestations in Marion county were classified infestations based on the pattern of trapped moths from one year to the next. In 1982, 11 moths were found in the two areas. This increased to 35 in 1983. In both areas egg mass surveys were negative. Mass trapping has been used in each area, and only one of the two areas had gypsy moth trapped from it in 1984.

Gypsy moth has been trapped from four state parks—Brown County, Chain-O-Lake, Clifty Falls, and Shakamak, one state recreation area—Paynetown (Monroe Reservoir), several private and county campgrounds, on or near the campuses of Notre Dame, Purdue, and Indiana Universities, rest areas on interstates, and classified forests. All locations where multiple catches have been made can be linked to someone moving and carrying gypsy moth on their cars or RVs and their personal property into Indiana. Nurserystock from an infested northeastern nursery has also carried gypsy moth into Indiana.

Discussion

The gypsy moth survey has found that Indiana can easily have this defoliator introduced into the state and its forests. The survey has also found that gypsy moth is more likely to be introduced in cities and large metropolitan areas where movement of man is more likely to occur. Thus, the recent change in the survey to target traps into these areas. The survey has also found that man's vehicles and other property are the primary means of carrying gypsy moth into Indiana.

Although cities and metropolitan areas may have a greater chance of introducing gypsy moth into Indiana, the rural areas of the state must not be forgotten. This is especially important for south central Indiana where the major forest areas of the state occurs (4). In this area, gypsy moth has been found in Brown County State Park, Paynetown Recreation Area, and the city of Bloomington. Should gypsy moth infestations start in this area, a major natural resource of Indiana is threatened.

The patterns of gypsy moth catches within a year and between years indicate that the current survey has done a good job in detecting the introduction of gypsy moth to Indiana. The survey has located many single catches of gypsy moth and subsequently shown that these single catches were not the start of an infestation. The detection survey and following delimitation survey have located six infestations with four of the six infestations eradicated and two under a control program. This early and efficient detection of gypsy moth will provide many years before a gypsy moth infestation becomes an established population that could spread from within the state.

As found in research on Dutch Elm Disease, an introduced pest to the United States like gypsy moth, efficient and intensive surveys to detect Dutch Elm Disease resulted in a greater length of service before elms were infected and killed and in an overall reduction in the cost of controlling the disease (1). This same intensive survey effort for gypsy moth in the noninfested states can provide similar benefits by lengthening the time to establish populations, by reducing costs of control and by defining introductions of gypsy moth in such a manner as to allow better match of control methods to the particular situation. Therefore, to protect the valuable forest resource and the wooded urban environments of Indiana, the gypsy moth survey should continue at the same or greater intensive level.

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