# REPORT OF THE TECHNICAL WORKING GROUP FOR THE RESPONSE TO AN ASIAN GYPSY MOTH CAPTURE SANTA CRUZ, CA 2017

November 15, 2017

A Technical Working Group (TWG) was convened by teleconference on 27 September, 2017 to develop recommendations on responses to the capture of one Asian gypsy moth (AGM) in Santa Cruz, CA. The panel consisted of Ring Cardé (UC Riverside), Lee Humble (NR Can), Dave Lance (APHIS-PPQ, ret.), Donna Leonard (USDA-FS), Sandy Liebhold (USDA-FS), Vic Mastro (APHIS-PPQ, ret.), Steve Munson (USDA-FS, ret.), Patrick Tobin (U. WA), Brian Van Hezewijk (NR Can), Jodi Axelson (UC Berkeley), and Scott Pfister (APHIS-PPQ, Chair). Also present on the initial call were Paul Chaloux, Helene Wright, Roxanne Broadway (APHIS-PPQ); Stephen Brown, Kevin Hoffman, Debby Tanouye (CDFA); and Pamela Cassar, (Santa Cruz County). The call lasted nearly two hours. During the first hour California Department of Food & Agriculture (CDFA), Santa Cruz County and PPQ program personnel described the situation and discussed concerns and opinions about possible responses. After that point, the TWG continued with internal conversations for another hour and in subsequent emails. The following observations, discussions, and recommendations were developed.

**The situation:**

On August 7, 2017 a single male moth was caught in a gypsy moth trap in Santa Cruz, CA and diagnosed by CDFA as an AGM. This diagnosis was subsequently confirmed by the PPQ CPHST Otis Laboratory, Buzzards Bay, MA. The male moth was homozygous for the Asian marker at the FS1 (nuclear DNA) site and N+/B+ ("A2" type) on restriction enzyme digestion of the COI coding region. This combination is almost exclusively restricted to eastern Asia. This AGM was further sequenced twice for the COI barcoding region, which again confirmed its identity

The positive AGM trap had been previously serviced on July 25$^{th}$, indicating that the moth could have been caught anytime between the negative and positive trap servicing dates (7/25-8/7). Trap density at the time of detection was two traps per square mile as per protocol, and was part of California's routine trapping of residential areas and high-risk sites. Traps were initially deployed in May and were inspected every two weeks. Post detection, a trapping array was deployed in a five-mile radius, 100-square mile delimitation, centered on the detection site, with a 4 sq. mile core. Deployment of the delimitation array began on August 8$^{th}$ and was completed on August 12$^{th}$. Trap densities were nominally 49 per sq. mile in the core area and 25 per mi$^2$ in the remainder of the delimitation zone. Because much of the delimitation zone was over water, the total number of traps was only 1050.

On August 15th, a second male moth was caught approximately three miles from the first moth and was subsequently identified as a North American gypsy moth (NAGM). The male moth was homozygous for the North American marker at the FS1 (nuclear DNA) site and N-/B- ("NA" type) on restriction enzyme digestion of the COI coding region. That trap had previously been serviced on July 31$^{st}$. CDFA indicated that it is not uncommon to recover single male moths late in the year. In 2016, extremely high populations of NAGM were documented in some Eastern states which increases the risk of introductions and detections in the west for several out years. A TWG member stated that warm winters can lead to a protracted hatch and long flight period. Another member mentioned that modeling of gypsy moth flight in Vancouver indicates a flight period from late July until early August, with some males flying into September. Santa Cruz looks like it is only about 1.66C warmer, on average, than Vancouver during the March-September period. This suggests that the moth that was caught does not seem to have been flying

particularly late for that area. There were no further detections of either AGM or EGM. A similar trapping array was in place in 2016 and there have been no AGM detections in Santa Cruz in recent years. The last time an adult EGM male was caught in Santa Cruz was in 2006. Santa Cruz did have an EGM infestation in the mid 1990's which was treated.

The AGM male was caught in an urban residential area with street trees and shrubs being the dominant vegetation. These plants include a number of hosts favored by the gypsy moth. The EGM male was caught in an area with a similar vegetation, but it was closer to the foothills and mountains comprised of mixed herbaceous vegetation and forest.

The apparent source of the Santa Cruz AGM is unclear. The city is home to a large University and is a tourist destination. The region is also home to several large and small nursery enterprises and an arboretum that from time to time have imported plants. There is a harbor which receives commercial fishing boats that have been along the coasts of WA, OR, AK and CA. International commercial fishing boats may off-load at the Port District commercial fishery, which is in the harbor. Recreational yachts that have traveled the world may enter the harbor and they typically clear customs at the first port they enter when returning from a foreign country, but not in Santa Cruz. The closest international cargo ships come to within four miles of the shore.

Santa Cruz receives cargo shipments from all over the world though this cargo is offloaded from vessels at other ports and transported via land to Santa Cruz. Since 2015, there have been nearly a thousand shipments received from AGM countries, but none were known to be plant material. Surveys were conducted of commerce sites in Santa Cruz County in response to the trapping of an adult male AGM. Analysts identified locations that had recently received goods from countries known to have AGM. A total of eight sites were surveyed including a plant nursery and a lumberyard. No additional moths or egg masses were found.

Neither the State representatives nor the TWG members felt that an immediate pathway was identifiable. A number of potential scenarios exist:

- AGM eggs were deposited on cargo or cargo containers in Asia. Infested containers/cargo were then transported to Santa Cruz from the port of debarkation. Hatching larvae found suitable hosts and the male AGM was caught sometime between July 25$^{th}$ and August 7$^{th}$. This is a feasible scenario for introduction as Asian gypsy moth egg masses are intercepted annually on ships and cargo.
- AGM larvae crawled to containers or cargo for pupation. Shipments of that cargo arrived in Santa Cruz prior to adult emergence. A moth subsequently emerged, flew from cargo and was trapped. This is possible but requires fairly precise timing as the pupal period only lasts a couple of weeks, and adult gypsy moths live only a few days.
- AGM egg masses were deposited on international fishing and /or cargo ships and hatched while they were near Santa Cruz. First instar larvae ballooned from the ships and found suitable hosts on shore, although the survival probability would be low.
- AGM egg masses were deposited on live plant material that was imported into Santa Cruz. However, there are no records of recent international plant imports into the area; therefore, if this was the pathway, the importation would have been likely illegal (e.g., imported without a permit).

Although these discussions cover possible scenarios, there are no "smoking guns" *per se*. Consequently, the TWG will not be offering a "most likely" explanation as to the pathway for this single male moth AGM capture.

**Recommendation:**

The TWG is recommending that only delimitation and detection trapping occur in 2018. No treatments are being recommended at this time. This recommendation is based on: 1) that only one male AGM was captured, 2) that a delimiting trapping array was deployed within five days with no additional detections, and 3) there are no identifiable high-risk pathways. This strategy has precedent with recent captures of a single AGM in port areas of California, South Carolina, British Columbia, as well as two finds in Oklahoma and South Carolina. In each case these have been followed by enhanced delimitation rather than treatment, and populations did not subsequently develop[1].

**Delimitation and detection trapping:**

The current *USDA-APHIS-PPQ Asian Gypsy Moth Survey and Response Guidelines* (January 2014 revision) suggest, for delimitation, "core" trapping levels of 25 to 49 traps per square mile, depending on the desired degree of precision, within two miles of any trap find. The TWG finds these guidelines generally appropriate, but is recommending at least 36 traps per square mile and extending the core trapping area out to three miles from the point of 2017 AGM capture. The recommended minimum of 36 traps per square mile retains detection power function comparable to higher trap densities (Appendix 1) and would reduce program costs over the increased detection radius of three miles when compared with 49 traps per square mile.

Beyond the core zones, trapping should be conducted at 25 traps per square mile for the next two miles (i.e., extending out to five miles from 2017 capture site). The TWG emphasizes that complete trapping coverage is more important than trap density, especially in remote areas. Traps within grids should be spaced as evenly as possible to avoid areas with large gaps in coverage. Viable populations may exist within these gaps and, if left undetected due to insufficient trap coverage, they could increase to undesirably larger population levels affecting much larger areas. Beyond areas of delimitation, normal port, gypsy moth detection, and Asian defoliator trapping should be conducted.

As previously mentioned, warm winter conditions in the area may lead to a protracted hatch and longer flight period; therefore, established degree day modeling may not be entirely accurate for Santa Cruz. The TWG recommends to the extent possible that several gypsy moth life stage models be consulted, such as BioSim, GMPHEN, and/or the GLS model to ensure that traps are in place throughout the entire GM flight period. Buffers of 3-4 weeks should be provided for both adult flight initiation and cessation to allow for inaccuracies of the degree-day model and possible biological differences between AGM and NAGM. The TWG also recommends the use of F1-sterile egg masses for monitoring purposes. As outlined in the AGM response guidelines:

> *If male gypsy moths are treated with the proper substerilizing dose of radiation and mated to an unirradiated female, a portion of the resulting eggs will hatch, but the larvae will develop into*

[1] The SC detection was in Charleston in 2014, and a single male AGM was caught again during the delimitation in 2015. Current plans are to continue delimitation. It should be noted that capture of a single male AGM in Oklahoma in 2013 also was not followed with treatment despite being in an area of low trap density. In this case, there was no apparent pathway to the area of the trap, with the most likely source being a military base that was centered ca. 9 miles from the capture. As such, it was felt that treatment around the trap (per AGM Response Guidelines) would likely have missed the actual population. An area-wide delimitation in 2014 again caught one AGM, this time on the base itself. Trapping in 2015, 2016 and 2017 turned up no males.

*fully sterile adults. These egg masses can be placed in areas with newly detected gypsy moth populations to help estimate timing of hatch without risk of adding to the incipient population. The egg masses are caged as an added security measure, to protect the egg mass, and to avoid possible confusion over the origin of any males that are subsequently captured. The Otis laboratory provides sterile EGM egg masses and can also provide cages or guidance on cage construction.*

*Egg masses should be placed outdoors in the area where suspect AGM were captured. This should be done as early as possible, preferably during the fall following the summer when the AGM were trapped. Cages should be placed in a variety of locations near the ground, but in places where they will not be disturbed by the public. Egg masses should be checked for hatch three times weekly starting about three weeks before phenological models or other indices indicate that hatch is expected. In areas with warm winters (e.g., coastal California or the Gulf Coast), masses should also be checked weekly through the winter.*

Traps should be serviced weekly throughout the core area and should be replaced if they become excessively degraded due to particulates or humidity. If a trap needs to be replaced then the lure should be replaced as well. The program should make preparations to continue trapping for three years, but may consider reducing the area and intensity after the first year.

**Regulatory measures:**

The TWG does not believe that the level of risk of transporting AGM out of the program area warrants regulatory restrictions at this time.

**Other recommendations:**

For the single male EGM detection, the TWG recommends following the standard one square mile delimitation protocol as outlined in the USDA-APHIS-PPQ Gypsy Moth Manual.

While the TWG does not recommend treating at this time, if regulatory officials wished to pursue treatment, they should generally follow recommendations in the USDA-APHIS-PPQ Asian Gypsy Moth Survey and Response Guidelines (January 2014 revision).

**Appendix 1.**

Predicted percentages of male gypsy moths captured in (+)-disparlure baited traps deployed at various densities when males are either distributed randomly throughout the habitat or all emerge at maximum insect-to-trap distances within the grid (work conducted on North American gypsy moths).

| | | Expected % of males captured[a] | |
|---|---|---|---|
| Traps per sq. mi. | Max dist. to trap (m) | Randomly distributed | Worst-case scenario[b] |
| 1 | 1138 | 1.78 | 0.22 |
| 4 | 569 | 4.33 | 1.51 |
| 9 | 379 | 6.11 | 2.84 |
| 16 | 284 | 7.71 | 4.07 |
| 25 | 228 | 8.80 | 5.00 |
| 36 | 190 | 9.95 | 5.80 |
| 49 | 163 | 11.12 | 6.43 |

[a] Results of Monte Carlo simulations using distance-capture functions derived from multiple release-recapture studies and modeled based on a negative exponential model.

[b] Assumes all insects are initially at the maximum distance from a trap when traps are placed in a "perfect" square grid.