

BED BUG NATION: IS THE UNITED STATES MAKING ANY PROGRESS?

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Abstract Contrary to recent news reports, the United States continues to be inundated with bed bugs (*Cimex lectularius* L.). Based on a nationwide survey of pest professionals, infestations still are increasing. While most pervasive in residences, the bugs are becoming more common in schools, offices, public transportation and other locales where beds are not normally present, paralleling historical trends for this insect. Bed bugs continue to be the most challenging pest encountered by professionals. The cost of extermination is exceeding the budgets of many households and businesses, the majority of whom are averse to spending more on proactive inspections and other preventative measures. Pest managers in the U.S. are becoming more experienced with bed bugs, and have better tools for providing relief to those who can afford their services. Prospects are less hopeful for the poor, and widespread resistance to insecticides is a global predicament. Absent of a coordinated societal response with affordable science-based pest management tactics, prospects for curtailing the resurgence appear unlikely.

Key words Survey, infestation status, management, monitoring, insecticides

INTRODUCTION

One of the remarkable things about bed bugs, *Cimex lectularius*, has been the reach of their resurgence. When pest management firms from 43 countries were surveyed in 2010, respondents confirmed that infestations were increasing worldwide (Potter et al., 2010). The following year, pest managers in the United States were surveyed again, revealing that infestations were becoming more common in ‘non-bed’ environments such as schools, office buildings, theaters, libraries, and on public transportation (Potter et al., 2011). Many respondents also reported ineffective, often desperate attempts at self-treatment by the public, including dangerous misuse of insecticides, heaters, open flame, and flammable chemicals.

In 2012, media coverage of bed bugs in the U.S. waned. Health officials in some notably infested cities (New York, Cincinnati) also received fewer calls on their bed bug help lines, prompting speculation that the problem was in decline (Palmer, 2013; Maseru, 2013). This paper provides a different perspective on the status of bed bugs, based on a recent survey of the pest management industry.

Survey Parameters

An online survey consisting of 32 questions was developed, covering topics ranging from frequency of bed bug infestation, to management and business practices. Many of the questions were similar to those in previous surveys in order to permit year-to-year comparisons. Responses were collected from January 19 to February 18, 2013. Letters requesting participation were emailed to 6972 contacts from member companies of the National Pest Management Association (NPMA). This

resulted in 251 completed surveys for a 3.6% response rate. Respondents worked for companies ranging in size from fewer than 10 individuals to thousands of employees. Participation by region was Midwest (33%), South (26%), Northeast (21%) and West (20%) (Potter et al., 2013).

STATUS OF INFESTATION

Nearly every pest manager (>99%) indicated their company treated or was asked to treat for bed bugs in the past year. When asked about the incidence of bed bugs in their region, 72% of respondents said infestations were increasing while 25% said they were staying about the same. Only 3% felt that incidence of bed bugs was decreasing. Regionally, more pest management firms in the West (79%), Midwest (77%) and South (74%) felt that bed bugs were increasing, than those from states in the Northeast (53%).

About half (49%) of respondents said their company receives more bed bug calls at certain times of the year. Fifty-six percent of those that did report a “busy season” mentioned receiving more bed bug calls during summer, while 24%, 12% and 7% said their busiest season for bed bugs, respectively, was fall, spring and winter. The same seasonal trend was noted in a previous industry survey (Potter et al., 2011). Mabud et al. (2014) also reported a seasonal cycle of infestation (peaking in summer, waning in winter), based on calls received by the Philadelphia Department of Public Health. Travel, relocation, and other activities tend to increase during warmer months of the year, which could boost the chances of encountering bed bugs. During summer, the ambient temperature of some dwellings also tends to be higher, which would result in a faster development time.

Bed bugs continue to be most pervasive in residences, with almost all respondents encountering them in apartments, condominiums and houses (Figure 1). Occurrences also are becoming more frequent in schools, offices, public transportation and other areas where beds are not normally present. When pest managers in the U.S. were surveyed in 2007 (Potter, 2008), only 5-6% mentioned finding bed bugs in schools and hospitals, and fewer than 1% encountered them in office buildings. By 2013, 41%, 36% and 33% of respondents, respectively, reported finding bed bugs in these places. Discovering bed bugs in diverse locations is consistent with the historical infestation pattern of this insect (Potter, 2011). This trend will likely continue now that the bugs are entrenched in housing, and brings into question how such occurrences should be handled. Bed bugs are less prolific when access to stationary hosts is intermittent. Consequently, when problems arise in places such as schools, office buildings and libraries, bed bug numbers tend to be small and the threat to the public minimal disproportionate, at least, to the unease and adverse publicity the incidents sometimes evoke.

MANAGING INFESTATIONS

Pest managers in the U.S. continue to find bed bugs harder to control than other key pests. More than three fourths (76%) of those polled said bed bugs were the most difficult pest to control; ants were deemed most difficult by 17% , cockroaches by 6%, and termites by only 1%. This opinion has not changed from previous industry surveys, despite many more educational seminars, workshops, articles, research, new products and technology. More than 20 U.S. universities are now conducting research on bed bugs, compared to only a few as recent as seven years ago. Significantly there were more papers presented on bed bugs at recent annual meetings of the Entomological Society of America, than on termites, ants or cockroaches (Figure 2).

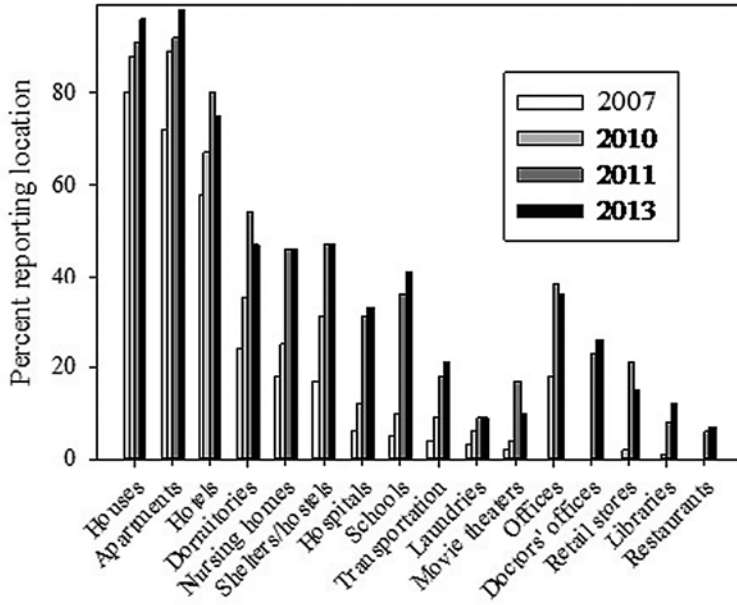


Figure 1. Locations by survey year where respondents reported finding bed bugs.

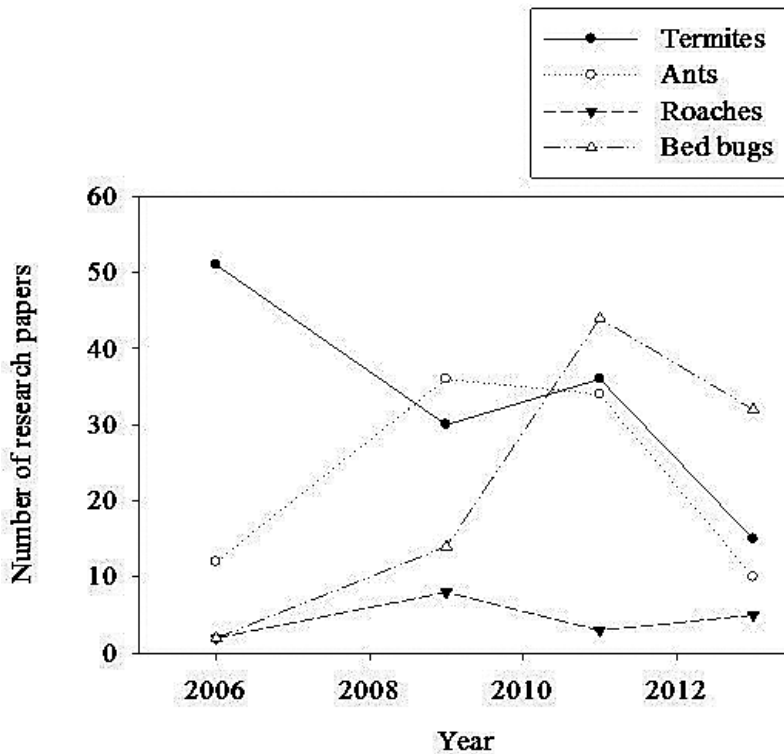


Figure 2. Number of papers on key pests presented at Entomological Society of America annual meetings.

The time initially spent treating an “average size bed bug infestation” in a residential setting, ranged from less than one hour to more than five hours. (Estimated median 3.4 hours, compared to 2.9 and 2.7 hours, respectively in 2011 and 2010 surveys.) Most respondents (94%) said their company spends more than one hour on the initial service. Thirty percent said one to two hours were spent, while 64% said more than two hours were typically spent on the initial service. The majority of respondents (69%)

said two or three services were typically needed to control infestations (16% said one visit was satisfactory, while 12% said more than three visits were typically needed).

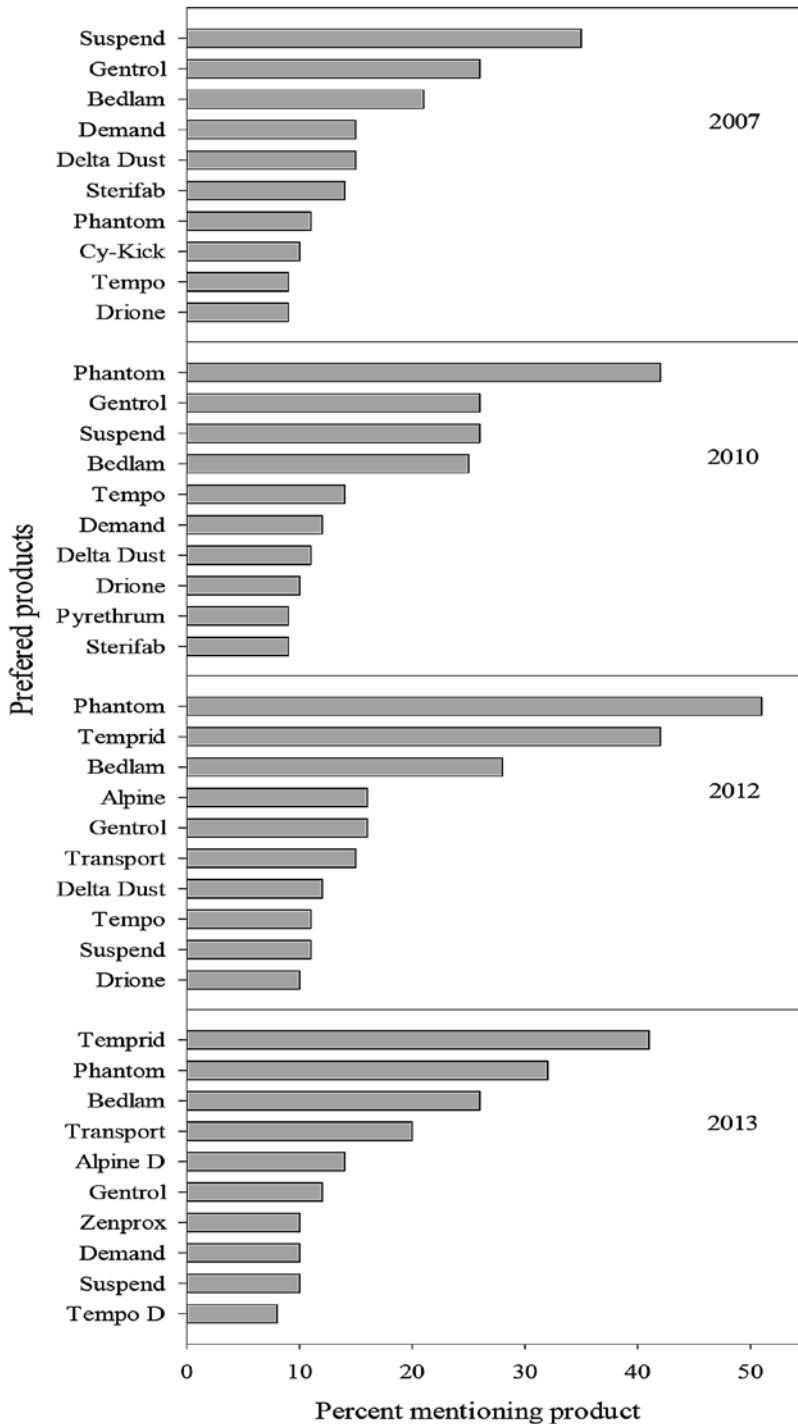


Figure 3. Most commonly used insecticides by survey year. Alpine (dinotefuran/DE); Bedlam (d-phenothrin); Cy-Kick (cyfluthrin); DeltaDust (deltamethrin); Demand (λ -cyhalothrin); Drione (silica gel/PBO/pyrethrins); Gentrol (hydroprene); Phantom (chlorfenapyr); Sterifab (d-phenothrin); Suspend (deltamethrin); Tempo, Tempo D (cyfluthrin); Temprid (β -cyfluthrin/imidacloprid); Transport (bifenthrin/acetamiprid);

Monitoring, Detection, Prevention

Vigilance and early detection have long been considered keys to managing bed bugs. Detecting infestations early simplifies treatment within individual living units and limits dispersal to other

areas of the building. Nearly all companies surveyed (99%) conduct visual inspections, but other approaches are gaining in popularity. Half (50%) of those polled mentioned using pitfall traps under the legs of beds and sofas, compared to 46% and 25% who mentioned using them in 2011 and 2010. More than a third (35%) also mentioned using monitoring devices emitting heat and/or carbon dioxide (versus 27% and 14% in 2011 and 2010). Conversely, utilization of glue traps declined (46% in 2013 versus 59% in 2011) — reflecting perhaps a greater realization by the industry that bed bugs tend to avoid capture by sticky surfaces. Also notable was the continued use of canine scent detection teams, either owned or sub-contracted through another company. In 2013, 45% of respondents said their company had used canines to find bed bugs, up slightly from 43% in 2011. Only 17% used the dogs when the pest management industry was surveyed in 2010. Undoubtedly there will be more bed bug detection devices in the future. Most promising will be those that reliably detect infestations at low levels, and are economical and inconspicuous.

More than two thirds of current respondents (68%) felt that customers are very (16%) or somewhat (52%) interested in some form of preventative service for bed bugs. In respect to the willingness of customers *to pay* for preventative inspections, 54% sensed they were very (7%) or somewhat (47%) willing to pay for bed bug prevention, while the rest felt their clients were not interested (31%) or were unsure (15%). Sixty percent of respondents said their company currently conducts some type of proactive service for bed bugs. Services performed by those that do include ongoing visual inspection (by 29%), monitoring/trapping (by 18%), canine inspections (18%), and insecticide applications (17%).

Treatment Methods

When pest managers were asked which methods they normally use to control bed bugs, 96% mentioned insecticides. Encasing beds was also widely mentioned by 85% of respondents, which was comparable to their usage in 2011. Utilization of vacuums (by 70%) and steamers (by 43%) was also similar to 2011. Volumetric heating of rooms and buildings was employed by 42% of this year's respondents, compared to 32% of those polled in 2011 and 17% in 2010. Other treatment methods employed included container heat treatment (by 19%), pesticide-impregnated bed liners (by 4%), and spot freezing (3%).

Insecticides

Insecticides continue to be the most universal control method for bed bugs. Ninety-six percent of respondents said they apply insecticide liquids, 90% dispense dusts, 52% use aerosols, and 22% employ resin strips impregnated with a volatile organophosphate insecticide. These were virtually the same use patterns reported in 2011. When asked which products they routinely use, Temprid containing both pyrethroid (β -cyfluthrin) and neonicotinoid (imidacloprid) formulation ingredients was mentioned by 41% of respondents. The next most utilized product Phantom (chlorfenapyr) was cited by 32% (28% mentioning the liquid formulation, 4% the aerosol). Chlorfenapyr was the most mentioned product (by 51% and 42% of respondents) in 2011 and 2010. Rounding out the third and fourth most-mentioned products in 2013 were Bedlam aerosol (d-phenothrin + synergist), and another dual formulation, Transport (bifenthrin + acetamiprid). Usage of pyrethroid-neonicotinoid combinations for bed bugs has increased dramatically in recent years. In 2010, fewer than 5% of those polled routinely used these formulations. Clearly the choice of insecticides has changed rapidly, due in large part to resistance concerns of the industry (Romero et al., 2007) (Figure 3).

When pest management firms were asked if they were satisfied with the performance of current insecticides, 24% said "very satisfied," 61% were "somewhat satisfied" and 15% were either

“not very” or “not at all satisfied.” Industry satisfaction with available products has increased modestly since we asked this question in 2010.

As in previous surveys, opinions varied on the extent to which bed bugs are insecticide resistant. About a third of 2013 respondents (34%) said they had encountered resistant populations in the field, 42% felt they had not, and 24% were unsure. Bed bug resistance tends to be less obvious in the field than in the laboratory. One reason for this is that pest controllers often employ multiple tactics, which can offset reduced effectiveness of insecticides. Encasement of beds, for example, can purge many bed bugs from a dwelling, especially when augmented by laundering, vacuuming, steam treatment, etc. Insecticides also tend to perform better when bed bugs (even moderately resistant ones) are contacted directly. Apart from the active ingredients, bed bugs can be impacted by solvents, propellants, synergists, and other formulation components. This is especially true with aerosol and oil-based materials. Newer products with different or dual modes of action (e.g., chlorfenapyr, β -cyfluthrin + imidacloprid, bifenthrin + acetamiprid), also generally perform better against populations resistant to pyrethroids (Romero et al., 2010; Potter et al., 2012). Such factors may help to explain why many respondents do not consider resistance to be a widespread problem in the field.

Nonetheless bed bugs are endowed with diverse toxicological defenses to resist insecticides (Yoon et al., 2008; Adelman et al., 2011; Mamidala et al., 2011; Zhu et al., 2013). Although the new pyrethroid-neonicotinoid combo formulations are performing better than pyrethroids alone, resistance to these compounds has recently been documented also (Gordon et al., 2014). Pest managers should be watchful for declining performance in the field, and vary their approach to preserve current materials.

BUSINESS AND OPERATIONAL CONSIDERATIONS

Bed bugs command considerable time and resources of the pest management industry, yet still comprise a rather modest percentage of total revenue. Almost half the respondents in our survey (49%) said bed bug-related services generated five percent or less of their firms' annual income. Nonetheless, 26%, 24%, and 11% of firms from the Northeast, West and Midwest reported revenue from bed bugs exceeding 20%. On the other hand, costs for treatment are outpacing the budgets of many households and businesses. Two-thirds (67%) of respondents said the average amount customers in single-family homes paid for treatment was between \$500 and \$1500, with a median expenditure of about \$1000. The amount that apartment and condominium managers spent treating their buildings for bed bugs ranged from \$1000 to more than \$50,000. Similar costs were incurred by owners and managers of hotels and motels. These expenditures far exceed what consumers are used to paying for relief from household pests. Companies have had limited success to date convincing clients to invest in pro-active inspections or pre-emptive treatments for bed bugs. Targeted preventive applications using non-repellent residual insecticides are currently being evaluated in hotels and apartments by some U.S. companies (Potter et al., 2012).

Several respondents stressed that the bed bug resurgence cannot be curtailed without the public's cooperation and vigilance. When pest managers were asked what the biggest customer oriented challenges were during treatment, most often mentioned were “too much clutter” and “not following their advice.” While many U.S. firms provide detailed preparation instructions to clients, the lists are often tedious and difficult to fully comply with, especially for the elderly and infirmed. Consequently, some companies have begun basing the level of requested preparation on extent of the infestation, i.e., low infestation, less preparation; heavy infestation, more preparation. Additional preparatory measures may be required as treatment proceeds.

Other respondents emphasized the need for effective and affordable solutions for the poor, pointing out that neglected infestations can also become massive reservoirs capable of infecting entire communities. Where the funding would come for community-wide bed bug eradication and prevention is unclear. Respondents also voiced concern about the devaluation of services as the bed bug market matures and prices decline. Some lamented that firms should not be doing bed bug work if their service lacks thoroughness, since this ultimately misleads the public. Unease was also expressed regarding the public's misuse of pesticides and flammable materials, which is also posing a risk for service technicians.

More U.S. cities are passing legislation defining the rights and responsibilities of tenants and landlords. Responsibility for treatment is usually incumbent upon property managers, while tenants are expected to promptly inform them of infestations and cooperate fully with treatment. One controversial issue is whether landlords should be required to inform prospective renters of infestations. While such notification may seem reasonable, it raises complex questions about when a formerly infested unit can be considered bed bug free. Another ethical dilemma is whether tenants have a right to know about the presence of bed bugs elsewhere in the building and especially in nearby units— or if this violates the privacy rights of those living in the infested units. Several lawsuits involving bed bugs are presently working their way through the U.S. courts, including the first case approved for class action status involving hundreds of poor, elderly and disabled tenants (Pitt, 2013).

What is clear from the current survey is that bed bugs in the U.S. are not subsiding, as some reports have suggested. Infestations continue to appear wherever people live, work and gather. Bed bugs continue to be the most challenging pest, by far, encountered by the pest management industry. Companies are becoming more experienced and have better tools for treating infestations. Yet there are no 'silver bullets' or easy fixes and the threat of insecticide resistance poses a global predicament. As a nation, the United States is making progress, but the lowly bed bug is proving to be a formidable adversary.

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