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IMPACT OF AREA–WIDE MANAGEMENT ON ALATE DENSITIES OF THE FORMOSAN SUBTERRANEAN TERMITE (ISOPTERA: RHINOTERMITIDAE)

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Abstract An area-wide management project to control the Formosan subterranean termite, *Coptotermes formosanus* Shiraki (FST), in the New Orleans French Quarter (FQ) began in1998. Initially, all properties within fifteen square blocks were treated with either commercially available non-repellent termiticides or baits. Application was by commercial applicators through state approved pest control contracts. The treatment area has been expanded twice since inception of the project, once in March 2002 and again in March 2004. Each area is labeled respectively according to the date treatment began. Thus, Area I is the original 15 blocks; Area II is the first expansion; Area III is the second expansion; Area IV is the area on the levee and Area V is the untreated blocks. To monitor the termite densities alate traps were installed throughout the entire FQ. The alate traps were monitored at least twice weekly during the alate swarming season from April 1 to July 30. Alate trapping across all areas since 1998 indicates that Area III and the northeast most part of Area V have been the most densely infested areas in the FQ. Area-wide treatment in Areas I and II resulted in at least a 50% decline each in the number of trapped alates two years after area-wide treatment began. Although the number of trapped alates in Area I has been consistently lower than the number trapped from the surrounding areas (In 2004, for example, Area I, X = 278 vs. Area III, X = 1023), the average number of alates captured in Area I has remained unchanged since the initial decline in 2000. The continuing presence of alates in Area I is attributed to above-ground infestations in the treated structures and to infestations in secondary untreated structures (e.g. storage sheds), untreated common walls, trees and debris buried in the area. Inspection of trees and all structures, followed by treatment when active termites were discovered was begun in October 2003 to further reduce the persistent FST infestations in the managed areas.

Key Words *Coptotermes formosanus*, area-wide management

INTRODUCTION

The Formosan subterranean termite (FST), *Coptotermes formosanus*, Shiraki is reportedly one of the most destructive termite species in the urban environment. It is believed to originate in south China but is now distributed worldwide (Su and Tamashiro, 1987). The FST was introduced to the continental United States after World War II (WWII) on military vessels returning from the Far East to southern and southeastern US port cities. It was not, however, until 1965 that the FST was identified from specimens collected from a shipyard in Houston, Texas. It was subsequently reported from New Orleans and Lake Charles, Louisiana and Galveston, Texas in 1966 and Charleston, South Carolina in 1967. The size and extent of these infestations led inspectors to believe that FST had arrived in the US many years earlier (Spink, 1967). The FST has now been discovered in 11 states; its range within these states is expanding and posing an ever-present threat to other, as yet, uninfested States (Woodson et al., 2001).

Since its introduction after WWII the FST population in metropolitan New Orleans has increased annually. Henderson (1996) and Henderson and Delaplane (1994) have estimated this increase by trapping alates during the annual swarm in late spring. Henderson reported that from 1989 to 1995 the annual catch of alates increased 14-fold in the Greater New Orleans area. This increasing population of FST causes significant, recurring damage to homes, businesses and trees in the area. In fiscal year 1998 the US Congress, responding to citizen's requests, established an annual appropriation of five million dollars to address the problem. The USDA Agricultural Research Service in New Orleans was given the tasks of developing a research program for improved termite control and specifically implementing a management program to demonstrate area-wide control of this pest. The New Orleans French Quarter (FQ) is near one of the original points of entry of the FST into the city (Spink 1967). It was selected for this management program because of the many historical

buildings and important role the area has in the New Orleans tourist industry. The expanding population of FST in the area since the 1960's had been particularly difficult to control in the FQ in part because its unique architecture makes thorough application of termiticides difficult. Property owners in the FQ repeatedly experienced costly repairs due to heavy FST infestations. A team of scientists assigned the task to develop a control strategy decided upon an area-wide approach that utilizes baits, non-repellent termiticides or a combination.

The strategy was to treat all properties in a selected area of the FQ with these termiticides with the goal to reduce the FST population in the treated area and thereby offer greater protection to structures than was previously possible with repellent termiticides. An assumption with the strategy is that actively foraging colonies are eliminated when members feed on baits or contact areas treated with non-repellent termiticides. One measure of this effect on population reduction is an estimation of the annual alate swarm in the area. This manuscript reports the impact of area-wide strategy on alate swarms in the managed areas of the FQ.

MATERIALS AND METHODS

The New Orleans FQ is approximately 108 square blocks. Its borders are: Canal, Rampart, Esplanade and the Mississippi River on the southeastern boundary of the FQ (Figure 1). There are several rail lines (RR) between the river and Decatur Street with active FST infestations in the wooden crossties. Several, large wooden planters on the levee are also heavily infested. Neighborhoods are comprised of a mix of government buildings, hotels, various retail businesses, entertainment establishments, churches and residences. The business and entertainment establishments are mostly located in the western and southern halves of the FQ bordered by Canal and Decatur Streets, while the neighborhoods to the northern and eastern sections (Rampart and Esplanade) are predominantly residential. Structures range in size from small, single-level dwellings to multi-storeyed structures. One notable feature of these structures is the common walls between neighboring structures.

To plan and conduct this extensive and large management project, the USDA-ARS established agreements with the Louisiana State University Agricultural Center, Department of Entomology and the New Orleans Mosquito and Termite Control Board (NOMTCB). Together, the partners developed policy, strategy and guidelines for participation by property owners and Pest Management Professionals (PMP). The LSU Agricultural Center was responsible for approval and management of termite control contracts and along with the NOMTCB and ARS the daily operations of the project. Termiticides were applied by licensed PMP's through state approved termite control contracts. Although specific products were not designated, PMP's were required to use only EPA labeled and state-approved baits, non-repellent termiticides or a combination of these products. Initially, program planners selected the 15 square blocks designated Area I for implementation of the area-wide strategy (Figure 1). Application of termiticides in Area I began in the spring of 1998. Contractual coverage and treatment by PMP's of all properties in Area I required nearly two years. Subsequently, area-wide treatment was extended to Area II beginning in March 2002 and to Area III in March 2004. Ninety percent of the properties in Area II and III are under contract as of January 2005. When all properties in these three areas are under contract, area-wide management will cover 56 FQ square blocks. Although the remaining blocks (Area V) are not yet included in the formal area-wide management program, approximately 40% of the properties in these blocks are receiving some termite treatment as a result of commercial sales to property owners in the area. Plans are to ultimately include all FQ blocks, the RR adjacent to Decatur Street and the levee under area-wide termite management.

To evaluate progress of the area-wide strategy a series of alate traps were used to estimate the annual alate swarm. These traps consisting of a glue board (9.5 x 19 cm, Bell Laboratories) attached to a small clipboard were suspended just below a street lamp located on or near a FQ intersection (Figures 1 and 2). Formosan termite alates actively swarm in the early evening hours and commonly gather around artificial light sources. The numbers of alates captured on these traps each swarming season were used to estimate annual changes in the FST alate population. Each year, traps were installed the first week of April and were present throughout the swarming season until the end of July. Alate swarms typically are at their highest numbers and frequency the first three weeks of May (Henderson, 1996; Henderson and Delaplane, 1994). The glue boards were replaced anew at least weekly or the next day immediately after a significant swarming event. The alates that adhered to each glue board were identified and the number recorded for each sampling period.

Trapping for alates along the levee (Area IV) began only in 2001. For this reason and because the levee is not typical of FQ neighborhoods (i.e. having no structures) data from this area are omitted from this presentation. Area III in 2004 is considered untreated since it was announced only in March of 2004 that the

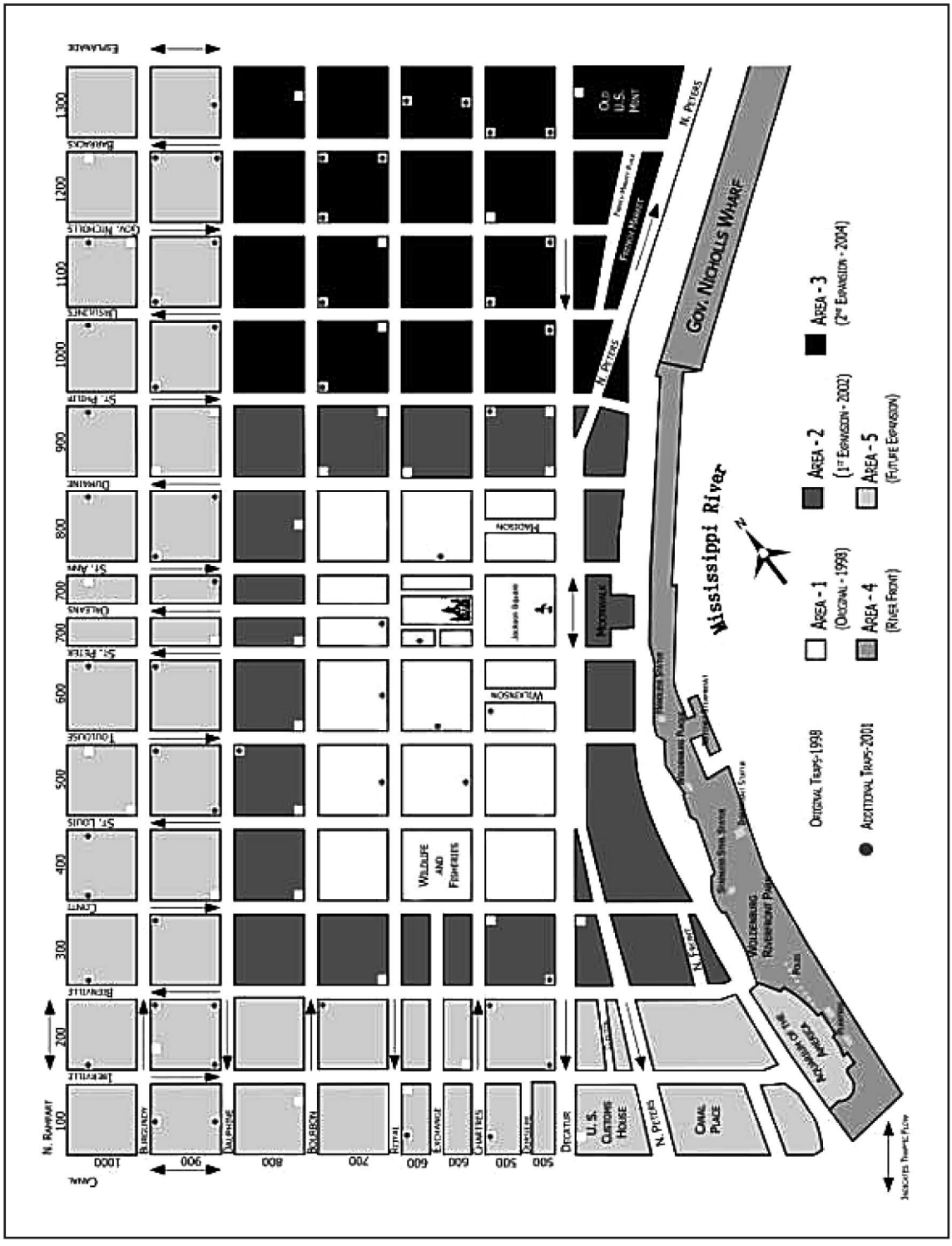

Figure 1. The New Orleans French Quarter with location of alate traps.

Figure 2. Typical alate trap suspended from street lamp in French Quarter.

area was to come into the area-wide program, too soon for impact on the 2004 alate swarm. Trap placement in the FQ is illustrated in Figure 1. Originally in 1998 there were only 47 traps placed throughout the FQ for sampling the alate population. There were 24 traps in Area I and 6, 6, and 11 in Areas II, III and V, respectively. In 2001 the total number of traps in the FQ was increased to 102 with a total of 32, 16, 20 and 32 in Areas I, II, III, and V, respectively. Prior to 2002 Areas II, III and V were not included in the area wide strategy and are considered not treated from 1998 to 2002. Area-wide management was begun in 2002 in Area II.

Statistical Inferences. In order to make statistical comparisons between areas, the four areas are defined as the population of inference. This means that the comparisons are between these specific areas and the error used for these comparisons do not apply to inference made to treatments if applied outside of these four specific areas. The average alates per trap were calculated and transformed ($\log_{10}$) for analysis. Analysis of variance (Proc Mixed, SAS) was performed using trap-to-trap variability as an estimate of error. The years 1998 and 2004 were treated as repeated measures on a specific trap by including traps within an area as a random block effect. Differences between two values on a log scale become ratios when converted back to the original scale. A ratio of the mean alate captures for two years with in each area was compared to the Least Significant Ratio (LSR) value for significance. The same comparison using the combined values for Areas I and II, representing the area-wide treatment and Areas III and V, representing the area without area-wide management were performed.

RESULTS

The average annual alate captures from each of four areas in the FQ are shown in Figure 3 (original traps) and Figure 4 (all traps after 2001). Both Figures illustrate apparent differences in alates captured from the FQ neighborhoods even in the beginning of the program. The different densities from among the neighborhoods are also apparent in Figures 5 and 6 where the sizes of the capture/trap are presented as frequencies or percentages, illustrating that in the beginning (1998), Area I had a greater percentage of traps with few captured alates than did those areas outside (Areas II, III and V) of the managed zone. Also illustrated are the reductions in the frequency of traps with high catches for Area I from 2000 to 2002 (Figure 5) and for Area II from 2001 to 2004 (Figure 6). In both instances the reduction occurred two years after the area-wide strategy began in each area, respectively. The trap catches in Areas III and V showed only a slight decrease in the frequency of traps with high catches from 1998 to 2004. This reduction is most likely due to the commercial sales to

individual property owners of termite protection contracts not associated with the area-wide management program. Area III, specifically, had the highest alate count throughout the entire period. Table 1 contains the statistical analysis for mean comparisons. The ratios of alate capture for the initial year (1998) and the last year (2004) for Areas I and II, the treated areas, were significantly (P=0.05) greater than the LSR values for each area, respectively. Comparisons of ratios for Areas III and V did not show significant changes in alate captures over time. A test for significance that at least one of these ratios differed from the others indicated that the differences among the four ratios were not considered significant (F=1.35, P=0.27) when the captures in Areas I and II (treated Areas) and Areas III and V (untreated Areas) were combined, respectively, the results were ratios for the treated and untreated groups that were different from each other with a 12% probability this inference is incorrect (F=2.54, P= 0.1184) (Table 1).

Table 1. Comparison of average alate captures from French Quarter Neighborhoods. Quarter neighborhoods (additional traps).

Area	1998	2004	1998/2004	P	LSR (p=0.05)
1	17.5	10.1	1.7	0.020	1.57
2	37.2	12.6	3.0	0.013	2.31
3	32.8	33.8	1.0	0.948	2.45
5	22.1	17.3	1.3	0.425	1.85
1 & 2	20.7	10.9	1.9	0.002	1.48
3 & 5	25.3	22.1	1.1	0.599	1.66

Although the results after two years of area-wide management in Areas I and II were very encouraging, the absence of further decline in the alate captures in Area I since 2000 suggested the continuing presence of mature colonies in Area I. This supposition has validity if, for example, one considers the several “hot spots” of activity as indicated by the persistent annual catches at several central locations and along the northeastern boarder of Area I (dark circles in Figure 7). The traps (>300 alates/trap) represented by the dark circles in Figure 7 have persistently been the most active traps since 1998.

An intense inspection program was begun in 2003 to discover the possible presence of mature colonies remaining in structures and trees located near these persistently active traps. One hundred fifty-eight properties in Area I have been inspected at least once since 2003. Inspection results show 19% had live FST infestations. The trees on 93 properties in Area I were also inspected for FST infestations. Six of these properties had a total of 16 FST infested trees or 2.3% of the total trees inspected. Although the number of infested trees represents a small proportion of the total trees, 10 of the infested tress were clustered on two properties. The proximate locations of these infested trees and structures to the most active traps suggest they too are likely sources of alates captured on these persistently active traps and that termiticide application around these structures and trees had not yet impacted these colonies (Figure 7).

DISCUSSION

While the architecture of its buildings and the design of many of its properties with an interior courtyard and ancient carriage way add to the charm and splendor of the FQ, these features of FQ buildings and properties add significantly to the difficulty of managing the FST. Many buildings share common walls and rest on brick

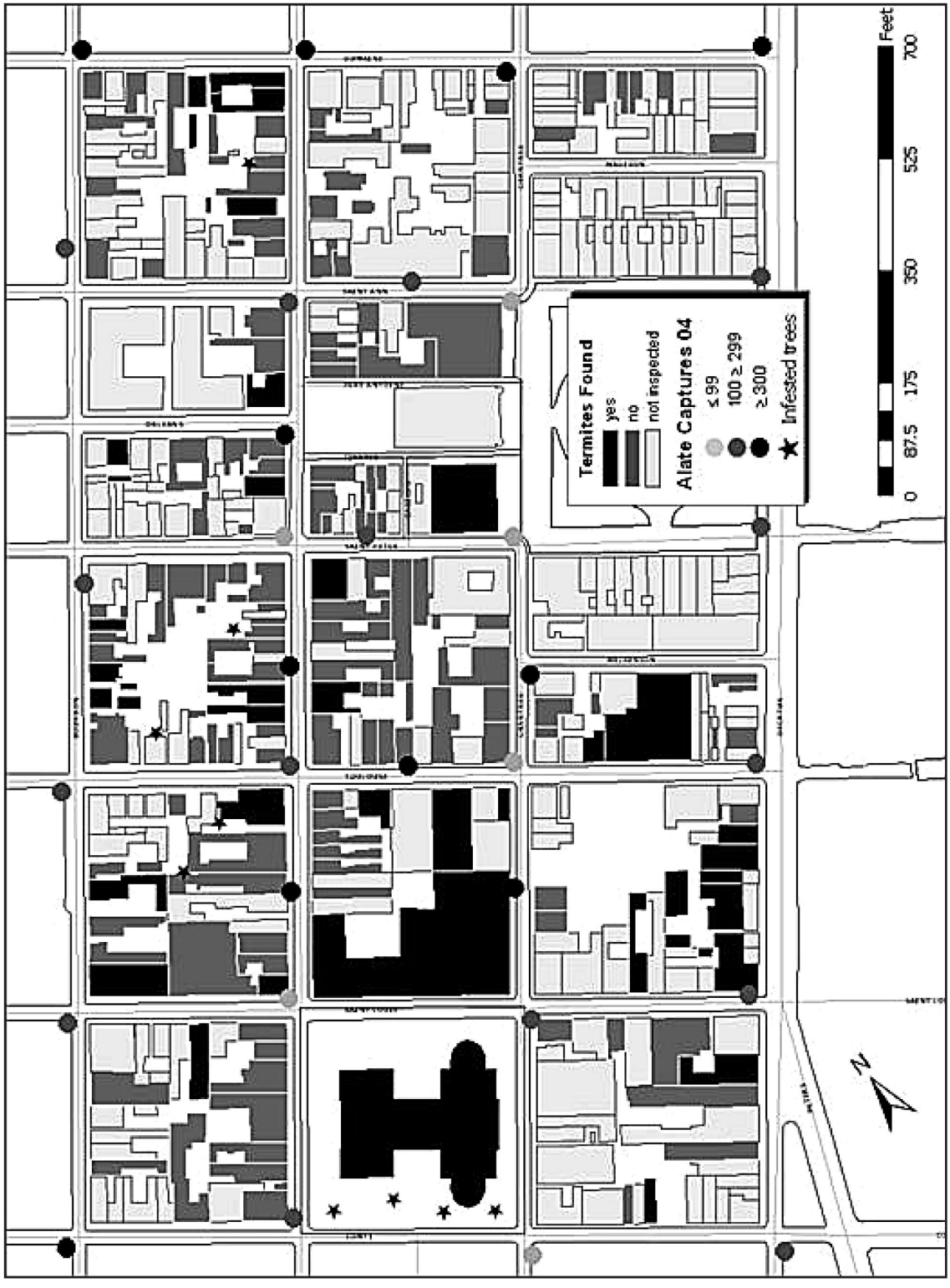

Figure 7. Results of inspection of properties in Area I. Quarter neighborhoods (additional traps).

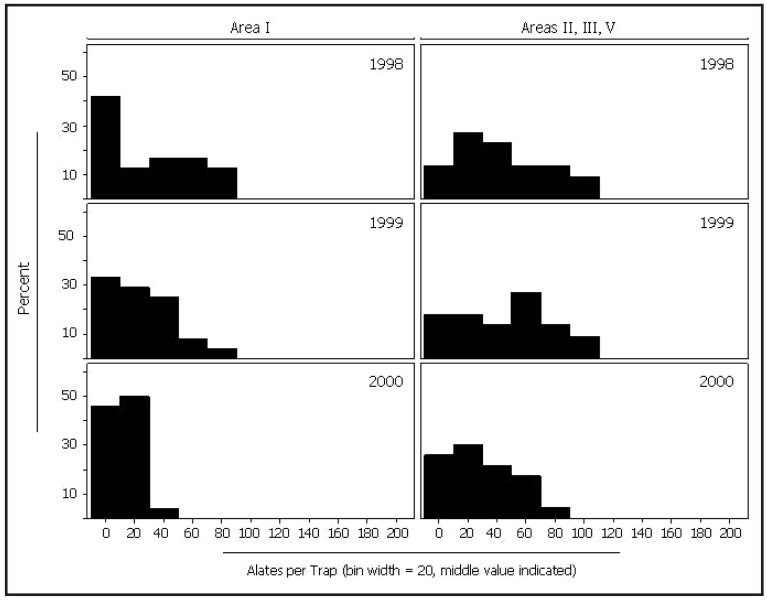

Figure 5. Percent average alate captures in French Quarter neighborhoods (original traps).

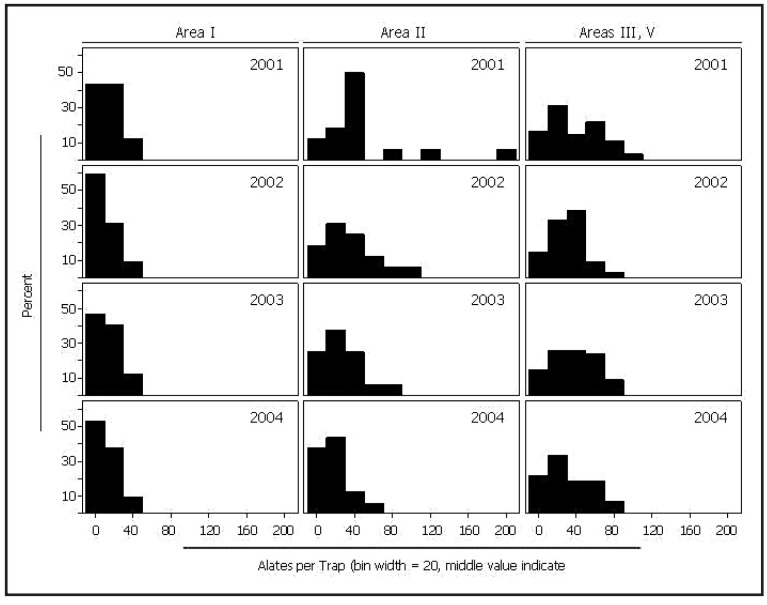

Figure 6. Percent average alate captures in French Quarter neighborhoods (additional traps).

foundations buried several feet below the surface. Shared walls and the thick, deeply buried brick foundations render a thorough perimeter treatment in the soil impossible. There are many buildings whose wooden supports have direct contact with the soil. Floor and ceiling joists are frequently notched into walls that are three or more bricks thick. These features are not only difficult to chemically treat, they also offer easy access for FST foragers and create highly favorable, moist conditions for establishment and survival of FST carton nests above ground within structures. These architectural and design conditions, the overall moist favorable conditions for FST survival in New Orleans and failure of the previous generation of repellent termiticides to prevent expansion of the FST population are believed primarily responsible for the increasingly large and entrenched population

of FST in New Orleans, especially in the FQ. The difficulty of controlling FST in the FQ is borne out by the persistently high levels of alate activity at specific trap locations in Area I even though nearly all structures have been treated for termites under the auspices of the area-wide program. Another factor, undoubtedly, is alate imigration into Area I as suggested by the alate activity along Dumaine Street which is only one block removed from Area III and whose neighborhoods have annually produced the most alates in the FQ.

It is believed that many of these remaining infestations are isolated above ground with no direct soil contact. To further reduce the termite activity in the area-wide management zones, an inspection program followed by applications of aboveground bait stations or spot treatments with a non-repellent termitide has been initiated. The initial inspections indicated the presence of mature colonies in the management zones in both structures and trees. Expectations are that treatments specifically directed at these persistent infestations would lead to further reduction of the FST population in the FQ.

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