Rodent Management at Food Distribution Centers, 2019

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Abstract

Rodent management programs at food distribution centers often conform to third party auditing schemes. Auditor guidelines provide recommended distances for the interval between control devices on the interior and exterior of a facility, including exterior fencerows. Although flexibility in device placement is possible with inspection-based justification, professional pest management companies use interval placements for convenience. Unfortunately, these placements do not consider the complex biological drivers of rodent behavior and movements, and devices may not provide the protection presumed by a three-tiered baiting and trapping system. Therefore, this project examined the features associated with rodent management devices to determine what conditions enhance bait take or trap capture. Overall, we found that 36.8% of observations on exterior rodent bait stations represented "no feeding," and less than half of indoor traps caught a rodent during the study period. These results indicate that rodents are not evenly distributed on the exterior or interior of food distribution centers, providing an opportunity for improved device placement. Furthermore, we found that proximity to categories of shelter and warmth increased feeding on exterior bait stations, and proximity to categories of pathway (located in a corner), near pest proof structures (specifically rodent proof single doors and poured cement walls), and warmth (on the south and west side perimeter walls) all increased trap capture for interior devices. We discuss our findings on the relationship between management equipment placement and conducive conditions in the context of an integrated rodent management project.

Background and Justification

Contamination to the food supply represents a significant threat to human health. Each year, an estimated 48 million Americans become ill from food-borne pathogens, resulting in 128,000 hospitalizations and 3,000 deaths (www.cdc.gov/foodborneburden/). An unknown number of these cases could be due to pests, which serve as vectors of food-borne pathogens.

Rodents are commensal animals that live in close association with humans and exploit our resources to survive (Gardner-Santana et al. 2009). In fact, consumption and/or contamination by rodents results in billions of dollars in losses to the food supply each year (Pimentel et al. 2005). Furthermore, rodents are known reservoirs of human disease (Meerburg et al. 2009), and recent investigations have demonstrated the diversity of pathogens in urban rodents that can impact human health (Firth et al. 2014; Himsworth et al. 2014; Williams et al. 2019). For example, rats in New York City were found to harbor one protozoan and eight bacterial agents associated with mild to severe gastrointestinal disease in humans (Firth et al. 2014), with house mice carrying similar gastrointestinal disease-causing agents, such as *Shigella*, *Salmonella*, *Clostridium difficile*, and diarrheagenic *Escherichia coli* (Williams et al. 2019).

Based on the threat that rodents pose to food safety, pest management programs at food facilities should include a significant effort to prevent pest entry and to intercept rodents that do gain interior access. Resulting from this philosophy is a well-intended, three-tiered approach for the placement of rodent devices around a facility (Corrigan 2002), which was adapted for use by independent, third party auditing agencies (Corrigan 2013). An example of this guidance is the specification that bait stations be placed every 50-100 feet along fencerows and the exterior perimeter of a building (Tiers 1 and 2), with interior traps placed 20-40 feet apart (Tier 3). Although easy to set up and enforce, specifications that rely on interval placement alone fail to address the complex behavior of rodents. As a result, deployed control devices may be ineffective if placed in locations away from rodent activity.

To date, there are no studies that scientifically evaluate the distribution of rodent pests around food handling establishments. Thus, while interval device placements offer a sense of protection, it is not known if these programs are effective at intercepting rodents on the building perimeter, or if/when rodents gain access to the interior. The decision to adhere to these standards is not without consequence, such as the placement of rodenticide bait in areas it is not needed or a lack of coverage in areas where rodent pressure is high. Bait that is not consumed must be discarded, contributing to environmental waste, and interval placement of traps also may lead to a sense of complacency in technicians servicing an account, who will check traps for the sake of changing bait/glue boards, but not evaluate the facility in terms of pest vulnerabilities.

Therefore, this project was undertaken to evaluate the efficacy of rodent management practices around food handling establishments (specifically distribution centers). We hypothesize that devices placed near important biological and structural features will enhance bait take and trap capture. Results from this work could inform pest management practices at food establishments to better protect the food supply.

Objectives

1. Document the distribution of rodent populations on the exterior and interior of food facilities.
2. Determine if rodent populations are equally distributed around a facility, matching the distribution of bait boxes imposed by third party guidelines.
3. Establish 'placement profiles' for devices in at least 12 facilities based on their proximity to conditions that favor rodents, including sources of food, water, shelter, or access points.
4. Document the distribution of conditions that favor rodents on the exterior and interior of food facilities (sources of food, water, shelter, warmth, etc.)
5. Obtain trap catch data from cooperating pest professional and determine which placement profiles or specific traits are correlated with higher trap catches
6. Develop preliminary guidelines for the effective placement of rodent management devices to better protect against contamination risks.
7. Compare the service cost for pest professionals and the amount of rodenticide used under current (auditor dictated) and proposed protocols.

Activities

1. **Document the distribution of rodent populations on the exterior and interior of food facilities.**
   The distribution of rodents was determined using rodenticide bait feeding data from exterior rodent bait stations, and trap capture data from interior multi-catch traps.
2. **Determine if rodent populations are equally distributed around a facility, matching the distribution of bait boxes imposed by third party guidelines**.
   Using bait feeding and trap capture data, the proportion of devices utilized at each site and overall was calculated.
3. **Establish 'placement profiles' for devices in at least 12 facilities based on their proximity to conditions that favor rodents, including sources of food, water, shelter, or access points.**
   A list of 27 conditions were grouped into 10 categories to describe exterior rodent bait stations. On the interior, a list of 76 conditions in 11 categories were used. The full list of conditions and categories is available upon request.
4. **Document the distribution of conditions that favor rodents on the exterior and interior of food facilities (sources of food, water, shelter, warmth, etc.).**
   A total of 857 conditions were assigned to 161 exterior bait stations at nine sites. A total of 3,588 conditions were assigned to the 610 interior devices at 12 sites. Conditions were non-mutually exclusive,

because devices were often located near multiple features. The proportion of devices in each category was calculated as a representation of condition distribution.

5. **Obtain trap catch data from cooperating pest professional and determine which placement profiles or specific traits are correlated with higher trap catches.**
   Bait station feeding data was obtained for up to the previous 60 months of service (range 10 to 60 months) for exterior rodent bait stations at four sites. Trap capture data was obtained for up to the previous 69 months of service (range of 10-69 months) for interior traps at twelve sites. These data were compared to conditions recorded at each device using multiple analysis.
6. **Develop preliminary guidelines for the effective placement of rodent management devices to better protect against contamination risks.**
   Results from this research have been summarized for various audiences in formal presentations, and will be used to write a trade magazine article and peer reviewed journal article to communicate guidelines for effective placement of rodent management devices.
7. Compare the service cost for pest professionals and the amount of rodenticide used under current (auditor dictated) and proposed protocols.
   Estimates of time and cost to service exterior bait stations and interior traps were obtained from cooperating pest professionals. By calculating the proportion of traps used across all sites, we were able to calculate a percentage of existing traps that are likely to experience rodent activity. Therefore, we compared the time and cost of servicing all devices to the cost of servicing only the proportion of traps likely to experience rodent activity.

Results and Discussion

This research examined rodent activity and attractive conditions at exterior bait stations and interior traps at food distribution centers. The goal was to determine if rodent management programs that rely on interval spacing of devices are effective, or if they can be improved.

Exterior Bait Station Feeding

Using exterior bait station feeding data, we learned that 100% of devices experienced some level of feeding during the 10 to 69 months when data was obtained from sites. However, feeding at devices was variable, and not uniformly high. In fact, of the 2769 observations made on the feeding status of bait, 1018 (36.8%) represented ‘no feeding damage.’ Furthermore, 2019 (72.9%) observations were considered ‘low bait consumption,’ representing consumption of up to one edge of the bait. Twelve of the 73 devices experienced one year without feeding, while two of the 73 devices experienced two years without feeding. Numerous stations experienced consecutive months without feeding.

Low and inconsistent consumption of bait supports an alternative approach to monitoring that is consistent with Integrated Pest Management practices - the use of non-toxic bait blocks. These baits are the same size, shape, and consistency as rodenticide blocks, but lack the pesticide active ingredient. These blocks can be used to monitor rodent activity and acclimate pests to the bait station, then switched out for rodenticide when pests are present. Alternatively, snap traps can be used in bait stations with non-toxic bait. In situations where rodenticide use will continue in bait stations, only a single bait block or soft bait packet should be used inside bait stations, with more bait added as needed. These practices can reduce the amount of rodenticide used and wasted if not consumed.

Interior Trap Capture

On the interior of facilities, we found that 276 (45.2%) of the 610 devices caught one or more rodents over the 10 to 69 months of available data at the 12 sites. However, when individual sites were considered, the range in trap use proportion was as low as 13.3% and as high as 91.7%. In addition, we found that in one year, trap capture rate ranged from 0 capture events to 20 captures for individual traps. Therefore, while less than half of devices were used on average, individual sites may have higher or lower trap usage based on the rodent population.

Considering that fewer than half of all traps caught rodents at two-thirds of our sites (8 of 12), these data provide evidence that rodents are not evenly distributed within food distribution centers. We recommend facilities utilize site maps to visualize where individual and repeat trap captures occur to hone management interventions to areas with rodent activity. These monitoring-based interpretations can justify the need for fewer devices placed in targeted locations.

Exterior Bait Station Placement

A total of 857 conditions were assigned to the 161 exterior bait stations at nine sites in this project. Conditions were non-mutually exclusive, because devices were often located near multiple features. For example, a bait station could be located between a door that was pest proof, and a non-pest proof door. Some key findings are that 151 devices (93.8%) were located near a feature that provided access to facilities, 108 (67.1%) near a pest proofed structure, 91 (56.5%) near shelter, 61 (37.9%) were in undisturbed areas, 20 (12.4%) were near a food source, and 15 (9.3%) were near a water source.

For exterior bait stations, proximity to categories of shelter (especially unmaintained vegetation), and warmth (placement on the west side of the building) significantly increased feeding. Additional individual conditions that increased bait take included location on the east side of the building, and location near an equipment boneyard where discarded items are stored and provide shelter.

Interior Trap Placement

Indoors, a total of 3588 conditions were assigned to the 610 traps at 12 sites. 553 (90.7%) were near shelter, 503 (82.5%) near access, 270 (44.3%) near a heat source, and 214 (35.1%) near food. Only 105 (17.2%) devices were found in areas other than perimeter walls.

For interior multi-catch devices, proximity to categories of pathway (located in a corner), near pest proof structures (specifically rodent proof single doors and poured cement walls), and warmth (on the south and west side perimeter walls) all increased trap capture. Additional individual traits that increased trap capture included placement along the perimeter wall, location in an undisturbed corner, near hollow racks and equipment voids, and if the device was shadowed during the day (at the time of inspection). Location near a dock leveler that was not rodent proof, near corrugated walls with insulation, and near a warm mechanical room decreased the rate of capture.

In the pest management industry, it is known that successful rodent control depends on effective placement of devices. This is because rodents are not attracted to devices, but may explore them if located in their normal activity areas. Therefore, the purpose of identifying conditions relevant to rodent management at each device was to determine if devices placed according to interval spacing are near conducive conditions. The results above, as well as categories not shown here, demonstrate that a high proportion of devices have at least one conducive condition ('Access' for exterior devices, 'Shelter' for interior devices), but this may not lead to trap capture. Interestingly, between 42 and 44% of exterior and interior devices were found near a feature associated with warmth, which is important for rodents. The list of conditions (and their categories) may prove useful as an assessment tool when placing rodent management equipment. For example, technicians may attempt to place devices in areas that include three or more of the noted categories. This may contribute to more effective rodent management that is based on pest biology.

Economics of Rodent Management

Where applicable, pest professionals collaborating on this project provided information on the average cost and time to service interior and exterior devices. In the US, the average time to service interior and exterior devices were 1.5 and three minutes, respectively. For sites in Canada, service of interior devices ranged from one to three minutes, and cost $1.25 to $2.50 (Canadian) depending on the site. Service of exterior devices can take three to five minutes, and cost $3 to $5 (Canadian).

In this study, the overall trap use proportion for interior multi-catch devices was 45.2%, and the average number of interior devices (for the 12 study sites) was 51 traps. Using these values as an example, we would predict that only 23 of the 51 interior devices would experience rodent activity (53 * 0.452). Using averages of the service time between the US and Canadian pest professionals (2 minutes per trap), departing from interval placements could save nearly one hour (56 minutes) of technician time, allowing for more time to inspect and interpret data. Keep in mind that these are only estimates, as the actual reduction in trap numbers would depend on a detailed inspection to identify placements that may not be effective at capturing rodents.

Rodent feeding data was obtained from 73 exterior bait stations for a combined total of 160 months. Considering that bait should be replaced on a four- to six-week basis (Corrigan 2007), this suggests that 160 rodenticide blocks may have been used for these stations during the study period if replaced monthly. From this study, we learned that 36.8% of observations represented no feeding, suggesting that 59 blocks (160 * 0.368) or 3.5 pounds of bait would have been discarded without any feeding damage. Furthermore, 72.9% of observations were feeding on one edge or less, and thus 117 blocks (160 * 0.729) or 7.3 pounds of bait would have been discarded with 'minor' feeding. It is important to consider these results in the context of how much bait is needed to kill target organisms, which varies depending on the rodent species. It is possible that feeding on one corner or one edge would provide enough active ingredient to kill one to a few mice.

Cost of service may be less important to calculate, considering that the goal is not to reduce the cost of service, but to improve the efficiency of service. Therefore, while the cost of service may decrease with fewer devices, the price of service should remain the same as technicians spend time on site performing additional responsibilities. This is an important outcome based on recognition by the pest management industry that a trap-checking mentality can lead to poor pest management (Fredericks 2019).

Summary

The results of this research suggest that certain conditions on the interior and exterior of food distribution centers lead to higher captures or more bait take, respectively. Further, rodents were not evenly distributed in food facilities. These findings have implications that affect rodent management practices at multiple levels. For example, pest professionals may be willing to depart from interval trap placements with knowledge that inspection-based placements improve program effectiveness and reduce the number of devices to service. Quality Assurance managers at distribution centers may have different expectations of pest management programs based on these results, while regulators and auditors for third-party inspection agencies may further refine their programs to account for the results obtained here. Guidelines are in development and will be reviewed by industry experts prior to dissemination. Guidelines will not only cover the results obtained from this research, but will provide relevant biological information about rodents that contributes to their management.

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