Suburban Sustainability

Volume 1 | Issue 1 Article 2

2013

The Economic Impact of Commensal Rodents on Small Businesses in Manhattan's Chinatown: trends and possible causes

Anthony Almeida
Hofstra University, aalmeida459@gmail.com

Robert Corrigan
RMC Pest Management Consulting, rcorriga@health.nyc.gov

Ronald Sarno
Hofstra University, ronald.sarno@hofstra.edu

The Economic Impact of Commensal Rodents on Small Businesses in Manhattan's Chinatown: trends and possible causes

Cover Page Footnote
Acknowledgements We would like to thank all of the cooperating businesses, employers, and employees of these businesses in Chinatown that provided us with information that made this study possible. Mike Deutsch (Arrow Exterminating) provided insightful comments on a previous version of this manuscript.

Introduction

Despite aggressive campaigns to thwart commensal rodents, their populations have exploded as urbanization has ensued (Lund 1994; Barnett 2001). In fact, current estimates of Norway rats, Rattus norvegicus Berkenhout in the United States vary between 150-175 million animals (Global Invasive Species Database 2011). Initially Corrigan (2006), and more recently, Kaukeinen and Colvin (2007) have suggested that New York City is the US city most at risk of rodent infestation, owing to high human density, old and aging infrastructure, impoverished neighborhoods, and budgetary constraints on public spending for housing, sewers, trash management, and utilities. Rodent infestations have been so pervasive in New York City that Mayor Michael Bloomberg expanded the rodent abatement initiative under the aegis of multiple city agencies comprising the Mayor's Rodent Task Force, which is still in full-thrust operation. A major objective of this initiative was "to create and advance a legislative agenda to provide new tools against rodent infestations and reduce barriers to effective enforcement" (Frieden and Kupferman 2003).

Because urban rats and mice exhibit high reproductive rates, have the capacity to spread diseases (Meerburg et al. 2009), and a propensity to destroy structures and consumer goods, they remain viable threats to human health and commerce (Tobin and Fall 2004). Initial estimates by the United Nations in 1982 reported that rats destroyed > 42 million tons of food worldwide that was worth $30 billion dollars. In the US, the economic cost of rat damage was estimated at $19 billion/year; many times greater than any other invasive animal species (Pimentel et al. 2000).

Controlling urban rodents, as other pests, requires the implementation of the Integrated Pest Management (IPM) model, which integrates monitoring, sanitation, physical intervention (exclusion, traps, repellents) and, if necessary, the application of rodenticides (Kaukeinen 1994; Bennett et al. 2010). As a result of Mayor Bloomberg's legislative agenda, novel approaches to Rodent Integrated Pest Management (IPM) programs were developed for New York City, which include comprehensive neighborhood "indexing" (Corrigan 2006; Bragdon et al. 2012), and where necessary the use of rodenticides.

Rodenticides should be considered as a last resort, however, - especially around food stores, food serving establishments and any shop that the public frequents. Nearly two decades ago, Buckle (1994) reported that the use of rodenticides was the *primary* approach of rodent control in urban and agricultural environments, and also predicted that this approach would continue in the foreseeable future. Despite the existence of the Integrated Pest Management Model, rodenticide use in 2012 constitutes between 60 to 80 % of all forms of rodent control products that are purchased (USEPA 2006). According to Kaukeinen et al. (2000) "householders" purchase about 40 to 50 million household-use containers (i.e., off the shelves at nearby stores) of

rodent baits each year. How much of this is purchased by small-business owners is unknown.

Rodenticides are categorized into two broad chemical classes: anticoagulants and non-anticoagulants. The mode of action of anticoagulant compounds is internal hemorrhaging via a coagulation imbalance in the blood system. Anticoagulants can be further subdivided into two groups: first generation anticoagulant rodenticides, FGARS (e.g., warfarin and warfarin-related compounds), and second generation anticoagulant rodenticides (SGARs). Second generation anticoagulants were developed to circumvent resistance that developed in rodents to FGARS. As a group, SGARs are considerably more toxic than FGARs (Lund 1988; Murphy and Gerken 1986), and comprise about 90% or more of the baits used by pest- control professionals (Corrigan 2011).

The modern non-anticoagulant rodenticides include active ingredients that disrupt the nervous system (bromethalin), which can cause heart failure (zinc phosphide), or excessive calcium release from the skeletal system into the body (cholecalciferol, or Vitamin D3). Older rat poisons including strychnine, thallium, arsenic and others, are no longer used in the US, and rarely used elsewhere due to high toxicity and inhumane modes of action (Rosell et al. 1979, Hone and Mulligan 1982). Because rodenticides target mammals, this has raised concerns about their use in urban environments, especially given the fact that they can be purchased over the counter (USEPA 2006). As with all toxicants, the hazards must be carefully managed as accidental poisonings do occur among dogs, cats, and wildlife –especially raptors that hunt rodents (Stone et al. 1999; Stone 2003; Hosea 2000; Khan and Farbman 2006). Nevertheless, when used within carefully planned IPM approaches, rodenticides can offer substantial benefits in protecting food supplies and world health (Kaukeinen et al. 2000, Kaukeinen and Colvin 2008b).

Despite persistent overuse of rodenticides, there does appear to be a shift towards more rodent IPM occurring perhaps within the "green movement". More publications are emerging that stress a truly sustainable approach to rodent control via practical exclusion (Geiger and Cox 2012), and novel non-chemical paths, including a consideration for humaneness (Corrigan 2009).

Although a shift toward a philosophy of IPM may be emerging, little is known about the portion of commercial shops, food stores, and restaurants (i.e., as addressed in this study) that actually practice the IPM approach (detail cleaning, sealing up entry holes, scheduled inspections) versus resorting to the more traditional approach of applying an over-the-counter rodenticide, snap trap, or sticky trap. Therefore, the objective of this study was to determine the economic impact of rats and mice within a small commercial sector of the major metropolis of New York City, as well as assess how rodent control is attempted. It is our goal to highlight the issues of rodent damage to small-business owners and rodent control by small-business owners given the near

DOI: http://dx.doi.org/10.5038/2164-0866.1.1.2

global distribution of urban rodents. To achieve this objective, small businesses in Chinatown were selected because of Chinatowns' defined borders, manageable study size, and high density of commercial food and nonfood establishments.

Materials and methods

Our study design comprised three methods: 1) a detailed questionnaire in two languages, 2) oral interviews, and 3) data analysis and inference.

Mailed questionnaire

Survey packets containing: (1) a letter explaining the nature of our study (Appendix 1), (2) a form to report (Appendix 2): (a) the amount of rodent-related damage, (b) do-it-yourself measures of rodent control, (c) seasonal differences in rodent infestation, (d) if the building was subject to a fire of unexplained origin, (e) questions regarding health and safety, and (3) a preaddressed, postage-paid return envelope. Surveys were mailed to 577 businesses in Chinatown. A survey was sent to every restaurant (N = 295), restaurant supply company (N=25), electronics and appliance store (N=32), furniture outlet (N=6), florist (N=15), clothier (N=54), hotel (N=10), health food store (N=55), seafood retailer (N=21), produce store (N=15), and miscellaneous businesses including hardware stores and industrial supply centers (N=49). We attempted to survey every business that was listed in the 2009 Manhattan Chinatown Directory - a publication released by The City of New York (Chin 2011). Because a proportion of the population did not speak fluent English all survey-related documents were written in English and Traditional Chinese.

Interview

As a means to supplement the mailed surveys, we conducted oral interviews with small business owners during normal business hours. We selected businesses (n = 233) that fit into one of the aforementioned target categories that were located on every third street between Canal St. and Worth St. (North to South) and Bowery St. to Baxter St. (East to West) (beginning with Canal St. and Bowery St., respectively). We believe that our approach was a practical means of accessing the diverse commercial sector of the neighborhood, while acknowledging the logistical constraints of time. All interviews were conducted by two researchers (one of whom spoke fluent Cantonese), and each interview consisted of a series of predetermined questions (Appendix 2) addressing rodent damage as well as health and safety issues. Each interview lasted between 5 and 20 minutes, and was conducted in either English or Cantonese (whichever language the proprietor was more comfortable with). In circumstances where the proprietor was extremely

cooperative, we conducted a visual inspection of the establishment. We conducted oral interviews on 10 occasions between October 2009 and May 2010, and each foray to the field lasted between 2 and 5 hours.

Quantification of Damage

Using the results of the surveys and interviews we estimated the financial cost to small businesses from rodent damage by quantifying costs associated with (1) loss of sellable goods, (2) repair to building structures, (3) use of do-it-yourself deployment (DIY efforts) of poison/traps, (4) damaged appliances, and (5) professional pest control service fees. We also quantified the frequency of rodent damage to various structures (e.g., walls, doors, electric and telecommunications wires and conduits, burrows in sidewalks, flower beds, plumbing, and pipes).

Results

Survey response

Of the 577 mailed surveys, 475 of them apparently reached their target destinations because they were not returned. The response rate to the mailed surveys was nearly six percent (n=28) and about 21% (n=48) for the oral interviews. Overall, ca. 11% (n = 76) of businesses responded to our queries.

Monetary costs associated with rodent infestations

Eighty percent (n = 61) of surveyed businesses reported that professional pest-control fees was the most costly aspect of rodent damage. This was followed by damaged merchandise, damaged or destroyed structural elements, and do-it-yourself poison and traps (Fig. 1). During oral interviews we observed chewed clothing, contaminated (with feces and/or urine) food products, damage to exterior packaging of electronics equipment, and gnawed books.

The most common structural damage involved gnawing of walls, floors, and doors. We also observed chewed electrical wiring and appliance components, plumbing and fuel lines, and furniture. A counter intuitive finding was that businesses that *did not* hire pest-control professionals reported structural repair costs ($\bar{x}$ = \$100, SE = 52, n =40) nearly three times lower than businesses that *did* contract pest-control professionals ($\bar{x}$ = \$275, SE = 34.5, n =35). Nearly 59% of (n=45) of respondents reported that rodent activity peaked during summer, while 20% (n=15) reported winter to be the season of peak rodent activity. The remainder (n=16) reported no seasonal differences in activity.

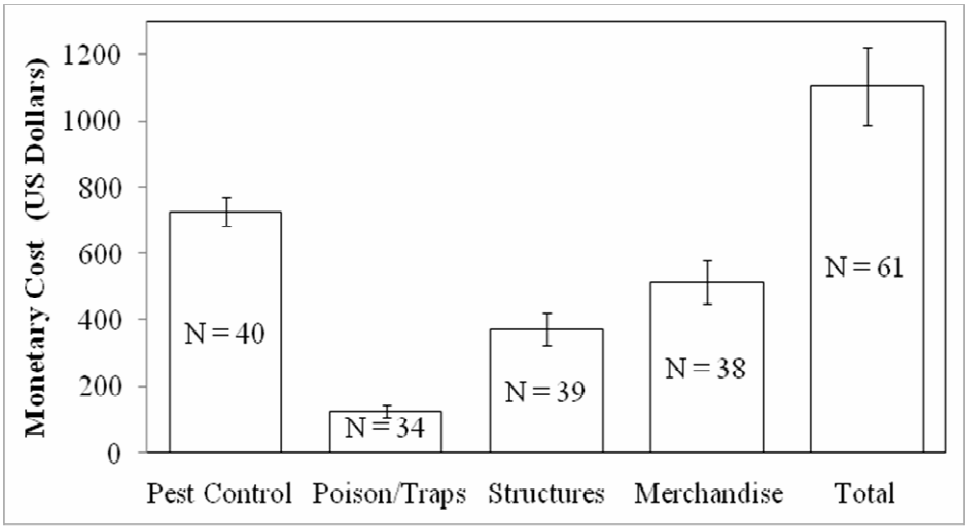

Figure 1. Sources of estimated annual monetary costs to small businesses due to rodent infestation in Chinatown, New York, October 2009 – May 2010. Extending lines indicate standard error.

Primary rodent control measures

Many establishments deployed traps or poisons themselves in addition to contracting a pest-control professional. The most common method was the installment (either do-it-yourself and/or professional application) of rodent glue traps, followed by live-capture traps, poison, and snap traps (Fig. 2).

Discussion

Monetary costs

Nearly all surveyed businesses reported loss of revenue directly from loss of merchandise, damaged appliances, damage to structures and/or indirect losses from fees associated with pest-control professionals. A common trend was to hire a pest professional as a preventative measure to avoid future infestation. If one business breeds an environment conducive to rodent infestation, that establishment not only threatens its' own livelihood, but also that of neighboring properties. This highlights the necessity of rodent control being a concerted and community-wide effort; not solely the inclination of proactive business owners. Based on our data, business owners may need to be especially wary of rodent infestations or re-infestations during the warmer months because reproduction is more likely to increase.

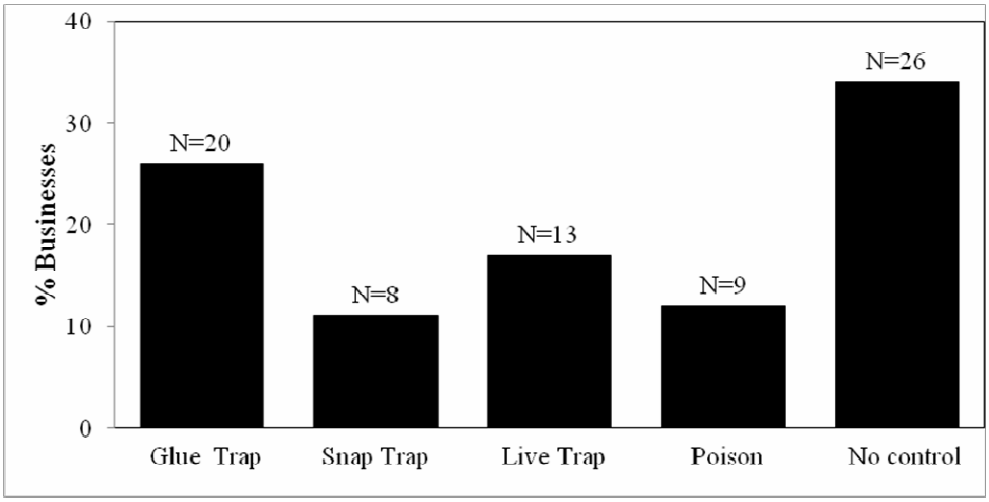

Figure 2. Percentage of surveyed businesses that reported utilizing each method of rodent control in Chinatown, New York, October 2009 – May 2010.

Primary methods of rodent control

Although at least one kind of "traditional control" method was used in most instances (e.g., traps, poisons) another less reported, but much more effective, method would be to fill in cracks and voids in walls, floors, and ceilings and/or to pest proof doors to deny rodent entry into buildings in the first place. This is referred to as "pest proofing", "rodent exclusion" or as "rodent stoppage" (Scott 1991; Scott and Borom 1965). Unfortunately, most businesses with a rodent problem did not utilize this highly effective practice (see Corrigan 2011 for a review).

Challenges and observations

One difficulty we encountered was the proportion (17.8%) of mailed surveys returned as undeliverable, as well as the overall low response rate. The lower east side of Manhattan is a dynamic area with businesses opening and closing regularly. This may partially explain overall response rates. Because Chinatown can be considered a unique cultural "island" within lower Manhattan, many residents may have been reticent to share information/problems with those perceived from being outside of the community.

While collecting data, communication was still a barrier despite surveys being written in English and Traditional Chinese. English-speaking businesses tended to be more cooperative due to more effective communication and a clearer understanding of the academic research that required their cooperation.

Survey response rates can vary between 10-100% (Hager et al. 2003, Kaplowitz et al. 2004), and survey quality is influenced by response rate, yet

the percentage of responses that make up an "acceptable" survey exhibits appreciable variation from 10% to 75% (How Many is Enough, 2009, Assess Teaching, 2007). Furthermore, there is not a linear relationship between response rate and statistical confidence (Statistical Confidence in a Survey, 2007). Even though our overall response rate may be lower than that deemed acceptable by some researchers (Babbie 1990), we believe that the data provide valuable insight into rodent infestations in this rather unique and difficult-to-access community.

One anecdotal observation was that businesses bordering food service establishments reported more pervasive rodent problems than those bordering nonfood-service establishments. Rodent control measures may not be a high priority for non-food related businesses, so rodents that inhabit or frequent food service establishments may possibly infest adjacent businesses rather easily. Another possibility is that since food-service establishments are likely more in tune with rodent exclusion, rodents are taking the path of least resistance and infesting non-food service establishments.

Potential for further research

Given the ubiquitous damage that we have reported, mice and rats in New York City certainly remain important urban pests capable of inflicting non trivial economic costs, and even total destruction to goods, structures and their essential utilities, city infrastructure, and ultimately, human health (World Health Organization 2008). Owing to the substantial effort put forth by The City of New York in the campaign against rodent infestations (Frieden and Kupferman 2003) one may wonder why rodents continue to flourish. To be fair, urban rodent pest management is a highly complex endeavor (see Battersby 2002). Furthermore, the age and infrastructure of New York City to some degree enables commensal rodents to thrive. Housing density and specifically the interconnectedness of structures and urban infrastructure in New York City (Corrigan 2006) are highly significant because dispersal by commensal rodents is more likely to occur over short distances, making it more likely that rodents infesting one building will disperse and colonize surrounding dwellings and areas (Battersby et al. 2002; Gardner-Santana et.al 2009). Therefore, in high density housing areas the home ranges of rats could easily encompass multiple dwellings.

Another more problematic explanation of persistent rodent infestations may stem from the possible development of rodenticide resistance to "second generation" rodenticides (Rowe et al. 1981**;** Greaves et al. 1982**;** MacNicoll and Gill 1987; Johnson 1988). The relentless application of second generation rodenticides in New York City over the past three decades has likely exerted considerable pressure on rodents to evade the toxic effects of these poisons by selecting for genetic mutations resulting in resistance. In fact, some pest management professionals have complained about a lack of rodent control

with bromadiolone – a 2nd generation anticoagulant - in the Northeastern US over the past 20 years (Corrigan 2011). Local resistance to these rodenticides may be developing, or may even be established. Although the 2003 Mayor's Rodent Task Force called for the development of "new tools" against rodent infestations, most of the city's agencies initiated programs that involved large-scale, and in some cases, continuous poisoning of rodents using second generation rodenticides. If, in fact, rodenticide resistance is occurring and/or developing among rats and mice in New York City, unyielding reliance on this one-dimensional approach of continuous baiting programs is likely to increase the selective pressure for, and thus further promote, rodenticide resistance. We are currently investigating this issue.

Finally, because businesses that employed "professional" pest companies reported the same occurrence of damages as those businesses that did not, the cost-benefit of these services in Chinatown may be questioned. The factors discussed above help to explain this. An additional consideration is that pest professionals are contracted when damage is readily apparent, and even though the situation might improve (i.e., via a reduction in the size and scope of the infestation) much of the damage has already occurred. In the future, one could assess the usefulness of various rodent-control measures (e.g., trapping vs. rodenticide application) by estimating damage before and after professional services are employed in an attempt to assess which methodology is most efficacious in controlling rodent infestations. Of course, it must also be stressed that the old adage "you get what you pay for" strongly applies here. "Professional" pest controllers are available from the very inexpensive (cheap, lowest bid, etc.), to costs associated with those professionals that perform detailed analysis of the problems and then employ customized control programs including the option of skilled pest proofing of the business property. This latter type of service requires time, and in the service industries (e.g., plumbers, carpenters, electricians and "exterminators"), time on the job -- not materials-- is associated with the majority of costs. All too often small business owners unfortunately opt for what they believe is a "smart" purchase decision when it comes to pest control and thus hire the cheapest pest service they can find. Regrettably, this level of service usually results in essentially no sustainable level of rodent control.

Given the ubiquity of commensal rodents, issues regarding rodent infestation, damage, and control are not endemic to New York City but likely reflect issues throughout the NY Metropolitan area. Perhaps a region-wide approach to rodent control would result in a more successful and sustainable level of rodent control.

DOI: http://dx.doi.org/10.5038/2164-0866.1.1.2

References

Assess Teaching: Response rates. 2007. http://www.utexas.edu/academic/ctl/assessment/iar/teaching/gather/method/survey-Response.php. Accessed 9 December 2011.

Babbie, E. 1990. *Survey Research Methods, 2nd edition*. California:Wadsworth.

Battersby, S., Hirschhorn, B.R. and Amman, R.B. 2008. Commensal rodents. In *Public health significance of urban pests*, eds. X. Bonnefoy, Kampen, H., Sweeney, K., 387-419. Copenhagen, Denmark: World Health Organization. ISBN # 978-92-890-7188-8.

Barnett, S. A. 2001. *The Story of Rats: their impact on us and our impact on them*. Salisbury South, Australia: Griffin Press.

Battersby, S. A. 2002. *Urban rat infestations-Society's response and the public health implications*. Dissertation, University of Surrey, UK.

Battersby, S. A., Parsons, R. and Webster, J. P. 2002. Urban rat infestations and the risk to public health. *Journal of Environmental Health Research* 1:57-65.

Bennett, G. W., Owens, J. M. and Corrigan, R.M. 2010. *Truman's Scientific Guide to Pest Management Operations* (7th ed.). Purdue University, West Lafayette, IN. and Questex Media, Cleveland, OH, 652 pp.

Bragdon, C., Kass, D., Matt, T., Merlino, M., Bonaparte, S., Johnson, S. and Corrigan, R. 2012. Evaluation of a Neighborhood Rat Management Program -New York City, December 2007- August 2009. *The Morbidity and Mortality Weekly Report*, Vol. 61. No. 37. CDC. Atlanta, GA.

Buckle, A. P. 1994. Rodent Control Methods: Chemical. In *Rodent Pests and Their Control*, eds. A.P. Buckle, Smith, R. H., 127-160. Wallingford, UK: CAB International.

Chin, R. K. 2011. A Journey Through Chinatown. http://www.nychinatown.org/directory. Accessed 11December 2011.

Corrigan, R. M. 2011. Rats and Mice. In *The Mallis Handbook of Pest Control*, eds. S. Hedges, Moreland D., 1-14. Cleveland, OH: GIE Publications.

Corrigan, R. M. 2009. Green Rodent Management. *Pest Control Technology* 37: 80-83, 91-97.

Corrigan, R. M. 2006. A Profile of the Norway rat, Rattus norvegicus, in New York City: Its' Impact on City Infrastructures and the Need for Collaborative Interagency Management Programs. In *Proceedings of the 22nd Vertebrate Pest Conference*, eds. R.M. Timm, O'Brien J.M., 131-141. Davis, CA: University of California-Davis Publications.

Frieden, T. R. and Kupferman, S. L. 2003. Rodent control task force report to the mayor. http://prtl-prd-web.nyc.gov/html/ops/downloads/pdf/rodent_taskforce/rodent_taskforce_report.pdf. Accessed 8 October 2011.

Geiger, C. and Cox, C. 2012. *Pest Prevention by Design. Authoritative Guidelines for Designing Pests Out of Structures*. San Francisco Department of the Environment. San Francisco, CA.

Global Invasive Species Database. 2011. http://www.issg.org/database/welcome/. Accessed 27 November 2011.

Greaves, J. H., Shepherd, D. S. and Quy, R. 1982. Field trials of second-generation anticoagulants against difenacoum-resistant Norway rat populations. *Journal of Hygeine-Cambridge* 89:295-301.

Hone, J. and Mulligan, H. 1982. Vertebrate Pesticides, Science Bulletin 89. Sydney: Department of Agriculture, New South Wales.

Johnson, R. A. 1988. Performance studies with the new anticoagulant rodenticide, flocoumafen, against *Mus domesticus* and *Rattus norvegicus. European Plant Protection Organization Bulletin* 18:481–488.

Kaukeinen, D. E. and Colvin, B. A. 2008. Concerns regarding proposed restrictions in the use of second-generation anticoagulant rodenticides for commensal rodent control. In *Proceedings of the 23rd Vertebrate Pest Conference*, eds. R.M. Timm, O'Brien J.M., 154-162. Davis, CA: University of California-Davis Publications.

Kaukeinen, D. E. and Colvin, B. A. 2007. Rodent Risk Assessment. Technical report submitted to d-CON®. 8 Pp.

Kaukeinen, D., E., Spragins, C. W. and Hobson, J. F. 2000. Risk-benefit considerations in evaluating commensal anticoagulant rodenticide impacts to wildlife. *Proceedings of the Vertebrate Pest Conference* 19: 245-256.

Kaukeinen, D. E. 1994. Rodent control in practice: householders, pest control operators and municipal authorities. In *Rodent Pests and Their Control,* eds. A. P. Buckle, Smith R. H., 249-271. Wallingford UK: CAB International.

Khan, S. and Farbman, D. 2006. *Analysis of Rodenticide Incident Data in Animals as Collected by the ASPCA Animal Poison Control Center for 2005*. Animal Poison Control Center ASPCA, 35 pp.

Lund, M. 1994. Commensal Rodents. Pages 23-44. In: *Rodent Pests and Their Control*, eds. A. P. Buckle, Smith, R. H., 23-44. Wallingford, UK: CAB International.

Lund, M. 1988. Anticoagulant rodenticides. In *Rodent Pest Management*, ed. I. Prakash, 341-352. Boca Raton, FL: CRC Press.

Pimentel, D., Lach, L., Zuniga, R. and Morrison, D. 2000. Environmental and Economic Costs of Non-indigenous Species in the United States. *BioScience* 50:53-65.

MacNicoll, A. D. and Gill, J. E. 1987. The occurrence and significance of rodenticide resistance in the UK. In: *Stored Products Pest Control British Crop Protection Council Monograph*, No. 37, ed. T. J. Lawson, 85-95. Thornton Heath, UK: BCPC Publications.

Meerburg, B. G., Singleton, G. R., and Kijlstra, A. 2009. Rodent-borne diseases and their risks for public health. *Critical Reviews in Microbiology* 35:221-270.

DOI: http://dx.doi.org/10.5038/2164-0866.1.1.2

Murphy, M. J. and Gerken, D. 1986. The anticoagulant rodenticides. In *Current Veterinary Therapy, IX, Small Animal Practice*, ed. R. W. Kirk, 143-146. Philadelphia, PA: W. B. Saunders Co.

Rosell, H. C., Ritcey, J. and Cox, F. 1979. Assessment of humaneness of vertebrate pesticides. *Proceedings of the CALAS Convention*, University of Guelph, Ontario, Canada.

Rowe, F. P., Plant, C. J. and Bradfield, A. 1981. Trials of the anticoagulant rodenticides bromadiolone and difenacoum against the house muse (*Mus musculus* L.). *Journal Hygeine-Cambridge* 87:171.

Stone, W. B., Okoniewski, J. C. and Stedelin, J. R. 2003. Anticoagulant rodenticides and raptors: recent findings from NY, 1998-2001. *Bulletin of Environmental Contamination and Toxicology*, 70:34-40.

Stone, W. B., Okoniewski, J.C. and Stedelin, J. R. 1999. Poisoning of wildlife with anticoagulant rodenticides in New York. *Journal of Wildlife Diseases* 3: 187-193.

Tobin, M. E. and Fall, M. W. 2005. Pest Control: Rodents. IOP Agricultural Sciences, from Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK. http://www.eolss.ne. Accessed 23October 2011.

United States Environmental Protection Agency. 2006. Impact Assessment for Proposed Rodenticide Mitigation. DP 332577, Memorandum.

Appendix 1

To Whom It May Concern,

We are currently undertaking a research project to investigate the economic impact that mice and rats have on the businesses and the infrastructure of New York City. Our objective is to assess the costs of rodent damage to small businesses, which can help to determine whether a future economic investment in improved rodent control strategies is justified.

We are writing to you in the hope that you could supply us with any information describing the amount of damage and economic loss caused to your place of business by mice or rats over the course of a year. (For example, damage to food stores, electrical wiring, appliances, damage to the structure of the building or the cost of exterminator's fees.) If you are not already aware, damage to NYC businesses, as well as public health problems caused by rodents amounts to millions of dollars per year and any information that you choose to supply may assist in the development of more efficient rodent control strategies in the future.

We understand that this information can be a sensitive and a delicate subject for small business owners to discuss. We would like to assure you that any information that you choose to provide will be used strictly for scientific research purposes, the name of your establishment will **not** be released. The identity of your establishment and any persons involved with it will remain confidential to the utmost and precautions will be carefully taken to preserve confidentiality. Any information you provide is greatly appreciated and we hope that your participation will help small businesses such as yours in the near future.

Thank you for your time and cooperation,
Anthony Almeida and William Wong

DOI: http://dx.doi.org/10.5038/2164-0866.1.1.2

Appendix 2

Economics

Please circle all that apply:

1. How long has this establishment been open at this location?
   Less than: **1 year** **5 years** **10 years** **>10 years**

2. Have you ever had rat/mice infestation problem in your establishment? **(Yes/No)**

   -If so, was it worse during the **(summer/winter)**?

   -Did you hire an exterminator? **(Yes/No)**

   -If so, how much did you spend roughly per year on exterminator fees?

   $300 **$500** **$750** **$1000** **> $1000**

3. Do you use poison or traps to control the problem? **(Yes/No)**

   -If yes, how much do you spend per year?

   $50 **$100** **$200** **$400** **>$400**

   -If yes, what kind of poison or trap was used?

   Glue Trap **Snap Trap** **Housing Trap** **Poison** **Other**

   -Did it solve the problem? **(Yes/No)**

4. Did the rat/mice cause any damage to the infrastructure of the building? **(Yes/No)**

   -If so what did they damage?

Walls **Floors** **Electrical Wiring** **Appliances** **Other**

-How much did it cost to repair/replace what was damaged?

$50 **$100** **$200** **$400** **$800** **>$800**

5. If rats/mice have ever caused damage to any products that you sell/use. Please list them in decreasing order of cost.

1. 2. 3. 4.

5.

6. How much do you feel you lose to rat/mice damaged merchandise/products per year?

$100 **$300** **$500** **$700** **$900** **$1000** **≥$1500**

7. Have rat/mice ever gnawed through a garbage car or garbage bags that were left outside? **(Yes/No)**

- How often does this happen per month?

1 **2** **4** **8** **16** **30 or more**

Health and Safety

1. If there was damage to electrical wiring, was there ever a risk of it causing a fire? **(Yes/No)**

-Has there ever been an electrical fire in the building? **(Yes/No)**

-Gnawed wiring/deemed to be caused by rat/mice? **(Yes/No)**

DOI: http://dx.doi.org/10.5038/2164-0866.1.1.2

2. Has anyone ever been bitten by rat/mice at the establishment? **(Yes/No)**

3. Are there any other sources of infestation present? **(Yes/No)**

4. Do any employees get sick when they handle rat/mice contaminated garbage or are working in a room that has had an infestation problem (i.e., allergies, asthma)? **(Yes/No)**