Norway Rat Sewer Baiting Program in the City of Oakland

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ABSTRACT: The County Service Area (CSA) 1984-1 for Vector Control was established in June 1984 to serve the public's needs for providing a comprehensive vector control program throughout Alameda County. In 1987, the City of Oakland recognized that it had a severe rat problem emanating from the sanitary sewers and in an effort to control them the voters approved a supplemental assessment. For thirty years the CSA has implemented an urban rodent surveillance program focusing on monitoring and controlling commensal rats (Norway and roof rats) and mice in residential, commercial, and business properties. In 2017, the CSA received 2,917 Requests for Service from the public about domestic rodents (2,282 re: rats and 635 re: mice), representing 38.9% of overall service requests. Those 2,917 rodent service requests had staff biologists performing 16,722 field services operations related to rodents. The field service operations included performing smoke and dye tests of sewer lines for breaks; field and residential surveys for rodent activity; recommendations and follow-up evaluations of rodent control measures; and assistance with enforcement actions. In 2017, a total of 8,150 sewer inspections and 1,531 applications of Contrac rodenticide bait were made in the City of Oakland. The CSA is now looking at incorporating rodenticide resistance testing, GIS data analysis, pulse-baiting strategies, and disease surveillance as part of an Integrated Pest Management program as improvements in 2018.

KEY WORDS: anticoagulant, Norway rat, pulse-baiting, *Rattus norvegicus*, rodenticides, sewer, urban

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INTRODUCTION

The Alameda County Board of Supervisors established the County Service Area (CSA) 1984-1 in June, 1984 to serve the public needs by providing a comprehensive vector control program. The County Service Area 1984-1 became known as the Alameda County Vector Control Services District.

Service Area

The District covers the entire county (813 square miles), supporting 14 incorporated cities as well as six unincorporated communities and rural areas with over 1.5 million residents. The largest city in the county is the City of Oakland.

Sanitary Sewer System in Oakland

Oakland has over 930 miles of sanitary sewers. Many of these sanitary sewers are over 50 years old and some are over 100 years old. The Oakland Public Works Department is responsible for maintaining these sewers and 31,000 sewer structures and seven pump/lift stations. The sewers carry the waste to the treatment plant operated by the East Bay Municipal Utility District (EBMUD).

District Funding

The District receives funding through benefit assessments from each property parcel throughout the County. In 1987, the City of Oakland recognized that it had a severe rat problem emanating from the sanitary sewers that exceeded the existing District's staff capabilities to control the problem. Subsequently, Oakland voters approved a supplemental assessment of $1.28 per property parcel within the City of Oakland, first levied in fiscal year 1988-1989, and provided $176,000 additional funding to control rodents in the sewers.

Rodent Service Program

The supplemental funding, in conjunction with benefit assessment funding, enables the District Biologists to provide the following services:

- Recommendations for rodent proofing and population control in homes, neighborhoods, open areas, and businesses.
- Conduct rodent suppression during vector-borne disease outbreaks, public health emergencies, or when the residents are experiencing a public health risk from rodents and their ectoparasites.
- Conduct surveys of rat populations to assess species abundance, distribution, and disease carrying potentials.
- Conduct inspection and rodenticide baiting of sanitary sewers for rats within the City of Oakland.
- Inspect and test sewer laterals and mains to detect breaks, which may provide an egress for rats to move into adjacent neighborhoods.

BACKGROUND

Research on the control and ecology of Norway rats (*Rattus norvegicus*) in sewer systems is sparse. Bentley et al. (1959) and Brooks (1964) found that recovery of sewer populations is likely within six months (or less) if they are not effectively baited. Baiting programs that only bait once or twice per year, without follow-up monitoring, simply remove a portion of the population and *enhance* the rate of population growth, due to the existing population being below the carrying capacity of the system (Colvin et al. 1998).

Colvin et al. (1998) cite only four previous papers looking at the control of Norway rats in sewer systems. Panti-May et al. (2016) conducted a two-year ecological study in a favela in Salvador, Brazil, looking at Norway rat

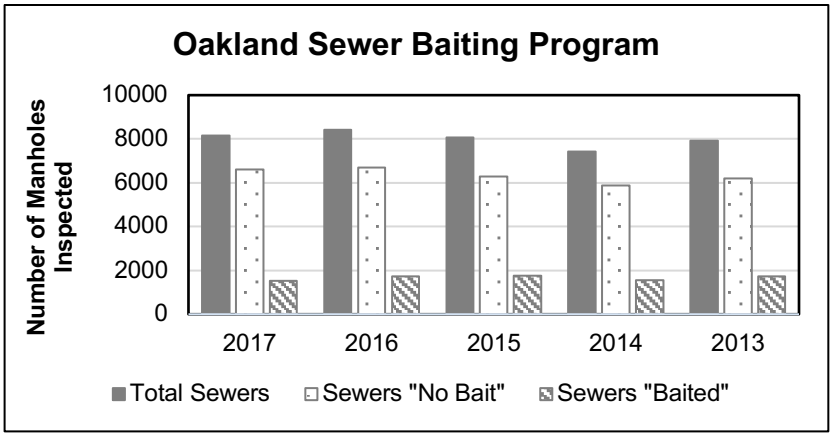

Figure 1. Total number of sewers inspected each year from 2013-2017, within the City of Oakland as part of the Sewer Baiting Program. Sewers that presented with "no active rat activity", i.e. "No Bait," were marked as inspected but not baited; and sewers that presented with "active rat activity" were baited with Contrac rodenticide bait.

population dynamics, but found no significant difference in population abundance between seasons. Norway rats are the main reservoir of *Leptospira* in the state of Salvador, Brazil. While this paper certainly lends much needed knowledge to the field regarding the ecology and control of Norway rats in a tropical region with limited infrastructure, the dynamics affecting rat population abundance in highly urbanized city settings, and specifically sewer systems, is still woefully lacking. Parsons et al. (2017) looked at the trends in urban rat ecology and associated gaps in current knowledge and suggested a framework for how academia, pest management professionals, and public health agencies could work together to address these gaps in understanding rat population dynamics within cityscapes. The authors state "knowledge of urban rat ecology is severely limited because researchers do not have regular, controlled access to municipal and privately owned infested properties." The authors outlined a multi-tiered approach on how best to address these knowledge gaps, and one of the main recommendations is for local Vector Control Agencies to help collect much needed data regarding Norway and roof rat (*R. rattus*) populations within their areas of service.

RODENT CONTROL PROGRAM IN OAKLAND

Sewer Baiting Program in Oakland 2013-2017

Between 2013 and 2017, the number of sewers within the City of Oakland that were inspected for rodent activity ranged from 7,900-8,400 sewers per year. In that time the number of sewers that presented with no "active rodent activity" ranged from a low of approximately 6,199 to a high of 6,687. "Rodent activity" is defined as the presence of droppings, live rats, dead rats, or evidence of burrowing. During that time the number of sewers that were baited due to signs of rodent activity was 1,531-1,765 (Figure 1).

Requests for Service for Rats

In 2013, the District received 73 Requests for Service (RFS) for Norway rats and 133 RFS for roof rats within the City of Oakland. In 2015, the numbers increased to 103 and 160, respectively. In 2017, the CSA received 2,917 requests for service county-wide (2,282 re: rats, and 635 re: mice) from the public for domestic rodents, representing 38.9% of overall service requests. Those 2,917 rodent service requests lead to staff biologists performing 16,722 field services operations related to rodents (Figure 2, Figure 3). In the City of Oakland in 2017, we again saw an increase, with 345 RFS for Norway rats and 281 calls related to roof rats. The District also received another 446 rodent-related RFS in 2017, but the identity of the rodents involved was not confirmed, totaling 1,072 RFS calls for rodents and rodent-related issues within the City of Oakland. This amounted to 37% of all the rodent-related RFS received by the District for the year, equating to 6,145 total field service operations. Whether this increase in rodent-related activity was due to increases in the population and abundance of Norway, and possibly, of roof rats within the sewer system, which subsequently moved above ground, is currently unknown (Figure 4).

Rodent Surveillance and Control Services Provided

To date, the District's Sewer Baiting Program has conducted rodent control operations by dividing the city into designated census tracts and mapping out the associated manholes needing inspection within a given tract(s). A three-person team inspects manholes two days/week, and can do upwards of 100 manholes a day, including inspecting and baiting. For the past ten years the District has exclusively used the rodenticide bromadiolone for control within the sewer system. A bait block is hung from a wire, which is then suspended into the hole. The wire is anchored to a nail to prevent the rats from moving the bait block to a different location and to prevent it being swept downstream. All manhole baiting is done from surface level, with the two-person crew doing the inspection and baiting and one person performing traffic control and data collection.

Inspected manholes are marked with paint, indicating to other staff biologists conducting Requests for Service (RFS) whether or not a manhole nearby has been inspected previously for rat activity. This becomes important if upon inspection of a nearby property the biologist(s) determine that a smoke or dye test needs to be performed to determine how rats are entering the structure. Currently, each manhole

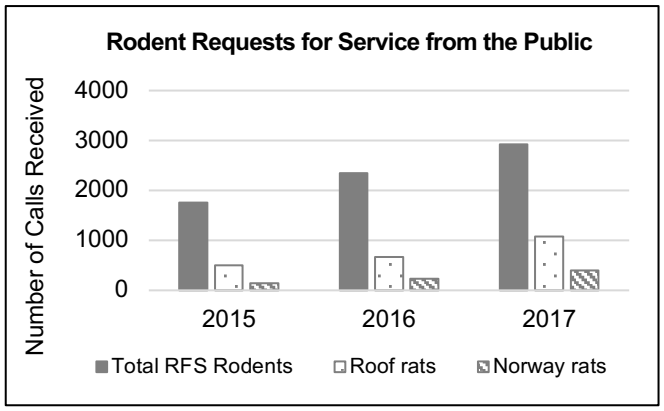

Figure 2. The total number of rodent-related Requests for Service (RFS) that were received by Alameda County Vector Control District over a three-year period, 2015-2017. The number of calls related to Norway rats and roof rats has increased over the past three years.

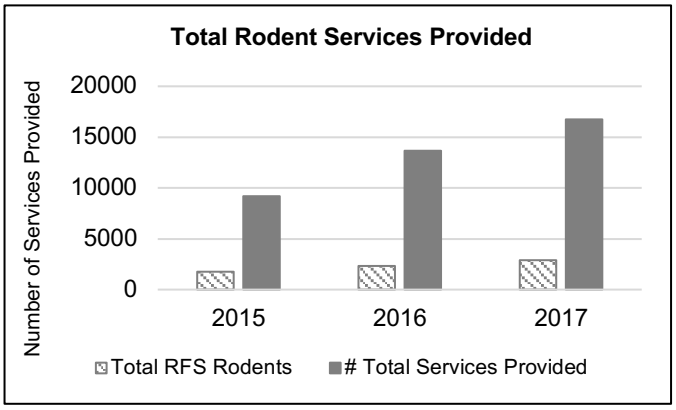

Figure 3. Total number of services provided by Alameda Co. VCD in response to rodent-related Requests for Service over the past three years. The trend has been an increase in services provided by the district over the past three years, with a total of 16,722 rodent-related services provided in 2017.

is inspected only once per year, and to date, follow-up inspections to determine the efficacy of the baiting program have not been performed on a routine basis.

Sewer baiting is currently performed in the cities of Oakland, Alameda, San Leandro, Albany, and Hayward as needed. Expansion of the sewer-baiting program will be determined based on rodent abundance in the county and the number and type of RFS calls received by the District.

Sewer Baiting Program in Oakland 2017

A Sewer Baiting Team comprises one or more District Biologists with two Environmental Assistants from the Environmental Health Department and they conduct the weekly inspections of underground sewer access structures (manholes) for signs of rodent activity (live rats or their droppings/burrows). To control rodent populations in areas with rat activity, rodenticide bait blocks are suspended in sewers to allow easy access for feeding above the water line.

In 2017, the Sewer Baiting Teams inspected 8,150 sewer manhole covers within the City of Oakland. They found 1,531 with rodent activity and baited with bromadiolone. The number of sewers inspected and baited has remained consistent over those five years (Figure 1).

Sewer Smoke Testing Program

Currently, Alameda County Vector Control District (VCD) conducts smoke and dye tests on an "as indicated basis." When conducting a home or property inspection, and successfully determining evidence of active rodent activity, the District biologist advises the home/property owner on exclusion techniques and proper trapping of rats/mice. However, in a subset of cases, the rodent problem persists, worsens, or returns at a later date. It is usually at this stage that a smoke or dye test is performed to determine if a break in the adjacent sewer line may be the source of the Norway rat infestations. Smoke tests are performed when a dye test is impractical or when a large area needs to be surveyed.

Unsheltered Encampments Issues

There are several homeless/unsheltered encampments in the City of Oakland. It was found that several of these encampments also had active Norway rat populations, as indicated by active burrows sites within and adjacent to the camps coinciding with reports of rats by residents of the encampments. Beginning in the fall of 2017, District biologists began live-trapping at a few of the larger encampments to try and ascertain the composition and load of flea species on corresponding Norway rat populations. At one of the larger encampments, near downtown Oakland, a total of 50 Norway rats were trapped over a two-and-a-half month period. An additional 39 rats were trapped at another encampment. How these numbers correlate to overall population abundance of Norway rats in the adjacent sewer system is currently unknown.

Rats from this camp were brought back to the District and euthanized in order to obtain tissue samples for rodenticide resistance testing and combed for ectoparasites (i.e. fleas). We are specifically interested in the species composition and abundance of fleas on the rats. Fleas were obtained from all the rats captured, with an average flea index of 15 fleas/rat. A high of forty-six fleas was collected from one Norway rat trapped at an encampment. The most common flea found was the Oriental rat flea, *Xenopsylla cheopis*, which is the primary vector of bubonic plaque and murine typhus (Himsworth et al. 2013). The cat flea (*Ctenocephalides felis*), was found on three specimens and the northern rat flea (*Nosopsyllus fasciatus*), was found on one specimen. Based on the high flea counts, burrows were dusted with Drione (Bayer Crop Science, Cary, NC) in December 2017. Fifteen pounds of material was used and after treatment the average index dropped to 9 fleas/rat. PCR testing of fleas for the presence of murine typhus and plague will be conducted by the District in 2018.

Crossroads

Due to the increase in rodent-related RFS received by the District over the last three years, it has become clear

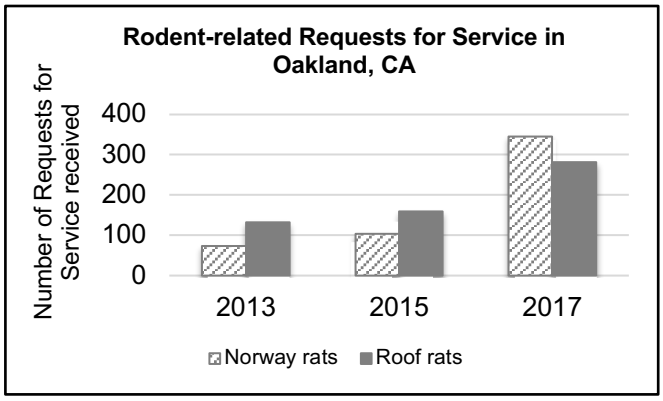

Figure 4. Rodent-related Requests for Service (RFS) received by Alameda Co. VCD from 2013-2015. Over the five- year period, the number of Norway and roof rat RFS received have increased.

that rodent population numbers are increasing and the current Sewer Baiting program is no longer providing adequate rodent control with the City of Oakland. Correlating above ground Norway rat abundance to population levels found in the corresponding sewer systems will require a multi-pronged approach. We are in the process of developing and implementing an Integrated Pest Management (IPM) program with the City of Oakland targeted at Norway rat control.

Our Integrated Pest Management Program will be composed of the following six targeted areas: 1) Pulse-baiting targeted areas in the sewer system within the City of Oakland and other cities covered by the District, 2) GIS data-tracking of inspected and baited manholes, 3) Follow-up inspections to determine the efficacy of the pulse-baiting program, 4) Tracking abundance of above-ground Norway rat populations using Requests for Service, 5) Resistance testing of Norway rats from various locations, both above and below ground within the City of Oakland, and 6) Disease surveillance.

Pulse-baiting Program

Using historical and current data, targeted areas within Oakland will be chosen for pulse-baiting. Census tracts with the highest level of active rat activity, based on data gathered in 2017, will be targeted first. Active rodent activity (i.e., the presence of droppings, live rats, dead rats or burrows) will be confirmed prior to baiting. The increased potency of second-generation compounds in rodent control baits has meant that rats may acquire a lethal dose after one feeding, defined by Dubock (1984) as "pulsed baiting." A preliminary study conducted by our staff showed that a seven-week rotation of pulse-baiting provided successful control of Norway rat populations within parts of the sewer system in the City of Oakland.

GIS Data Tracking

Data will be collected and entered into the GIS data tracking system that has been developed specifically for Alameda Co. VCD and the City of Oakland. The database contains the maps and locations of all the manholes within the City of Oakland. Each manhole that is inspected and baited is entered into the database and color-coded based on rodent activity, i.e., blue = inspected, green = baited. The system allows us to input historical data of past rat activity and overlay that with current rodent activity. This information will be used to determine which areas should be targeted first, and subsequent locations within the city ranked in order of importance based on rat activity levels.

Follow-up Inspections of Baited Manholes

District biologists will assist the Sewer-Baiting team in collecting data by performing manhole inspections post-baiting. The optimal monitoring period post-baiting will be determined (i.e., 6-8 weeks). Manholes with evidence of continued rat activity will then be marked for re-baiting by the Sewer Inspection Team.

Tracking Norway Rat Populations

Requests for Service, specifically for Norway and roof rats, will be tracked and used to determine if a higher proportion of calls are where the Sewer Inspection Team has determined that active rat activity is taking place. In these cases, smoke and dye tests will be performed to determine if breaks in the sewer lines have occurred and to ascertain their location. This information will be passed on to the Oakland Public Works Department as an area of high priority for repair.

Resistance Testing

Norway rats will be live trapped within the sewer system, as well as above ground, and tissue samples will be collected in order to perform rodenticide resistance testing. To date we do not know if any of the rats in Oakland are resistant to bromadiolone. Once resistance is discovered steps must be taken immediately to decrease the likelihood of resistance becoming fixed in the population, i.e., baiting with bromadiolone will become ineffective at controlling the population. PCR testing will be done at the District in our on-site laboratory. A program will be developed incorporating rotation of baits with different formulations in order to decrease the likelihood of resistance developing to any one compound in the future.

Disease Surveillance

Ectoparasites, namely fleas (if present), will be collected from euthanized rats from both the sewer and above ground locations, identified, and tested for the presence of plague and murine typhus. We are in the process of developing PCR protocols for testing, which will be done at District in our on-site laboratory.

CONCLUSION

Even though the overall number of sewers baited for Norway rats did not exceed that of previous years, the number of Requests for Service (RFS) received by Alameda Co. VCD related to rodent issues steadily increased from 2015-2017. District-wide, over the three-year period, we received a total of 2,917 rodent-related service requests. While 635 of the rodent-related calls received in 2017 were for mice, the number of calls related to both roof rats and Norway rats increased over those received in both 2015 and 2016.

From 2013-2017, within the City of Oakland alone, the District has received an increase of 79% in RFS related to Norway rats and a 53% increase in the RFS for roof rats. It is clear that the overall populations of Norway and roof rats within Oakland are increasing and that we need to develop a new management strategy for controlling their populations.

To that end, the District is developing an IPM program that will encompass six different targeted areas including pulse-baiting, on-going monitoring, resistance testing, and disease surveillance with the aim of controlling Norway rat and roof rat populations.

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