Leveraging Single-Sight and Sight–Resight Survey Methodology for Street Dog Population Estimation in Metropolitan City of Bruhat Bengaluru Mahanagara Palike, Karnataka, India

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Introduction

Dogs, renowned for their loyalty, diversity of breeds, and innate ability to forge connections, have made them a permanent part of the urban ecosystem [1]. The free ranging Street Dogs or the street dogs which are owned, need to be looked upon with compassion and seen that they are not overgrown in population to cause problems to their human companions.

In this context, the Bruhat Bengaluru Mahanagara Palike (BBMP), embarked on a significant endeavor that extends well beyond its typical municipal duties. As the custodian of Bengaluru's civic amenities and Stray Animals, BBMP's mandate extends far beyond the realm of roadways and waste management. In a bid to comprehensively address the dynamic relationship between the city's human and canine inhabitants, BBMP conducted a street dog survey. This survey, a testament to BBMP's commitment to effective civic management, holds immense importance in shaping policies, fostering harmonious coexistence, and ensuring the well-being of both the city's residents and its four-legged companions.

Bruhat Bengaluru Mahanagara Palike (BBMP) is carrying out Animal Birth Control-Anti Rabies Vaccination (ABC-ARV) program in all of its 08 zones. In order to study the impact of the ongoing ABC-ARV program [2] on the Street Dog population in Bengaluru, it is necessary to carry out systematic survey estimation of the street dog's population using National Action Plan for dog Mediated Rabies Elimination (NAPRE) [3] recommended method (single sight and sight-resight surveys) in Bengaluru city (BBMP) with the following objectives which include estimating the current neutering percentage among street dogs, analyzing the geographical distribution and zone-wise density of the street dog population, formulating a ward-wise micro plan, setting reliable ABC-ARV targets based on estimated street dog populations, and intensifying systematic Anti Rabies Vaccination (ARV) drives to achieve a 70% vaccination rate among street dogs.

Accurate population estimation in BBMP enables targeted and efficient public health interventions. By employing methods such as Single-Sight and Sight–Resight surveys, authorities can gather essential data on the size, distribution, and health status of the stray dog population [2]. This information forms the foundation for strategic implementation of Animal Birth Control (ABC) programs [4] and Anti-Rabies Vaccination (ARV) campaigns [5]. ABC programs, which involve spaying and neutering, help manage and reduce the stray dog population, thereby limiting the potential for rabies transmission [6]. Concurrently, ARV campaigns ensure that a significant proportion of the roaming dog community is immunized against rabies, acting as a barrier to the virus's spread.

Rabies, a lethal viral disease, poses a significant public health threat globally. Transmitted through the saliva of infected animals, particularly through bites, the rabies virus targets the nervous system, leading to severe neurological symptoms. The disease is almost universally fatal once clinical signs appear, making prevention crucial. In urban settings like BBMP, the presence of a substantial stray dog

population amplifies the risk of rabies transmission. Understanding the magnitude of the roaming dog population through accurate population estimation becomes a critical tool in rabies control [7]. In essence, an accurate estimation of the stray dog population in BBMP is instrumental in designing and implementing targeted measures for rabies control. This proactive approach not only protects the health and well-being of the community but also fosters a more harmonious coexistence between the human and animal populations in urban environments. Through responsible and data-driven management strategies, BBMP can significantly contribute to the reduction of rabies risk and enhance the overall health and safety of its residents [8].

Methodology

2.1. Study Area

The study was conducted in the wards of BBMP (Fig. 1) in Bengaluru Urban district located in the southern part of India with coordinates of 12° 58' 17.7564'' N and 77° 35' 40.4376'' E between 11th July 2023 and 2nd August 2023. BBMP jurisdiction has 243 wards. These 243 wards are divided into 6850 grids (micro zones) for Survey purpose [9] [10].

2.2 Selection of the Micro-zones

The micro zones (n=6850) each having an area of 0.5 Sq.km, were created within the 243 wards for more detailed and precise analysis of data. It is assumed that this level of granularity allows for a better understanding of localized trends and variations with reducing the risk of missing important data points and ensures a comprehensive assessment. Challenges or opportunities identified in specific zones can be addressed with tailored solutions, optimizing resource allocation and efforts.

The methodology employed (Fig. 3) for the selection of wards involved the utilization of Stratified Random Sampling. With a total of 243 wards and 6850 micro zones, the aim was to ensure a representative sample. To achieve this, the Sample size formula $m1 = \left(\frac{200}{Q}\right)^2 \left(\frac{s}{N}\right)^2$ Where Q is PRP (10),is the estimated mean number of dogs per sample, s is the estimated sample standard deviation, N is the total estimated population size, or 20% of the sampling results, whichever is higher was used [15]. A total of 1360 micro zones, were required to be chosen for analysis (Fig. 2(b)).

The initial step involved the subdivision/stratification of the 6850 micro zones into four distinct categories, carefully aligned with the unique facets of the urban environment. These categories encompassed micro zones surrounding lakes, in slum areas, in commercial areas, and other general areas (Fig. 2(a)). By categorizing the micro zones into these four strata, the methodology acknowledged and embraced the diversity inherent in the city's fabric. The micro zones within each stratum were meticulously chosen for inclusion in the survey. This methical selection process was driven by the aim to capture a cross-section of the city's various dynamics and characteristics, thereby enhancing the validity and reliability of the survey outcomes.

To uphold the integrity of the sample, the selection process involved picking minimum five micro zones from each ward. This systematic approach of selecting micro zones from different wards while maintaining the prescribed quantity within each ward adheres to the principles of Stratified Random Sampling. This technique was chosen to provide an accurate and well-rounded understanding of the city's diverse dynamics. By embracing a systematic and balanced approach to selecting wards and micro zones, the survey outcomes are poised to provide a robust foundation for decision-making, policy formulation, and the harmonious coexistence of both humans and their canine companions within the urban landscape.
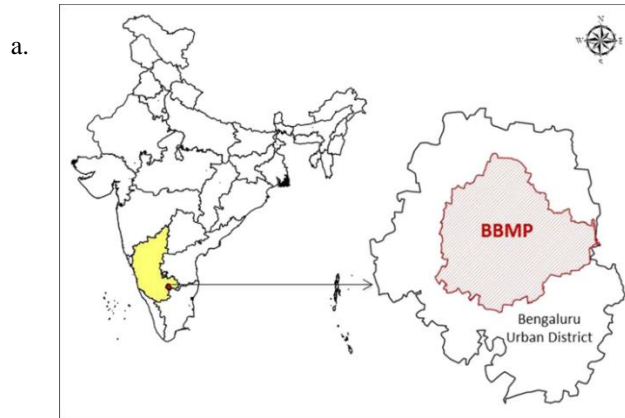
Fig. 1. Study area showing BBMP in Bengaluru Urban district of Karnataka State
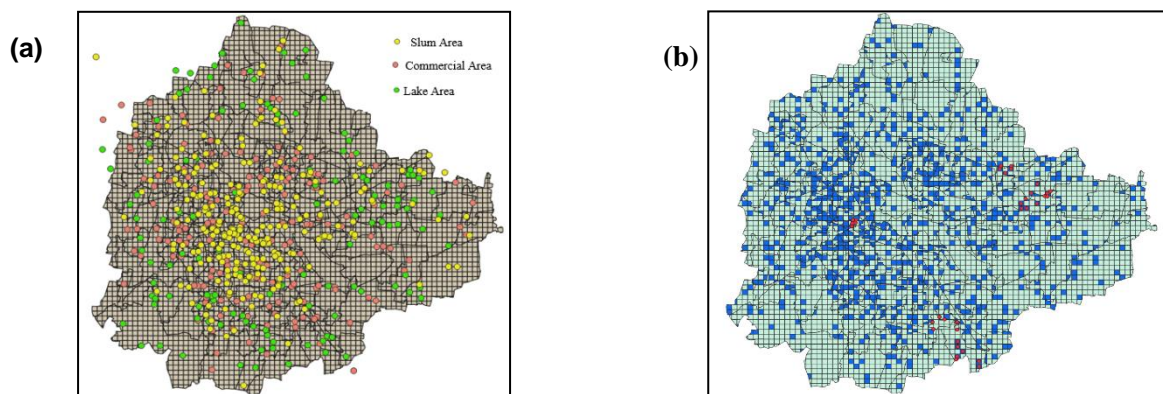
Fig. 2. Study area showing BBMP gridded map demarcated with lakes, slums & commercial area (a), sampling area (b)
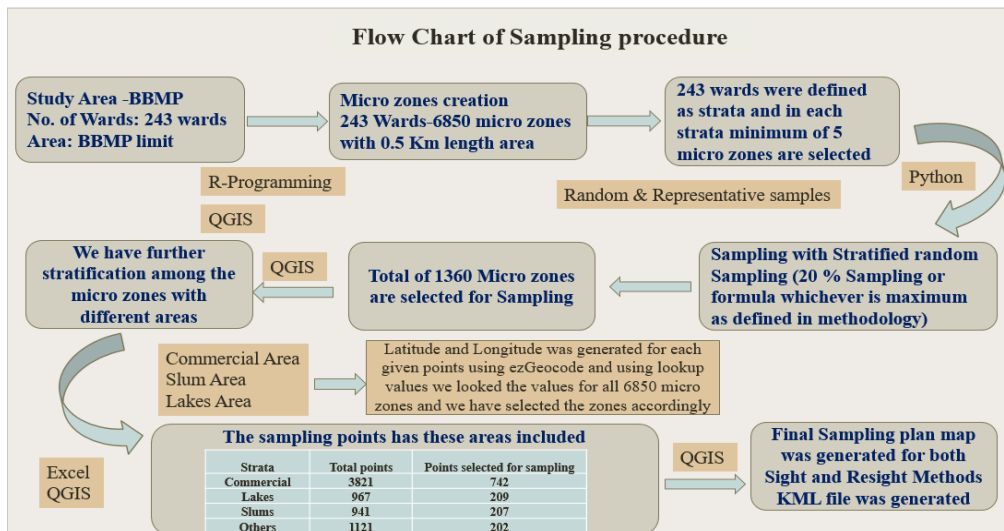
Fig. 3. Flow chart of Sampling (Stratified Random Sampling) procedure

2.3. Mode of Survey

2.3.1 Single-Sight and Sight –Resight survey

The Single-Sight and Sight-Resight Survey [11] was conducted within the BBMP limits over twelve days. For the first six days, single-sight survey was carried out for gathering information about the number of dogs in a particular area by a pair of surveyors by travelling down every road on a 2-wheeler, taking photographs and recording information about dogs seen in all parts of an allocated zone and also recording details of every dog they saw. On the next six days, all of the dogs seen on the first six days are recorded, whether or not, they were captured as seen on the first six days. This proportion makes it possible to estimate the total dog population for the region using Lincoln–Petersen's formula given below.

Unlike the Single-Sight Survey method, the SRS Survey method provides an estimate of the total population in the surveyed area, however, they require more staff expertise and time to implement, limiting the area, which can be covered. Therefore, a combination of both SS and SRS surveys makes it possible to benefit from both scale and intensity of method.

2.3.2. Lincoln–Petersen's Formula with Chapman's Correction for population estimation

The sizes of the Street Dog populations were estimated using the Lincoln–Petersen formula with Chapman's correction [12][13] according to equation 1 in which N is the estimate of the total population size, n1 is the total number of dogs sighted during single sight survey, n2 is the total number of dogs sighted during Sight–Resight survey, and m is the number of sighted dogs re-sighted Sight–Resight survey. An approximate unbiased variance of N was estimated by using Seber's formula [14][13] (equation 2). The 95% confidence interval for N was estimated according to equation 3

$$N = \left[\frac{(n1+1)\,(n2+1)}{m+1} - 1 \right] \quad (1)$$

$$var(N) = \left[\frac{(n1+1)(n2+1)(n1-m)(n2-m)}{(m+1)^2(m+2)} \right] \quad (2)$$

$$95\%\ confidence\ interval\ (CI) = N \pm 1.965\sqrt{var(N)} \quad (3)$$

2.4. Survey Execution and Data Collection

The BBMP Street Dog Survey was executed with a carefully planned methodology to ensure accuracy. Covering 1360 micro zones in Bengaluru, the survey enlisted 79 para-veterinarians from AHVS, Bengaluru Urban District, and 30 from BBMP (AH). Supervised by 15 Veterinary Officers, ICAR-NIVEDI designed the sampling plan, and Worldwide Veterinary Service (Mission Rabies) provided technical support through their mobile application. A dedicated committee oversaw logistics for transparency. The survey employed the Single-Sight and Sight-Resight Survey methods, with 50 teams covering 1360 micro zones [10] over 12 days. Each team, assigned to 5 wards, conducted surveys on 2-wheelers from 6:00 AM to 8:30 AM. The resight survey involved 12 teams meticulously revisiting locations over two days to capture photographs for calculating the crucial "m value". The careful cross-referencing and calculation of "m values" for a subset of micro zones, followed by extrapolation to the entire dataset, underscored the survey's commitment to accuracy and reliability in estimating the street dog population.

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