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Use of aerial photograph to enhance dog population census in Ilorin, Nigeria

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Abstract

The ground survey method for dog population census is considered to be prone to error in enumeration. As a result, use of aerial photography has been suggested as capable of enhancing ground survey methods for more accurate results. Dog population census was carried out within Ilorin city in October 2010 using direct street count and questionnaire survey aided by coverage precision of the 2010 aerial photograph of the city to define enumeration areas. The city was classified into three functional zones, namely residential (low, medium and high income areas) non-residential (educational, government offices, commercial and recreational areas) and transit zones (vehicle terminals for cars, buses and trucks traveling from southwestern to northern parts of Nigeria and vice versa). Five hundred questionnaires were administered to obtain primary data on socio-economic characteristics of dog owners and dog count. A total of 16,348 households were covered in the city. Dog population was estimated to be 1,258 comprising 668 (53.10%) male and 590 (46.90%) female. There were 356 (28.30%) young dogs (<6 month old) and 902 (71.70%) adult dogs (> 6 months old) in the population. Dog distribution ranged from 510 (40.54%) in non-residential areas and 480 (38.16%) in residential areas, to 268 (21.30%) in transit areas of the city. Dog population density of 1:13 dog per household was obtained. Poorly managed garbage collection points were found to be associated with and aid the distribution of roaming dogs. The census figures generated in this study are valuable for public health planning in Ilorin, Nigeria, particularly for anti-rabies control programme among dogs in the city.

Keywords: Aerial photograph, dog census, geographic information systems, Ilorin Nigeria

Introduction

Dog population studies are important pre-requisite in planning for an effective rabies control programme. The population size, ecology, and proportion of ownerless dogs in a community, as well as accessibility of dogs to vaccination campaigns and public attitude towards rabies control programmes and measures are valuable information for planning and evaluation of anti-rabies campaign (WHO, 2002). The cross-sectional study method that combines direct street count with the administration of questionnaire or door-to-door interview of urban and rural residents is the traditional technique for dog population studies in African countries. This method has been reported as used in Kenya, Madagascar, Nigeria, Tanzania and Zimbabwe by several authors, including Ezeokoli & Umoh (1986), Brooks (1990), Butler & Birgham (2000), Kitala *et al.* (2001), El-Yuguda *et al.* (2007), Knobel *et al,* (2008) and Ratsitorahina *et al.* (2009). The technique was considered to be economically and logistically affordable, yet it is known to be prone to some degree of bias in enumeration process (Oboegbulem & Nwakonobi 1989), which may limit the success of public health programme, especially in the planning for rabies control in dog population within a community of a developing African country.

Aerial photograph and its supporting geographic information systems (GIS) technology are becoming more available and affordable in developing countries, and playing increasing roles and importance in both domestic and wild animal census coverage precision and biological risk management (Olorunfemi, 1985; Ramirez *et al*., 2004). Identification of city extent and internal growths are two potential factors that may introduce some bias in census coverage for human and animals alike, especially in densely populated communities (Aiyedun, 2011). This is one function that makes the use of aerial photography with high resolutions (such as Satellite image at 0.5m resolution) to be valuable in improving the planning and coverage precision, when combined with the traditional

ground survey method of dog population census.
In both the traditional and GIS enhanced methods of dog census operation, one outcome parameter that is derived is an estimation of dog population density**,** calculated from the dog to humans ratio or dog per household and expressed as dog per unit area index (Oboegbulem & Nwakonobi 1989). Some of the earlier studies that applied different techniques for estimating dog population densities include use of total street-dog count by Ezeokoli & Umoh (1986) estimates from the rate of capture by Okoh (1988) and estimates from rate of re-capture of the same dog Okoh (1988). Most of these methods are adapted from techniques developed for estimating the density of wild animals in their natural habitat (Oboegbulem & Nwakonobi 1989; WHO & WSPA, 1990). We conducted the present study to generate reliable population records of domestic dogs in Ilorin city for an evaluation of prevalence of antibodies against rabies among dogs in this transit city between northern and southwestern Nigeria (Olugasa *et al.*, 2011), in view of current trends in rabies control in Africa (Kaare *et al.,* 2009).

Materials and methods

The study area

Ilorin, the capital city of Kwara state is located in the North Central geo-political zone of the country. It lies on latitude 8°, 31′N and longitude 4° 35′E. Kwara state shares boundaries with Oyo, Ekiti, Kogi, Niger and Osun states. Geographic area of Ilorin is an estimated 50.2 km^2, approximately 400 km from the Federal Capital Territory, Abuja. The city comprises three major land use areas namely, residential areas (low income traditional settlements, medium income residential areas and high income government residential areas), non-residential areas (government offices, recreational, commercial, industrial and educational areas) and transit areas (vehicle terminals for cars, buses and lorries). (Olorunfemi, 1985; Olorunfemi & Odita, 1998; Olugasa *et al.,* 2011). Ilorin lies within the guinea savanna ecological belt of Nigeria, and shares ecosystem with Borgu game reserve to the north and Old Oyo Park to the South.

The 2006 national census report indicates that human population in Kwara state was 2,371,089. Among this is Ilorin city alone that has a total of 777,667 persons (FGN Official Gazette, 2007). The city consists of three Local Government areas, namely: Ilorin East with 204,310 people, Ilorin South with 208,691 people and Ilorin West with 364,666 people. Its strategic location as the gateway between the northern and southwestern parts of the country makes it easily accessible to all parts of the country by air, road or rail transport (Figure 1).

Mapping of enumeration units using aerial photograph

Aerial photograph of Ilorin was obtained from Google Earth satellite image and geo-referenced for use in ArcView GIS 3.2 by layering on ArcView. This was used to guide and focus dog population census (Figure 2). The number of roof-tops and streets in the city were counted on GIS displayed aerial photograph. The counts were translated onto traditional paper map of Ilorin, obtained from the Kwara State Town Planning Development Authority (KSTPDA), Ilorin, for growth changes and street names harmonization. Harmonized street records were used to allocate number of questionnaires and enumerators for the census coverage. These were distributed as functional ratios of roof-tops across land use areas and streets in the city.

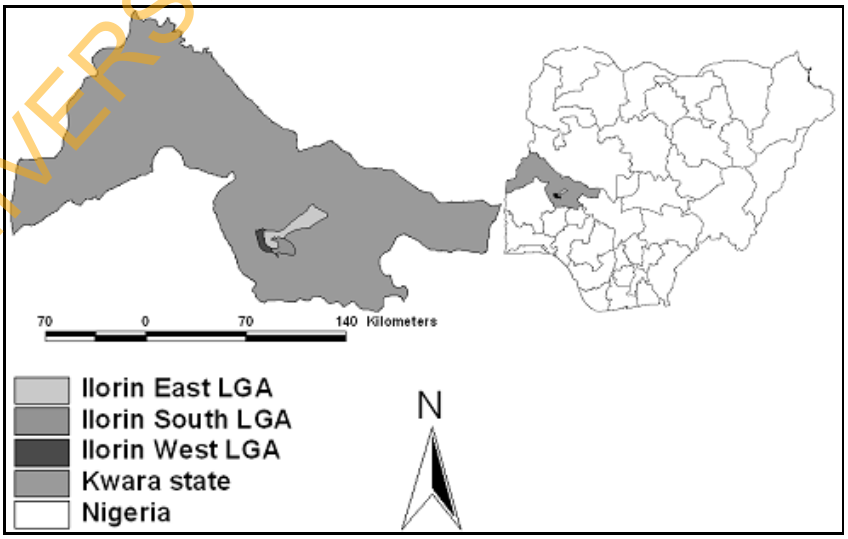

Figure 1: Study areas with insert showing the location of Ilorin within Nigeria

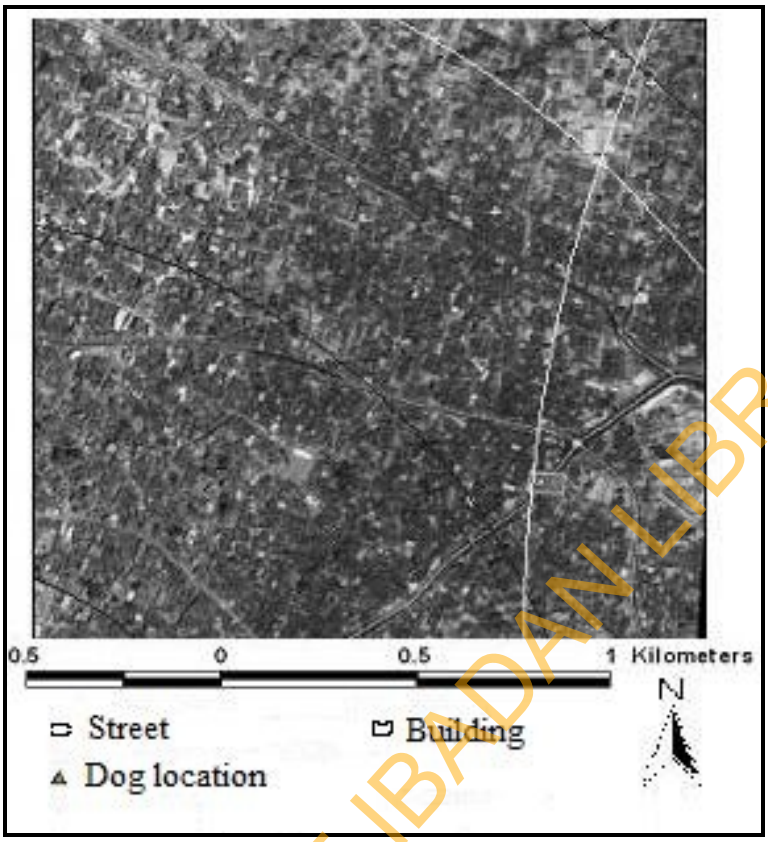

Figure 2: Dog enumeration household units on ArcView GIS for Ilorin city, Nigeria

Enumeration of dogs in this survey adopts a modified version of two previous studies, namely by Okoh (1988) in Jos, Plateau State, Nigeria and Beran (1982) in Central Philippines. The major modifications were in the addition of aerial photograph of Ilorin city to map enumeration units, define coverage area by harmonized boundaries. Census administration was subsequently guided in procedure and coverage of enumerators across streets and land use areas to include all dog management forms including confined, free-roaming (as well as stray dogs), their number, means of survival and healthcare history. Number of roof-tops counted was 16,348. Number of major streets counted was 242. On the average, number of roof-tops per street was 67. About 90% of the streets within Ilorin city were identified and numbered serially in agreement with the enumeration area demarcated earlier by the National Population Commission of Nigeria.

Direct street count of dogs

Streets were sorted into neighborhood groups each of which could be covered within few hours by a trained enumerator. Five enumerators were recruited and trained for two weeks for the exercise. They were given guidelines and instructions for an effective and efficient dog census aided with GIS. Enumeration was carried out daily from 7.00a.m to 6.00p.m over a 4-month cycle. Each enumerator was provided with a form for recording counts and special features of the dog: colour, sex, body marks and breeds. The exercise was repeated three consecutive times, making a year. The mean of three repeated counts was obtained and the standard error of the mean was calculated at 95% confidence limit to reduce enumeration error.

Every dog seen within and outside a house or compound (free-roaming or confined) was counted. Classification into free-roaming and confined was based on informed opinion of resident respondents in nearest neighborhood. This method was similar to Beck photographic recapture technique of 1973, except that dogs were not photographed but observed and identified by physical characteristics

(Okoh, 1988). The five enumerators submitted daily reports that were summarized to give dog population by street counting technique.

House-to-house questionnaire survey

Questionnaire for gathering dog population data and for assessing human attitude towards dog was designed. The questionnaire survey was done on the same areas as of street count. An adult and literate member of the household was interviewed using questionnaire designed for dog population survey (WHO & WSPA, 1990). The questionnaire consist of two parts: part one covers information about the household and biodata of dog, part two was concerned with management of dogs and cases of dog bite. In some cases the questionnaire was read to the respondents and the answers they gave were filled in appropriately. The interviews were conducted in the local language but later translated and English depending on the situation, the time for the interviews varies from approximately 10-15minutes. Households with dogs were asked about the number of dogs owned and their ages and sexes. Their methods of feeding and restrictions on their dogs were asked. All the households were asked about the presence of other dogs, (owned or free-roaming) at their homes and premises.

Each household interviewed was asked about the number of people living on the premises, their waste disposal method, presence of an incinerator, toilet facility and if they would like to own more dogs. Statistical summary for each street was recorded on the back page of the questionnaire to conclude on dog population on each street. Questionnaire was distributed at the ratio of one to thirty-three (1:33) roof-tops. Two questionnaires were administered per street on the average. A total of five hundred (500) questionnaires were administered in all. The number of questionnaires was decided based on a merger of level of accuracy and logistic convenience.

Results

The first complete cycle of dog census using street count technique gave a total of 3,004 dogs. The second cycle gave 2,800 dogs; while the third cycle gave a total of 2,704 dogs. The mean of the three was 2,836 dogs. There were 1,159 dogs in the non-residential areas, 612 dogs in transit areas and 1,065 dogs in residential areas. Error corrected population was 2,455 dogs.

The results of questionnaire survey revealed 1,258 dogs (Table 1). There were 668 (53.10%) male and 590 (46.90%) female in the population (Table 2). Young dogs (<6months old) were 356 (28.30%), while adult dogs (>6months old) were 902 (71.70%). Dog distribution ranged from 268 (21.30%) in the transit areas and 480 (38.16%) in the residential areas to 510 (40.54%) in the non-residential areas. The number of roof-tops counted were 16,348. There were 242 major streets in the city with an average of roof-tops on a street being 67. Dog population density was estimated at 1:13 dog to households during the study period of October, 2010.

Table I: Dog population in major land use areas of Ilorin city, Nigeria (October, 2010)

Location and land use area	Dog population	Proportion (%)
Transit area (vehicle terminals)	268	21.30
Residential area	480	38.16
High income		
Medium income		
Low income		
Non-residential Area	510	40.54
Total	1,258	100.00

Table II:Breeds and sex distribution of dogs in Ilorin city, Nigeria (October, 2010)

Dog breed	Male	Proportion	Female	Proportion	Total
Exotic	257	20.43	188	14.94	445
Local	183	14.55	194	15.42	377
Cross	228	18.12	208	16.53	436
Total	668	53.10	590	46.90	1,258

Discussion

Dog population census in Ilorin was investigated in this study, using a combination of direct street counting of dogs, questionnaire survey and the enhancement of enumeration procedure with aerial photograph and geographic information system to reduce errors in the study. A population of 1,258 dogs was obtained during the study period. In addition, dog population density of 1:13 (dog per household) was obtained. Dog to human ratio of 1:139 obtained in this study for Ilorin was considered low, compared to some other Nigerian cities, including Jos which ranged from 1:24 to 1:13 and Kaduna 1:30 to 1:27 respectively by Okoh (1988). A likely reason for this may be the predominance of Muslims in Ilorin city (Olorunfemi, 1985). Muslims do not keep dogs as they are considered unclean animals. American and European cities have reported a dog to human ratio of between 1:10 and 1:6 respectively (WHO & WSPA, 1990).

Direct street count result was much higher than the result obtained from questionnaire survey in this study. In operational terms, the result of the direct street count may be considered more valuable in that it was repeatable. The observed difference might be attributable to poor response from residents in the survey. The conservative 1,258 dogs obtained by questionnaire survey, and 2,455 obtained by direct street count may be a range of dog population in Ilorin. Our results compare favourably with findings of the National Bureau of Statistics (Annual Abstract of Statistics, 2008) that estimated dog population in Nigeria to be 6,983,585, while that of Kwara state alone was estimated at 8,835 dogs. An estimated dog population density for Ilorin may range from 1:316 (dog to man ratio) to 1:139. This however contrasts the report by Oboegbulem & Nwakonobi (1989) on dog to man ratio of 1:45 in rural Lagos, Nigeria.

The present finding also differs from findings by Ezeokoli & Umoh (1986) who reported dog to man ratio of 1:27 and 1:30 in urban and rural Kaduna, Nigeria, but agrees remarkably with the report of less than one dog per 1,000 humans in the Muslim dominated parts of the state. This variation in man to dog ratio in different areas of Nigeria are attributable to the socio-cultural, economic and religious status of the inhabitants of different communities in Nigeria. Dogs were more numerous in the non-residential areas, especially in major commercial areas and in government residential areas in Ilorin than in the traditional low income residential areas. This conforms with previous observations that dog population is more sustained in the affluent and security conscious areas of Nigerian community than in the less affluent and rural areas.

The presence of several poorly managed garbage collection points was found to aid the clustering of roaming dogs in the city. Garbage collection points that were weekly or monthly disposed off, including those that were allowed to pile-up indefinitely on major streets provided foci where free–roaming dogs congregated for food, mating and may equally serve as environmental risk factor associated with human rabies exposure in the city (Olugasa *et al.,* 2009; Olugasa *et al.,* 2011). Non-residential areas with high number of garbage collection points were associated with high number of free-roaming dogs during the study period. This finding also corroborates the report by Oboeghulum & Nwakonobi (1989).

Dog population studies are needed in various parts of Nigeria to aid regular, adequate and sustainable programme for canine rabies control in the country as observed across African countries (Kitala *et al.,* 2001; Knobel *et al.,* 2008; Ratsitorahina *et al.,* 2009; Olugasa *et al.,* 2011). The method employed in this study is less commonly available, more expensive than the traditional methods for dog population census, but capable of direct and indirect organizational capacity building for effective planning of rabies control in various campaign interventions. Increasing local institutional efforts may lead to an increase in use of this technique in Nigeria.

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