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Baseline Survey for Street Dogs in Haryana State, India

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Baseline Survey for Street Dogs in Haryana State, India
June and October 2014

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TABLE OF CONTENTS

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SUMMARY

Humane Society International (HSI) conducted a systematic dog survey in Haryana, India, in June and October 2014. This survey was undertaken in support of the National Rabies Control (NRC) program of India. The primary goals of the survey were to:

1) Collect baseline data prior to initiation of a program of humane dog population management (DPM) and rabies control,
2) Establish a standardized survey framework for future monitoring of DPM program impact, and
3) Generate a population size estimate for street dogs to assist in strategic and logistic planning for the DPM and NRC programs in Haryana.

Data collection occurred during two periods. The first was initiated in early June, 2014, continuing until the onset of monsoon season in late June. Data collection resumed in late September, 2014, continuing through the first week of October. This report covers the basic analysis of data collected during these two periods.

Baseline dog population surveys are a critical prerequisite for DPM management programs for several reasons. First, obtaining a reliable estimate of the number of street dogs in the project area facilitates effective strategic planning, and allows managers to better determine the resources and time that will be required to achieve specific management goals. Second, determining the correlates of high dog density can suggest ways to more effectively target management efforts. Finally, the baseline survey establishes a reference point against which future changes can be evaluated, including the changes that are attributable to DPM. Without such a reference point, progress of the DPM program at the population level cannot be accurately quantified. This type of "trend monitoring" requires periodic follow-up survey effort, but does not require the same level of intensive effort that characterizes the initial baseline survey.

The survey program was designed using a stratified-random sampling plan that distinguished between different Districts and different human population densities. Sample units were 1 km x 1 km survey plots that were randomly selected within each unique combination of District and human population level. The survey plan relied upon rapid survey methods to efficiently cover a large number of plots, along with intensive surveys in a smaller subset of plots. Intensive survey results provided a basis for correcting rapid surveys to account for incomplete coverage and incomplete dog detections. In total, 209 plots were selected and surveyed, and these allowed us to

extrapolate results across all of Haryana to generate a dog population estimate. In addition to tallying dogs, several basic attributes were recorded for each observed dog, including sex, age, health status, and reproductive status, and whether the dog was free to roam or confined.

Using this approach, we estimate that there are approximately 1.8 million street dogs in all of Haryana. This translates to about 7 dogs per 100 people across the very broad range of human population densities. This estimate does not include owned and confined dogs. As in most areas, the ratio of dogs to people is higher in smaller villages, and lower in larger cities. Several other attributes of the street dog population could be estimated from this data, including sex ratio (54% male, 46% female), percent females pregnant or lactating (13.5%), percent of dogs visibly sick or wounded (1.3 %), and percent of dogs visibly undernourished (1.2%).

To our knowledge, this is the first attempt to systematically survey a street dog population over such a large and heavily populated geographical area within the framework of a single project. Other characterizations of street dogs over large areas typically rely upon conjectural extrapolations derived from much smaller survey areas. Information from the dog survey indicates that the street dog population in Haryana is breeding at a relatively high rate, which in turn indicates the need for aggressive DPM. Current sterilization rates appear to be quite low (< 15%) based on these findings. As a simplified rule of thumb, sterilization rates of females need to reach sustained levels of at least 65% in order to potentially achieve significant population size reduction. Additionally, the World Health Organization suggests that regardless of street dog population size, a dog rabies immunization rate of ~ 70% must be achieved at annual (or more frequent) intervals in order to reduce rates of rabies transmission and incidence. We emphasize that the goals of DPM and rabies management are synergistic in many ways. For instance, unmanaged dog populations experience fairly rapid turnover, which makes maintaining a 70% vaccination rate a far more difficult undertaking that it would be for managed dog population, where lifespans are longer and turnover lower.

Ancillary analyses derived from this survey program will be available in a comprehensive report update by December, 2014. These include findings from the household survey effort, which will add significant perspective to the dog survey data discussed in this report.

INTRODUCTION AND PURPOSE

This report describes a systematic dog survey program that was performed by Humane Society International (HSI) in Haryana state, India, in June and October 2014. This survey was conducted in support of the National Rabies Control (NRC) program, with its primary goals being to:

1) Collect baseline data prior to initiation of a program of humane dog population management (DPM) and rabies control,
2) Establish a standardized survey framework for future monitoring of DPM program impact, and
3) Generate a population size estimate for street dogs to assist in strategic and logistic planning for the DPM and NRC programs in Haryana.

Data collection activities occurred during two periods. The first was initiated in early June, 2014, continuing until the onset of monsoon season in late June. Data collection resumed in late September, 2014, continuing through the first week of October. This report covers the basic analysis of data collected during these two periods. Ancillary analyses will be conducted in the near future and presented in a comprehensive follow-up report by early December, 2014.

Haryana state is located in northern India, abutting the national capital region of Delhi to the east (Figure 1). The human population of Haryana is approximately 25 million, distributed across 21 districts (Figure 2) with a combined land area of 44,000 km^2, resulting in an average human population density of about 570 people / km^2. Although Haryana is a relatively prosperous Indian state, unconfined dogs are commonly seen on the streets, and rabies is a significant public health concern. These unconfined "street dogs" are comprised of a mixture of unowned dogs and owned dogs that are free to roam. As in most parts of the world, traditional methods of managing street dogs and controlling rabies have not produced adequate results, and therefore the government of Haryana and the Animal Welfare Board of India have entered into an agreement with HSI to undertake a program of humane, sterilization-based DPM and rabies control as an alternative to previously-used methods. HSI has conducted many successful DPM programs in India in recent years, though previously at the city-level. The DPM management program that is envisioned for Haryana is unique in its broader, state-wide scale of implementation.

DPM is an integrated approach that employs an intensive, systematic, and sustained surgical sterilization effort to reduce dog population size within a target area over time, followed by a less intensive ongoing maintenance phase. Other critical components of DPM are vaccination for control of rabies and other diseases, improvement of veterinary care, and public outreach and education to improve the standards of responsible dog ownership and discourage practices that

Figure 1. Location of Haryana state (in red) in northern India.

contribute to the current street dog problem. When performed with sufficient intensity over time, humane DPM not only reduces the number of street dogs, but results in the control or elimination of dog-born rabies, a reduction in dog nuisance behaviors, improvements in public health and safety, and a better quality of life for dogs.

Figure 2. Districts in Haryana state.
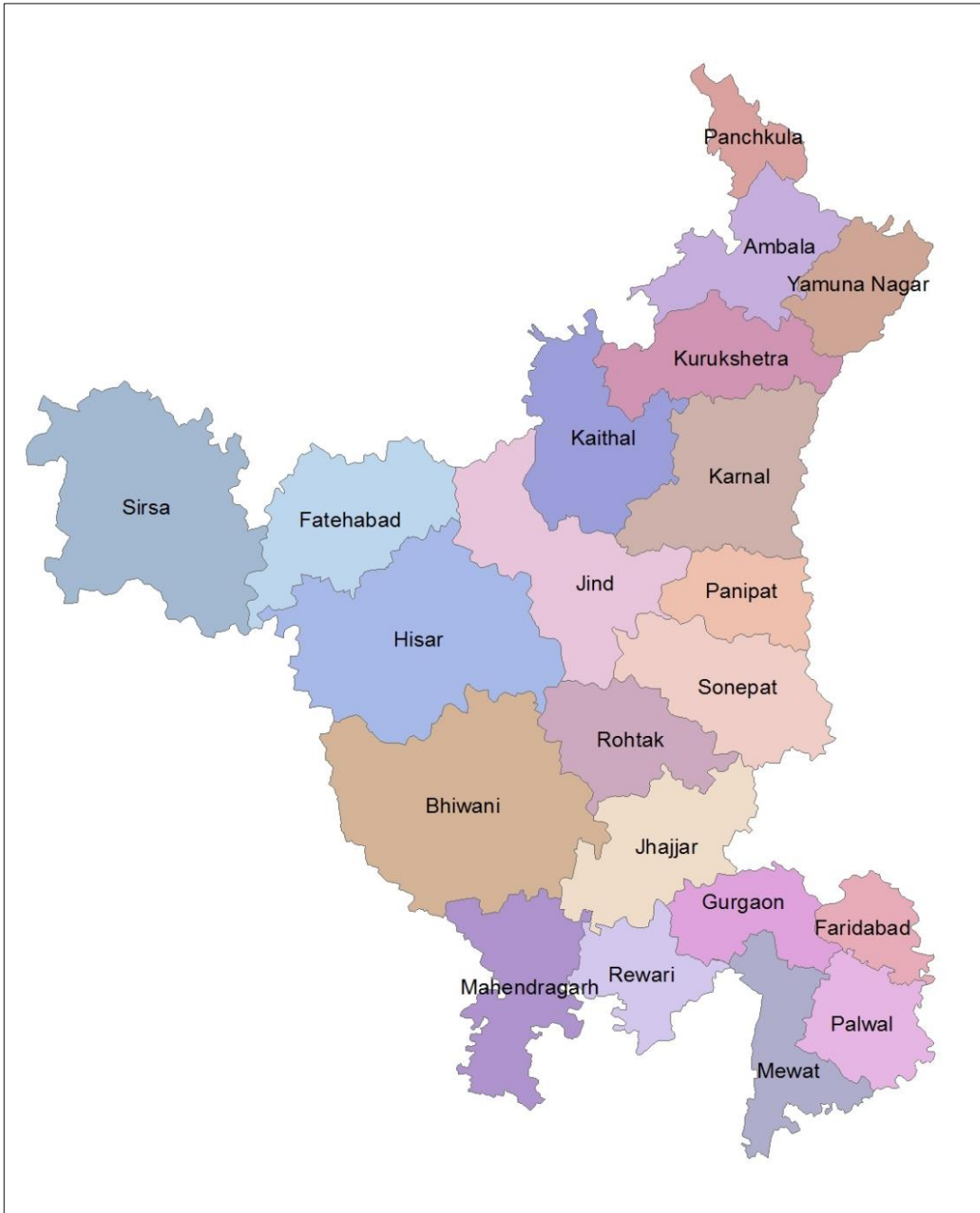
Baseline dog population surveys are a critical prerequisite for DPM management programs for several reasons. First, obtaining a reliable estimate of the number of street dogs in the project area facilitates effective strategic planning, and allows managers to better determine the resources and time that will be required to achieve specific management goals. Second,

determining the correlates of high dog density can suggest ways to more effectively target management efforts. Finally, the baseline survey establishes a reference point against which future changes can be evaluated, including the changes that are attributable to DPM. This type of "trend monitoring" requires periodic follow-up survey effort, but does not require the same level of intensive effort that characterizes the initial baseline survey.

Establishing the initial baseline for trend monitoring is relatively straightforward, requiring only that a representative set of survey routes or plots be established, and that they be operated periodically using a standardized protocol. This standardization minimizes sources of potential measurement variability, and allows trends to be determined from direct dog counts, without reference to underlying population size.

In contrast, generating population size estimates, particularly for a very large and diverse project area like Haryana, is a considerably more complicated undertaking that is subject to many sources of potential measurement and estimation error. Important considerations in this process are as follows:

1) It is not possible or necessary to survey all or most of the project area in order to generate a reliable population size estimate, but it is necessary to achieve representative statistical sampling. In principle, this could be accomplished by randomly selecting a sufficient number of survey plots, but in practice, random sampling can be inefficient when applied to diverse landscapes. A spatially random sampling approach in Haryana, for instance, would result in a preponderance of samples from areas with relatively low human (and dog) population density, and only a very small number of samples from the metropolitan areas that cover a minority of the surface area in the state. The solution to this problem is stratified-random sampling, which is described in more detail below.
2) A good population size estimate requires a sufficient sample size, which is determined based on the size of the overall survey area, the variability of data, and desired level of estimation accuracy.
3) In order to produce a reasonably accurate estimate for the project area, raw survey counts must be corrected to account for dogs that were present in the surveyed plots but not directly observed. This requires that we estimate the "detectability" associated with the primary survey method.
4) It is also necessary to correct for the proportion of the survey plots that are not effectively surveyed.
5) Corrected results from the surveyed plots must be appropriately extrapolated to unsurveyed portions of the project area. If performed incorrectly, the extrapolation can result in a badly biased overall population size estimate. Our approach to addressing these requirements is described in more detail in the next section.

Our survey program targeted "street dogs", which are defined as any unconfined outdoor dog, regardless of ownership status. Street dogs were quantified using two different kinds of "dog surveys", which are described in subsequent sections. To more fully characterize the owned dog population (including fully-confined dogs not present within the street dog population), we also conducted "household surveys" by interviewing residents in the survey areas about their attitudes and practices as they relate to dogs and animal issues. This household survey data is currently under analysis, and not covered in this report, which focuses on dog survey results. Household survey results will be presented in a comprehensive report in the near future.

SURVEY DESIGN

As mentioned previously, establishing a population size estimate for an area as large as Haryana that is comprised of a broad range of human settlement types (from very large cities to rural agricultural areas) is a significant undertaking. The idealized survey design process would involve the following steps:

1) Acquisition of multiple data sources in map format (Geographical Information System, or GIS) or tabular format describing key attributes of the project area.
2) Identification or creation of one or more a classification frameworks for the project area. These may be based on existing geopolitical boundaries (Districts, Sub-Districts, etc.), natural physical or environmental divisions (land-use types, climate, etc.), an artificial superimposed framework (typically a grid), or a combination of methods.
3) Attaching data obtained in step #1 to the individual elements of the classification framework(s). Such data might include human population size or density, type of settlement pattern (city/town/village/rural), mean income and education, predominant religion or ethnic group, or other similar factors.
4) Formalizing a stratification for the survey design using materials from steps # 1-3. Stratification involves identifying a small number of critical attributes likely to affect dog distribution, defining a simplified set of values for these attributes, and mapping all of the unique combinations of values of these simplified attributes that occur within the project area. For instance, a three-factor stratification might involve human density (high vs. low), land-use (urban, residential, commercial, agricultural), and human socio-economic status (above-average vs. below-average), creating a stratification with 16 unique values. Such a stratification could be further refined by recognizing different Districts within the survey area.
5) Selecting a statistically sufficient number of random samples (survey plots or routes) within each stratum to ensuring that a valid within-stratum estimate can be obtained.

As an example of this process, Figure 3 illustrates a survey stratification for the city of Lilongwe, Malawi, which was the subject of an HSI-conducted street dog survey program in September

2013. An artificial grid has been superimposed on a geopolitical framework (existing districts within the city) and a map of major land-use types. Grid squares were randomly selected for surveys within each stratum with sufficient replication to generate reliable results.

Because the MOU between the Animal Welfare Board of India and HSI that formalized the Harayana DPM project was executed in mid-May, 2014, time was not available to conduct an idealized survey stratification plan prior to the scheduled initiation of field work in early June, 2014. Therefore, we generated a simplified stratification for the June surveys based on District (21 values) and human population density. The inclusion of human population density as a stratifying factor is based on the accumulation of HSI data from many program areas indicating that dog population varies in relatively predictable ways with human population density (see Discussion). Human population data for Haryana was obtained from the LandScan (2013)™ High Resolution Global Population Data Set (copyrighted by UT-Battelle, LLC, operator of Oak Ridge National Laboratory under Contract No. DE-AC05-00OR22725 with the United States Department of Energy). As shown in Figure 4, the Landscan product uses a variety of input data to estimate human population size across a grid of small pixels (each ~ 0.00833 latitude / longitude degrees in extent on each axis, approximately equivalent to a 1 km^2 cell size; see http://web.ornl.gov/sci/landscan/). It is important to note that method of representing human population patterns operates at a different spatial scale than a typical census-derived classification. More specifically, Landscan classifies each pixel in isolation, without regard to human population patterns within the larger surrounding area. Therefore, a pixel that encompasses a small but densely settled village may have the same Landscan value as a pixel located in the middle of a large metropolitan area, as illustrated in Figure 5. A census-derived classification, in contrast, will by default report human population associated with an entire designated settlement, regardless of its spatial extent. Ideally, both of these approaches should be combined in a stratification and analysis to produce the most robust results.

Using a combination of power analysis, previous experience in survey design, and bootstrapped simulations, we determined that approximately 220 independent sample units would be required to generate a state-wide population size estimate with a $\pm$ 20% confidence interval. Sample units could consist of either standardized plots or delineated survey routes. For Haryana, we opted to use 1 km x 1 km plots as sampling units for the following reasons:

1) Survey plots correspond well with the grid-based Landscan product that is used for stratification.
2) Using plots simplifies subsequent GIS analysis, particularly if we eventually acquire data from the Indian census or other sources.

Figure 3. Example of a stratified sampling plan for Lilongwe, Malawi. Selected survey plots are shown in red. Shades of green indicate different land use or zoning areas, and numbered sections are municipal districts within the city.
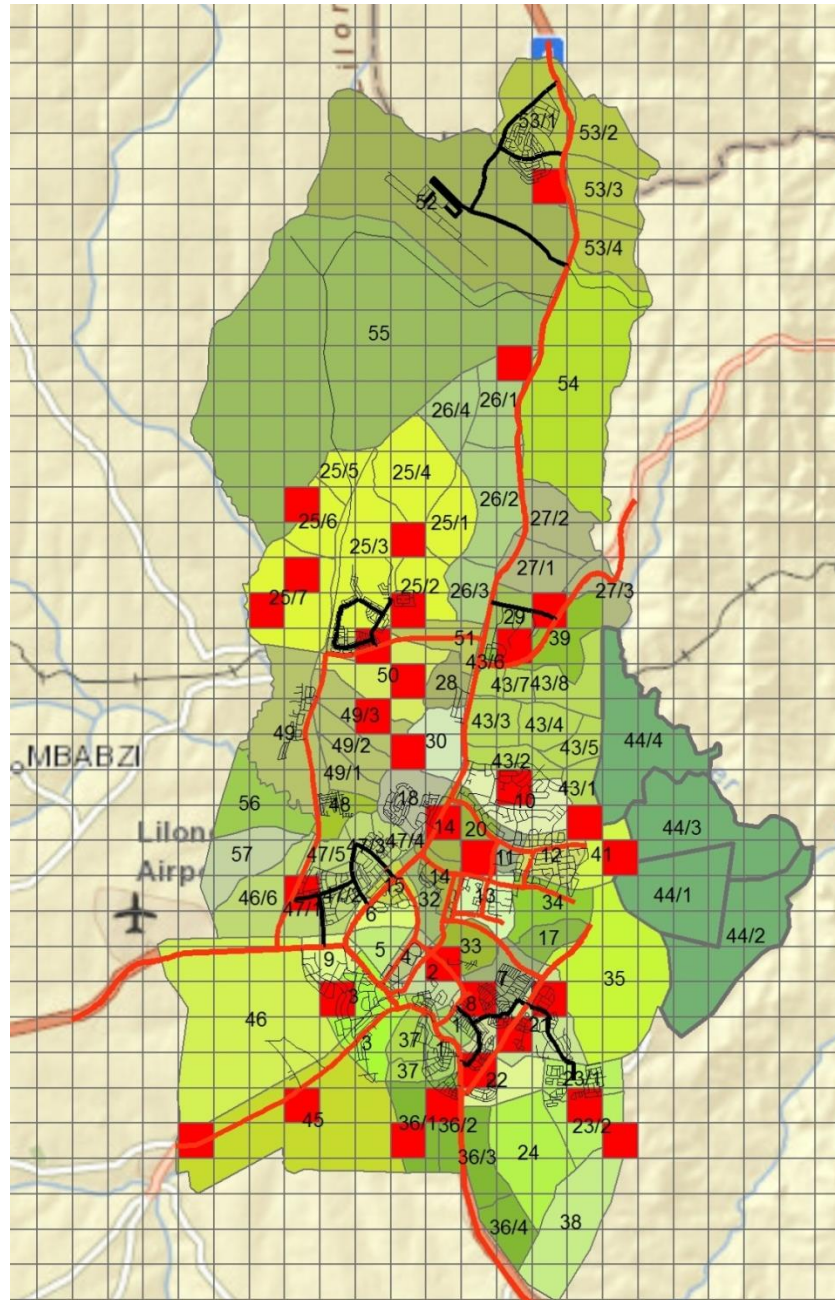
Figure 4. Landscan classification of Haryana state by human population density. Categories of density (number of people per grid cell) are shown in the legend.
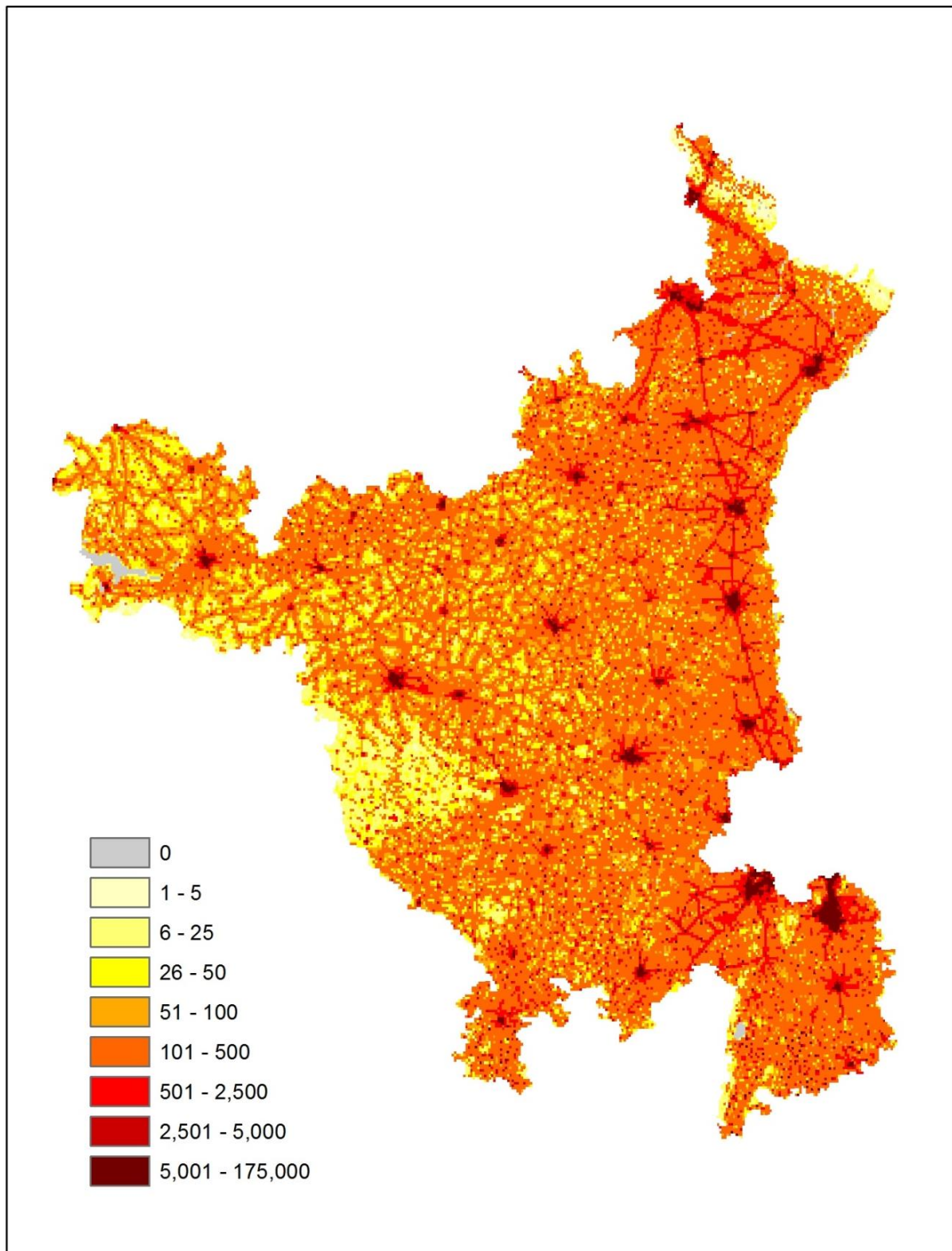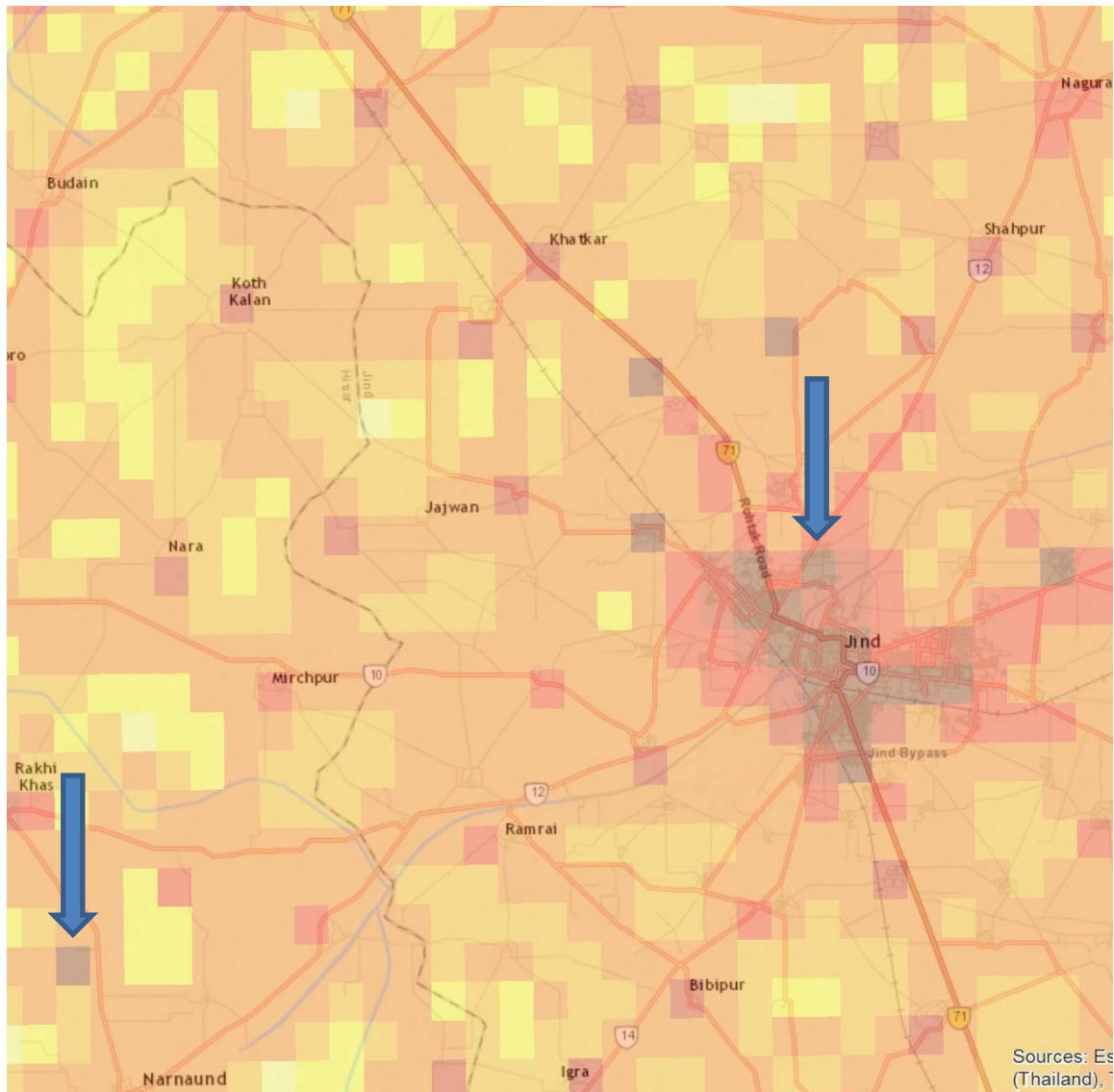
Figure 5. Detail of Landscan classification, showing how a grid cell in a small municipality can have the same value as a grid cell in a large municipality. Cells with comparable values but lying in different types of municipality are indicated by the blue arrows.

3) Comparison of available electronic road maps in Haryana (which are necessary for delineating survey routes) with satellite imagery indicated that mapped road coverage in many parts Haryana was incomplete, especially in smaller villages and towns. It is simpler to make relatively unbiased field adjustments for incomplete road mapping in a plot-based design than when using a delineated route-based design.

4) The need to generate a population size estimate. For trend monitoring alone, route-based survey designs offer many logistical advantages, and are often the better choice.

Population estimates, however, rely more heavily on map-based analysis, and this analysis can often be more easily accomplished when working with plots as a fundamental sampling unit.

To create plots, a 1 km x 1 km grid was overlaid on all of Haryana, comprised of 45,440 individually numbered plots (see Figure 6 for detail of the grid pattern). For the initial survey period in June, 150 survey plots were chosen from this grid, as shown in Figure 7. This was the maximum number of plots that could realistically be completed by the available crew within the available time frame (prior to monsoon) for the June surveys, but was less than the minimum number of 250 plots required for achieving the described level of estimation accuracy, as previously described. The plots were chosen randomly within the strata defined by District and by the upper range of Landscan population values (> 2,000 people / square km, simplified into three categorical ranges). The lower range of Landscan values (< 2,000 people / square km) was not well represented in this initial sample by intent, for several reasons:

1) The upper-range of Landscan values was emphasized for the June survey effort because it is likely that DPM program activities in the initial stages will focus in these higher-density areas.
2) Lower-density areas exhibit a wide variety of land uses, and collectively they comprise a large majority of the total land-area of Haryana (96.7%) and approximately half (49%) of the total population of Haryana. We determined that sampling these areas based only on Landscan data would result in poor statistical resolution and provide an inadequate basis for information extrapolation of survey results.
3) Because the alignment system of the Landscan data grid does not correspond exactly to the alignment of the 1 x 1 km survey plots (which are based on Universal Transverse Mercator coordinates), misrepresentation of true human population values can occur at the lower range of human population density. This renders the basis for extrapolation of dog / human ratios suspect. The solution to this problem is to utilize other census-based data sets for stratifying and analyzing low-density areas, which will require more preparation time and additional data acquisition.

For the second survey period in early October, we focused on sampling in small to medium sized villages (< 5,000 human inhabitants), using data from the India Census and area-based GIS delineations to supplement Landscan data as a basis for stratification. This effort focused in the Rohtak and Sonepat Districts in order to make most efficient use of available personnel and a limited time span. This survey effort encompassed 59 distinct survey plots, resulting in a total of 209 sampling units, less than but relatively close to the 220 units calculated as being necessary to achieved desired estimation accuracy.

Figure 6. Detail of the numbered sampling grid covering Haryana.
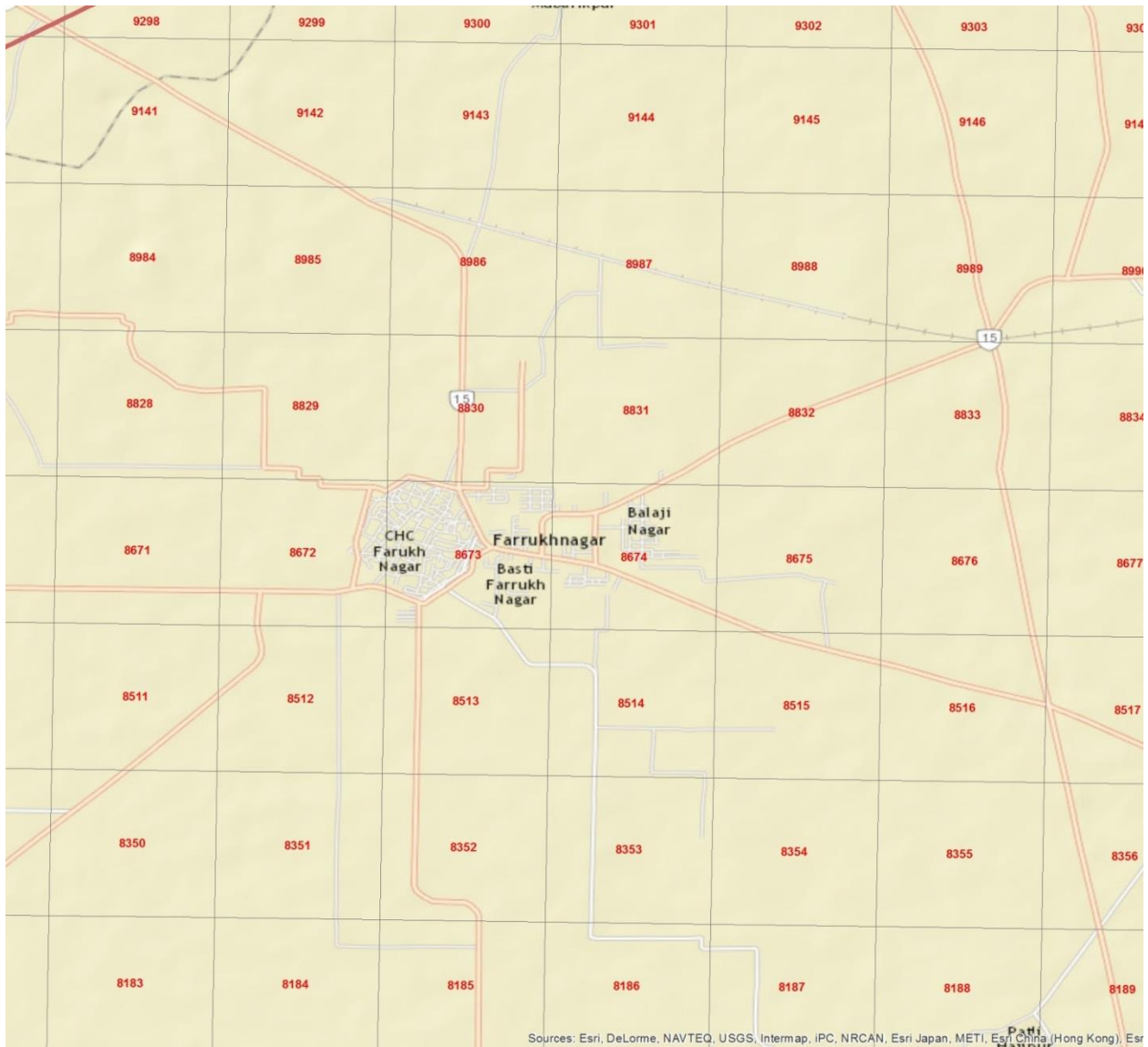
SURVEY METHODS

Animal monitoring and census programs often make a distinction between "rapid" survey methods and "intensive" survey methods. Rapid surveys use a simple counting protocol, and can be conducted more quickly than intensive surveys. Therefore, they are more appropriate for general use when the survey design calls for widespread surveys to occur in many areas. For most animals (including street dogs), rapid surveys detect only a subset of the individuals that are actually present in the designated survey area, with an unknown proportion remaining uncounted. This deficiency is irrelevant for the purposes of trend monitoring, and a standardized

rapid survey method is entirely adequate and appropriate for conducting trend monitoring over time, if replicated at a sufficient number of locations.

Figure 7. Locations of 150 selected survey plots in Haryana for the June 2014 survey period. The 59 plots surveyed in early October 2014 are not plotted on this map.
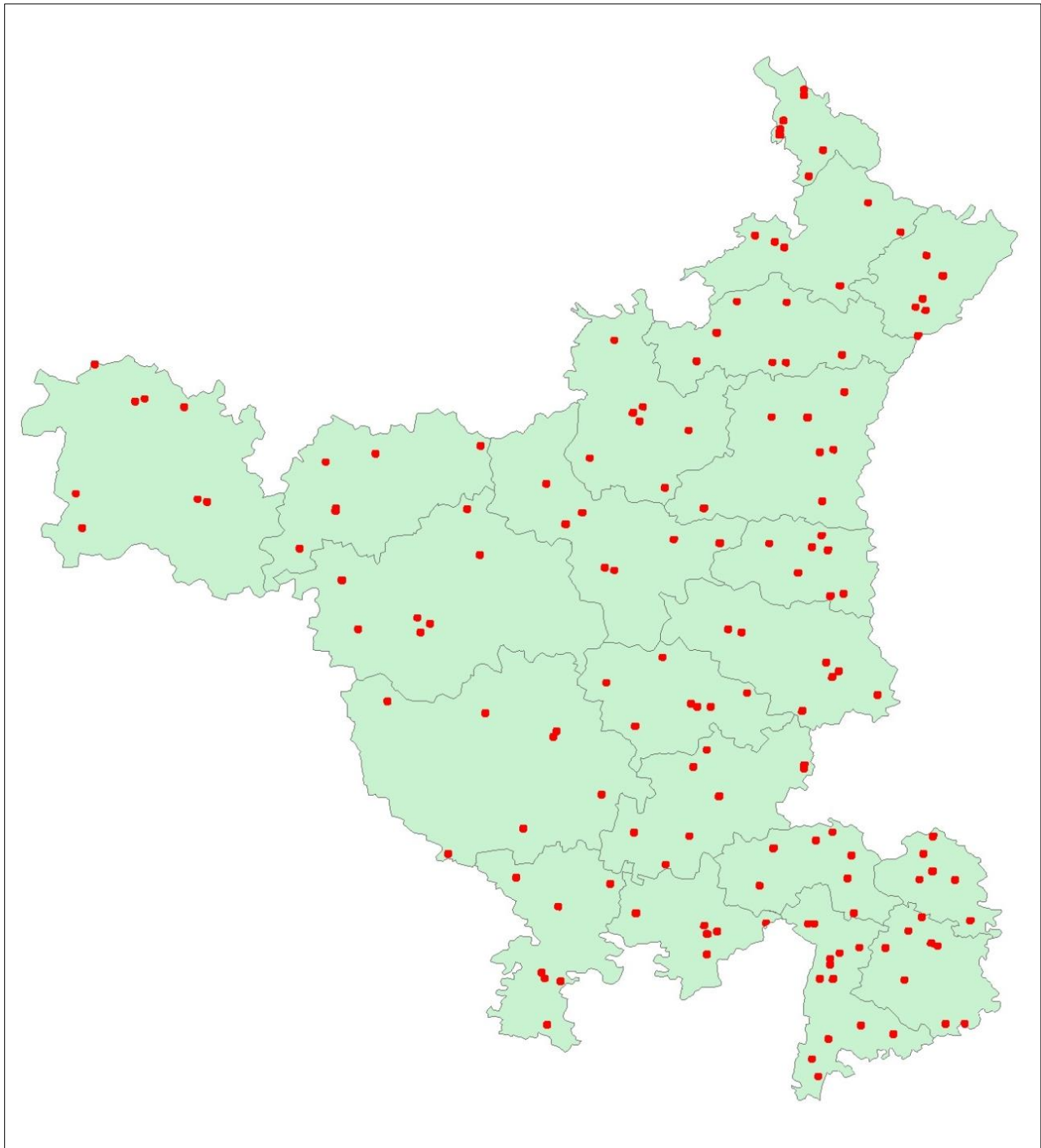
Intensive surveys, in contrast, use more complex protocols to estimate the true number of animals present within the designated survey area. While not necessary for trend monitoring, intensive surveys are a critical element of generating population size estimates. Because of the effort they require, however, it is typically not feasible to employ intensive survey methods on all of survey locations within a large project area. Instead, they usually implemented on a subset of the sites that also receive rapid surveys. The rapid survey count can then be compared to the intensive survey population estimate for that same site to generate a "detectability ratio". When averaged over a number of different sites that are "double-sampled" in this way, the resulting detectability ratio can be applied to the larger set of rapid survey data, generating an array of location-specific population size estimates for each sampled location.

We combined a rapid dog survey method and an intensive dog survey method in Haryana as described above. The rapid survey method was similar to the protocol described in WSPA 2007 (http://www.icam-coalition.org/downloads/Surveying%20roaming%20dog%20populations%20-%20guidelines%20on%20methodology.pdf), and has become relatively standardized by HSI in many dog survey projects in many countries. In brief, surveyors were provided with assigned plot boundaries that were viewable in a Google Maps smart phone application. This enabled the surveyors to remain within the bounds of the survey plot and to generate an electronic track of the surveyed route. Surveyors travelled as many roads within the plots at a slow pace as possible within a three-hour period beginning at or soon after dawn, and tallied observed dogs on the data sheet as they progressed. Survey work could not occur after this allowable three hour period, in order to ensure that increasing heat as the day progressed did not create a systematic bias. If backtracking on any road segments was necessary, the surveyors ceased counting on the return trip down that segment and resumed counting when reaching a new road segment. In addition to tallying dogs, several basic attributes were recorded for each observed dog whenever they could be determined, including sex, age, health status, and reproductive status, and whether the dog was free to roam or confined.

In the time available to design and implement the preliminary June survey program, the only intensive survey method that was feasible to employ was the sight-resight (SR) method. This two-day protocol has been used in multiple program areas in India and elsewhere by HSI. On the first day, a pair of surveyors travels through the assigned plot on a motorbike, with one team member driving and the other operating spray unit loaded with a temporary dye solution. This team sprays the dye on the flanks of as many street dogs as possible, leaving a highly visible but temporary mark (see Figure 8). On the second day, the team travels through the survey plot in a manner that is analogous to a rapid survey, with the exception that they note whether each

Figure 8. Dog being temporarily marked during the performance of a SR dog survey.

observed dog is marked with the dye or unmarked. By entering the number of marked (M) and unmarked (U) dogs observed on the second day along with the total number of dogs marked on the first day (TM) into the mathematical formula (TMM+U))/M = T, a population size estimate (T) for the survey plot can be derived.

It should be noted the accuracy of SR population estimates, and estimates from the wider family of mark-recapture survey methods, depend fundamentally on the degree to which the assumptions of the method are met. These assumptions include equal probability of detection of any individual dog, and lack of bias in day 2 detections with regard to marking status. For many animals, these assumptions are violated to varying degrees, resulting in a systematic estimation error. To date, the degree and directionality of this bias has not been determined for dog surveys. For this reason, our full survey design included an alternative intensive survey method to act as independent check on detectability estimates based on SR surveys. This protocol involved one surveyor walking multiple replicates of the same survey route within the standard three-hour morning survey period. During the first circuit, 6 – 8 dogs with highly distinctive markings or

features are noted and plotted on a map. During subsequent circuits, the surveyor records whether or not these specific dogs were observed. As this process is repeated over multiple survey routes, an average resighting frequency can be calculated, serving as in independent estimate of survey detectability.

Of the 209 selected plots, 184 were assigned to receive only rapid dog surveys. SR surveys were conducted on 25 plots.

DATA ANALYSIS

The process of deriving a population size estimate from raw dog survey data has been largely described above, but is consolidated here into a series of steps, which are as follows:

1) <u>Correcting for survey coverage</u>: In most plots, survey teams could not cover every road segment within the plot within the allowable time frame. In these cases, the direct counts they obtained were extrapolated to the unsurveyed roads in the plot. This process required standardizing the dog counts for each plot by road distance (i.e. dogs / km) and road type (primary vs. secondary). This process was conducted using manual measurement over Google Maps (www.googlemaps.com) basemaps or Google Earth satellite imagery (when Google Maps road coverage was incomplete).

2) <u>Determining detectability</u>. SR survey data were used to determine the average detectability associated with the standard rapid dog survey. This process consisted of comparing rapid survey results to SR results in comparable areas, and comparing the SR population size estimate with the day 2 SR total count for given plots. These plot-specific detectabilities were then averaged to generate an overall detectability estimate.

3) <u>Correcting for detectability</u>. After being corrected for survey coverage, rapid survey results were further corrected by dividing by the average detectability estimate. This produced our best estimate of the street dog population size for each surveyed plot.

4) <u>Extrapolation</u>. By design, plot-level street dog population estimates should be averaged within each stratum and then projected to unsurveyed areas within that same stratum. Alternately, mathematical relationships can be developed between street dog estimates and some predictive factor within a given stratum, and the relationship then used as the basis for projection into unsurveyed plots within that stratum. In the case of our preliminary survey program, replication with each District ($n \leq 7$ for most Districts) was too low for District distinctions to be statistically meaningful. Therefore, for the current analysis District distinctions were ignored, and we developed a categorical mathematical relationship between human population density and the plot-level street dog estimates as the basis for an extrapolation to unsurveyed plots.

5) <u>Overall estimate</u>. Street dog population estimates at the plot level were summed to create an overall population size estimate for all of Haryana

RESULTS

Surveys were performed by multiple teams from 12 June – 22 June, 2014, and from 30 September – 7 October, 2014. Of the originally-assigned 209 plots, seven could not be surveyed for logistical reasons or because access to the area could not be obtained, resulting in a final sample size of 202. The survey teams directly counted 20,344 dogs during the survey effort. These surveyed plots form the basis for a standardized monitoring network for assessing trends in dog population over time. In order for this trend monitoring to be effective, the original protocol should be followed exactly on subsequent visits, and the exact survey routes that were followed initially should be repeated. These routes are available in different map formats that can be referred to by future field crews.

Based on a comparison of SR survey results and rapid survey results, combined with the alternative intensive protocol performed in October, we calculated an average detectability of 55% for the rapid dog surveys. Using this detectability estimate, we calculated the relationship between human population density and street dog density, as shown in Table 1.

Table 1. Dog density per person as a function of human population density, as determined by a combination of Landscan data and India Census data.

Human Population / km^2	Average # Dogs / 100 Persons
> 15,000	1.88
10,001 – 15,000	2.81
5,001 – 10,000	5.01
≤ 5,000	8.87

It has been noted in previous HSI work that the relationship between dog and human population density tends to vary predictably along a spectrum of human population density. More densely settled areas tend to have fewer dogs / 100 people than less-densely settled areas, even if the absolute density of dogs is higher in the more densely settled areas. This relationship also occurs in Haryana as illustrated in Figure 9.

Through the process described previously, these survey findings allowed for the calculation of a population size estimate for street dogs. The street dog population size estimate for all of Haryana is 1.8 million, or about 7 dogs per 100 people on average across this very broad range of human population densities. This estimate does not include owned and confined dogs.

Figure 9. Variation of dogs / 100 people as a function of human population density in Haryana.
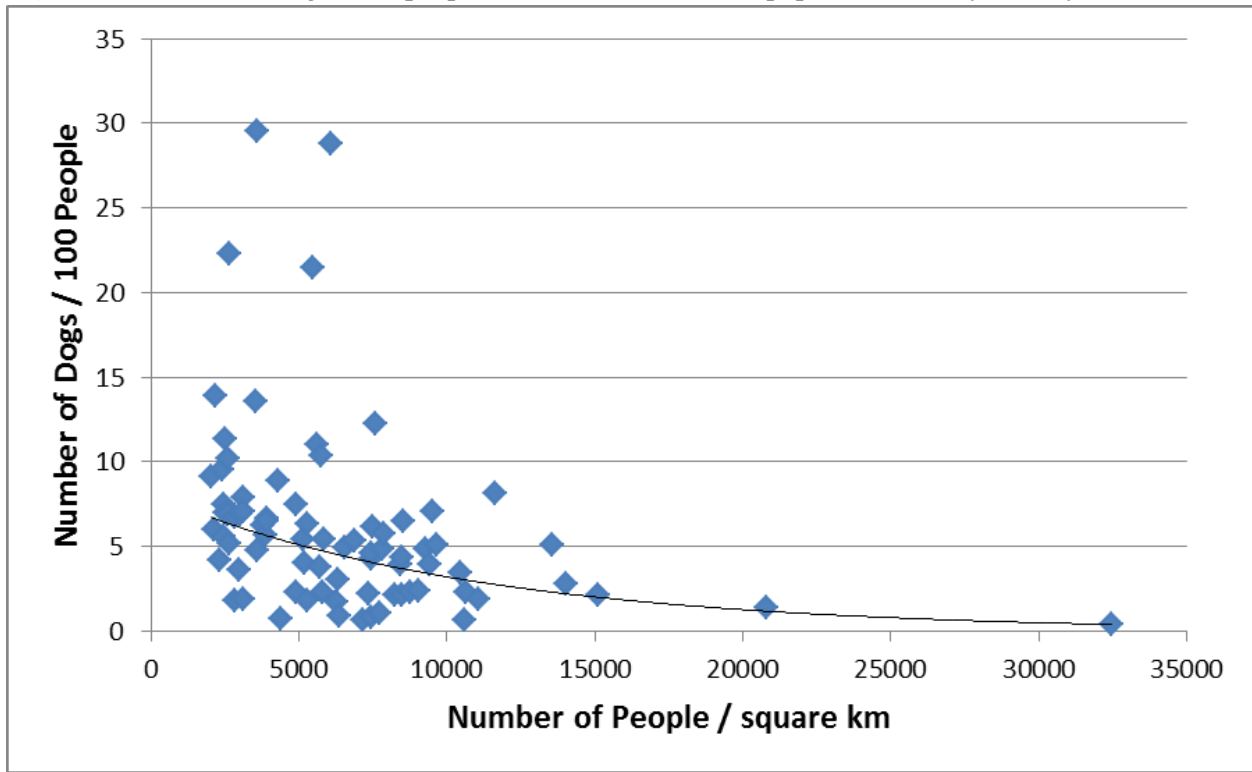
Estimates of the street dog population in each of Haryana's four Divisions and 21 Districts is shown in Tables 2 and 3. These estimates were derived by applying the dog / human ratios shown in Table 1 to the distribution of human density in each Division and District as determined by Landscan data.

Table 2. Street dog population estimates for each of Haryana's four Divisions

DIVISION	
Ambala	380,179
Gurgaon	547,221
Hisar	515,361
Rohtak	435,442
TOTAL	1,878,203

Table 3. Street dog population estimates for each of Haryana's 21 Districts

DISTRICT	
Ambala	104,594
Bhiwani	128,927
Faridabad	145,493
Fatehabad	85,820
Gurgaon	124,956
Hisar	113,929
Jhajjar	63,478
Jind	88,811
Kaithal	85,687
Karnal	123,165
Kurukshetra	72,904
Mahendragarh	78,864
Mewat	68,698
Palwal	71,069
Panchkula	39,711
Panipat	74,024
Rewari	58,141
Rohtak	73,233
Sirsa	97,873
Sonipat	101,543
Yamuna Nagar	77,283
TOTAL	1,878,203

Several other attributes of the Haryana street dog population could be quantified from dog survey data as shown in Table 4.

Table 4. Attributes of dogs counted during the course of survey work.

Sex Ratio:	54.3 % Male	45.7 % Female
Age:	88.4 % Adult (> 6 mo.)	11.6 % Puppy (< 6 mo.)
Percent of Females Lactating or Pregnant	4.8 % Visibly Pregnant	8.7 % Currently or Recently Lactating
Percent Visibly Sick or Wounded:	1.3 % of All Dogs	
Percent Visibly Undernourished:	1.4 % of All Dogs	
Percent with Visible Mange:	1.2 % of All Dogs	

The male sex bias is typically observed among street. The age structure of the population, along with the frequency of females currently pregnant or lactating, suggests essentially unchecked reproductive activity and a low level of current sterilization among street dogs in Haryana. Street dogs observed during surveyed tend to be relatively healthy, with low percentages of visible illness, wounding, mange, and malnourishment.

DISCUSSION

To our knowledge, this is the first attempt to systematically survey a street dog population over such a large and heavily populated geographical area within the framework of a single project. Other characterizations of street dogs over large areas typically rely upon conjectural extrapolations derived from much smaller survey areas.

Information derived from the dog survey indicates that the street dog population is breeding at a relatively high rate, which in turn indicates the need for aggressive DPM. Current sterilization rates are likely to be quite low (< 15%) based on these findings. As a simplified rule of thumb, sterilization rates of females need to reach sustained levels of at least 65% in order to potentially achieve significant population size reduction. Additionally, the World Health Organization suggests that regardless of street dog population size, a dog rabies immunization rate of ~ 70% must be achieved at annual (or more frequent) intervals in order to reduce rates of rabies transmission and incidence. We emphasize that the goals of DPM and rabies management are synergistic in many ways. For instance, unmanaged dog populations experience fairly rapid turnover, which makes maintaining a 70% vaccination rate a far more difficult undertaking that it would be for managed dog population, where lifespans are longer and turnover lower.

We remind the reader that ancillary analyses derived from this survey program will be available in a comprehensive report update by December, 2014. These include findings from the household survey effort, which will add significant perspective to the dog survey data discussed in this report. More specifically, household survey data will provide insight into current human attitudes and practices that influence the current street dog situation and suggest how educational and outreach approaches may be most productively targeted. It will also provide a mechanism for estimating the size of the owned dog population, particularly dogs that are confined to homes or properties that are not counted during dog surveys, and thereby provide a more complete picture of the strategic situation that must be addressed in order to achieve rabies control and humane DPM.

RECOMMENDATIONS

The recommendations listed below will aid in the pursuit of an effective DPM program.

1) Ensure that a formal dog monitoring plan, consisting of standardized rapid dog surveys in established survey plots, is incorporated into the DPM plan. The monitoring plan should provide not only for conducting the surveys, but for periodic data analysis that can be utilized to modify and adjust DPM activities on an ongoing basis to better ensure timely progress towards program goals.

2) If possible, implement a standardized method of marking dogs that are sterilized under the DPM program. If sterilized dogs are clearly marked, population-level sterilization rates can be more easily monitored and evaluated. Additionally, population size estimates can be continually refined if marking of sterilized dogs is systematically performed, using a type of mark-recapture analysis.

3) Use the estimate presented in this report to calculate reasonable timelines for the achievement of specific population-level goals, given the amount of effort that can be mobilized for the DPM program.