World Organisation for Animal Health

An overview of the dog population estimation methods with focus on Free-roaming dogs in Asian Context

Karma Rinzin
Regional Animal Health Coordinator
WOAH SRRSEA

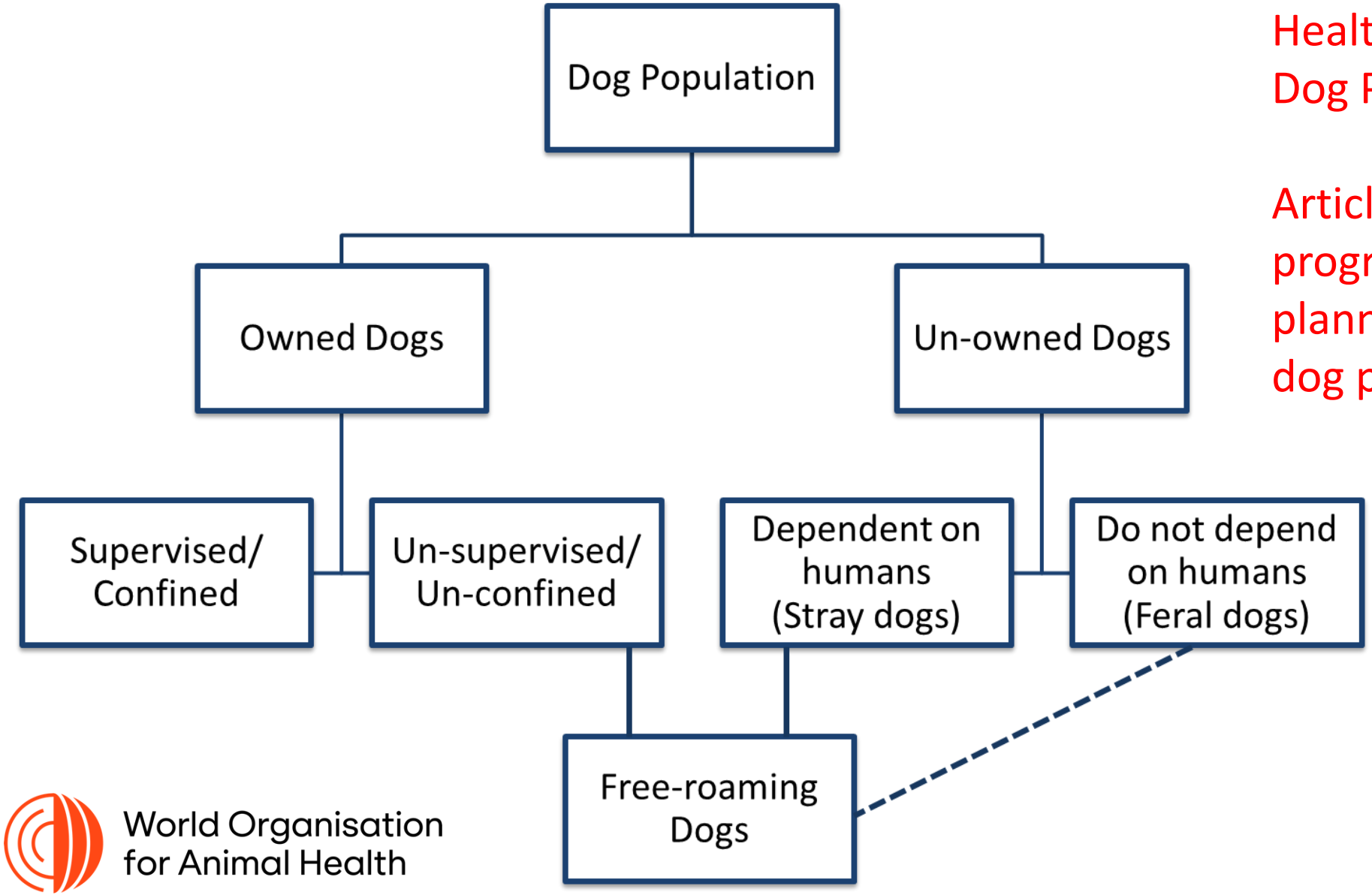
ASEAN Rabies Meeting for development of ARES Implementation Plan
24 – 26 February 2025, Pattaya, Thailand

Outline

- Background
- Why estimate dog population?
- Common dog population estimation methods
- Mark-Resight survey to estimate detection Probability or Detectability Rate
- Case study to estimate dog population
  - In small town
  - In large city
- Conclusion

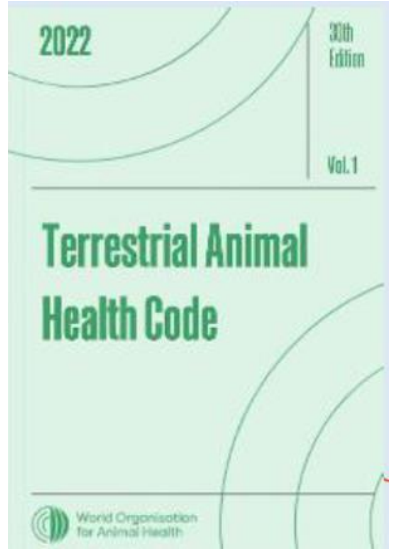
World Organisation for Animal Health

Classification of dog population



WOAH Terrestrial Animal Health Code Chapter 7.7 – Dog Population Management

Article 7.7.11. – DPM programme assessment and planning – brief section on dog population estimation



World Organisation for Animal Health

Why to estimate dog population size?

- To plan an intervention (Eg: DPM, MDV)
  - How much resources is required?
    - Manpower, vehicles, vaccines, medicines, consumables
  - Where to focus?
    - Places with higher dog density; and areas with higher proportion of un-neutered dogs
    - Prioritize areas: Cities, Districts, sub-Districts, towns, zones etc
  - When to implement/ how much time required?
    - Months, duration?
- To monitor and evaluate an intervention
  - An initial estimate of the population serves as the base line for future comparisons as the programme progresses
  - Coverage (%) - vaccination and sterilization coverage
  - Quantify population in terms of dog human ratio; dogs per square km; ratio of un-owned to owned dogs etc

Common method used for estimating dog population size

Owned dogs

- Household survey - Extrapolating number of dogs per dog owning household to total number of HH with dogs
  - Survey – door to door survey, random phone survey, vaccination campaign
  - Mean number of dogs multiplied by total dog owning household
- Mark-resight method using Lincoln Petersen formula (Post-vaccination survey)

$$N = \frac{n_1 n_2}{m}$$

Free-roaming dogs

- Population estimate by total or direct counts
  - Count in blocks
  - Count in street length
- Mark-resight surveys
  - Photographic recapture (Beck's method)
  - By application of temporary marks (collars, vegetable paints)
  - By application of permanent marks (ear notch, tatoos)

World Organisation for Animal Health

asean

Principles behind estimating dog population size

Population estimate by direct counts

- All dogs may not be sighted during the counts
- Some proportions of dogs will be missed during the field counts
- Corrective factors should be incorporated into the resultant estimates
- Detection probability/ Detectability Rate should be estimated through mark-resight survey
- Impractical to count all the dogs in a large city
- Estimate by counting all the dogs in a random sample of blocks/ street length and extrapolating this count to the whole city

Population estimate by mark-resight method

- There is no mortality, emigration and recruitment into the population between the mark and recapture times
- Marks should not wash off or wear off
- All individuals within the population have an equal chance of being counted

World Organisation for Animal Health

asean

Mark Resight survey methods

$$N = \frac{n_1 n_2}{m}$$

Lincoln-Petersen Formula

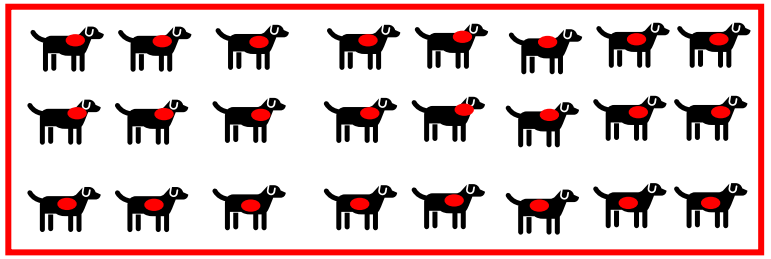
n_1 = Number of dogs marked, and released back into the population (Day 1)

n_2 = Number of dogs that are sighted on the following day (Day 2)

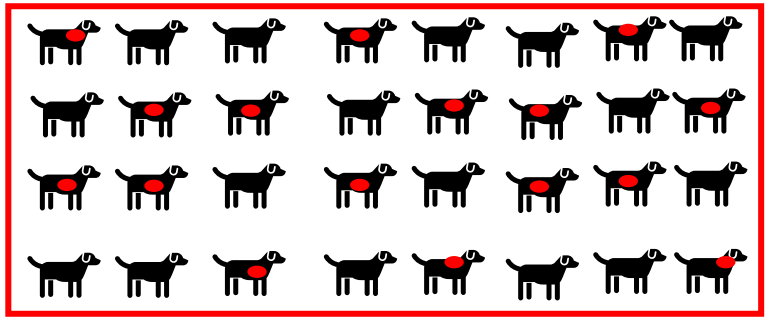
m = Number of dogs that are marked on Day 1 are resighted on Day 2

N = Total population size

Day 1 $n_1 = 24$



Day 2 $n_2 = 32$



Mark Resight survey – Estimating the detection Probability

$$N = \frac{n_1 n_2}{m}$$

$$N = \frac{24\ x\ 32}{16} = 48$$

Total population size (N) = 48

Detection Probability

Detection probability *(p) is* the likelihood the dog would roam and sighted on any given day

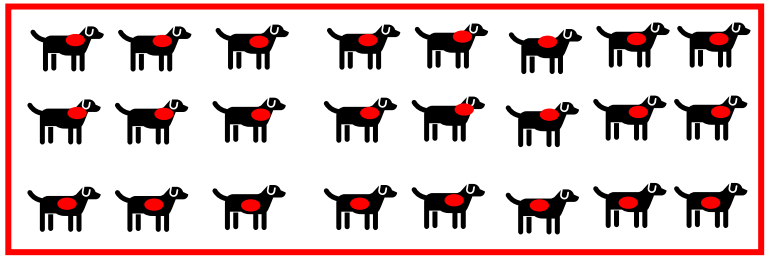
p = likelihood the dog will be sighted on Day 1 out of the total dog population

$p = n_1 / N = 24/48 = 0.5$

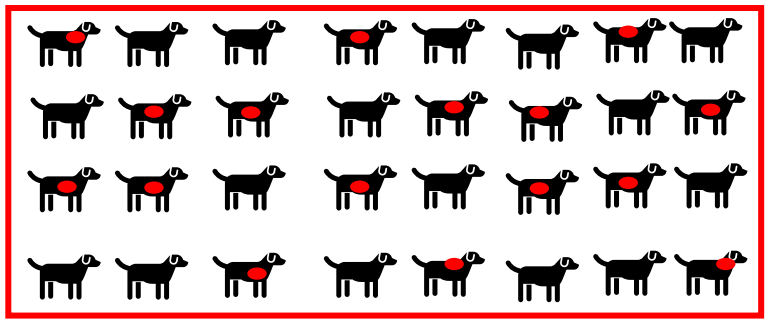
p = likelihood the dogs marked on day 1 will be sighted on Day 2

$p = m / n_2 = 16/32 = 0.50$

Day 1 $n_1 = 24$



Day 2 $n_2 = 32$



$m = 16$

World Organisation for Animal Health

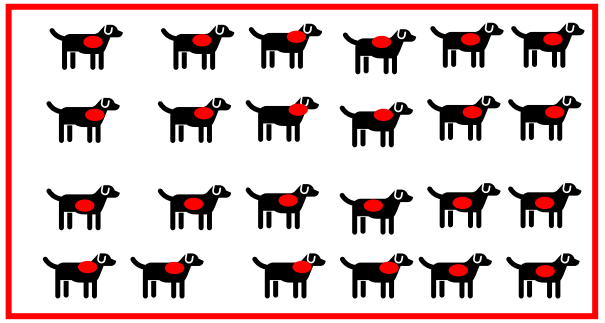
Applying Detection Probability to correct missing proportion

$N = C/p$ where C is dogs counted or sighted on any given time

Estimated detection probability is 0.5

This indicates that the 50% of the dogs will be missed during the count, *C*

Therefore the population estimate should be corrected for the detection probability of 0.5



For example on Day 1 we sighted 24 dogs, we know that the detection probability is 0.5

Therefore dog population size is

$N = C/p = 24/0.5 = 48$

$N = C/p = 24/0.4 = 60$

$N = C/p = 24/0.8 = 30$

$C = 24 \quad p = 0.5$

$C = 24 \quad p = 0.4$

$C = 24 \quad p = 0.8$

World Organisation for Animal Health

asean

Different methods for estimating free-roaming dog population

Mark-resight survey
Lincoln Petersen Index

$$N = \frac{n_1 n_2}{m}$$

n_1 = Marked dogs
n_2 = number sighted during second count
m = number resighted

Mark-resight survey
Proportion of permanently marked dogs

$$N = \frac{n_s}{p}$$

n_s = No. of surviving ear notched dogs
p = proportion of ear notched dogs

Rapid survey and detection probability

$$N = \frac{C}{p}$$

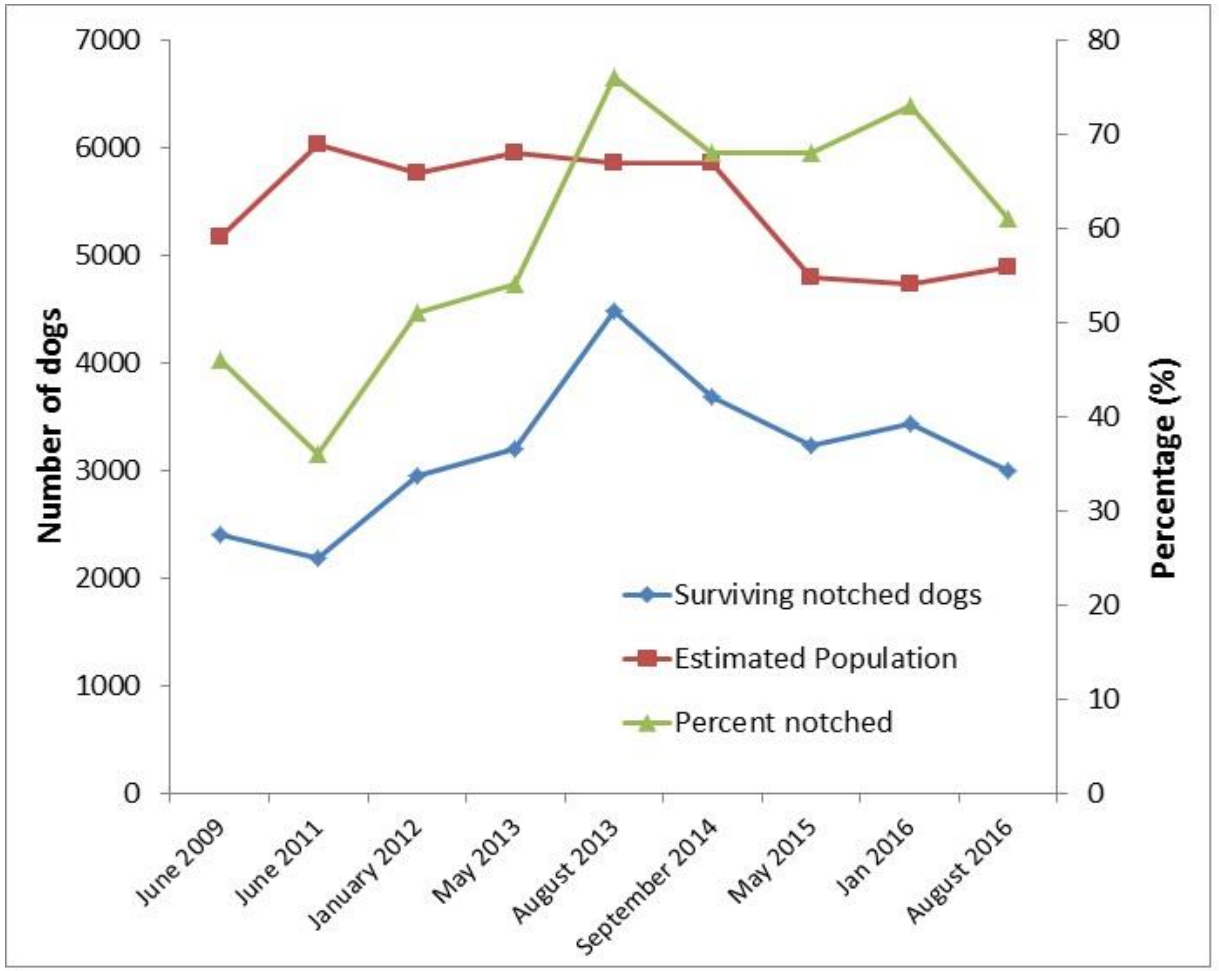
C = No. of dogs sighted - rapid survey
p = detection probability from MR survey

World Organisation for Animal Health

asean

Population estimate based on number of permanently marked dogs

Estimated number of surviving ear-notched dogs, the total free-roaming dog population and the percentage of ear-notched dogs out of all total sighted dogs in Thimphu (June 2009 – September 2014)

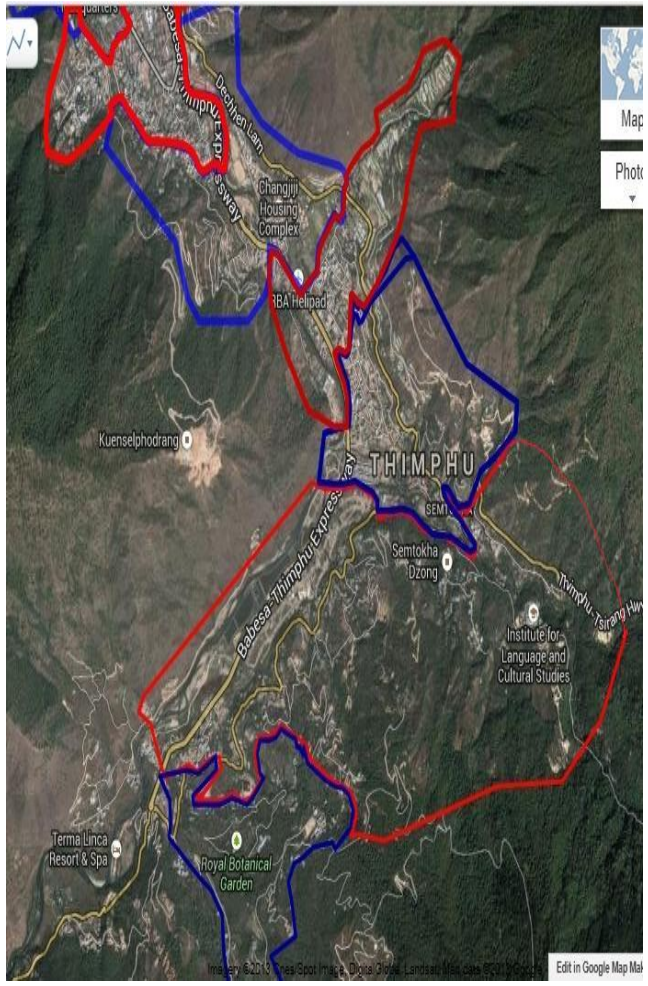


$$N = \frac{n_s}{p}$$

Population estimate is determined by surviving ear notch dogs. Any outbreak of infectious diseases (CD) may affect the number of surviving ear notched dogs. Any biased intervention on the dog population will influence estimate of "p", in this case proportion of ear notch dogs

World Organisation for Animal Health

Population estimate using Mark Resight Survey and Rapid Counts



- Thimphu city divided into 15 wards (7 blue & 8 red wards)
- MR survey undertaken in blue wards
- Estimated pop size in BLUE ward (MR)

  $= n_1 \times n_2 / m = (658 \times 558)/323 =$ **1137**
- Detection probability *(p)* in blue ward

  $= n_1/N = 658/1137 =$ **0.58**
- Dogs counted *(C)* in RED ward = 1635
- Estimated pop size in red wards

  $= C/p = 1635/0.58 =$ **2819**
- Total population size in Thimphu is

1137 + 2819 = **3956**

$$N = \frac{C}{p}$$

World Organisation for Animal Health

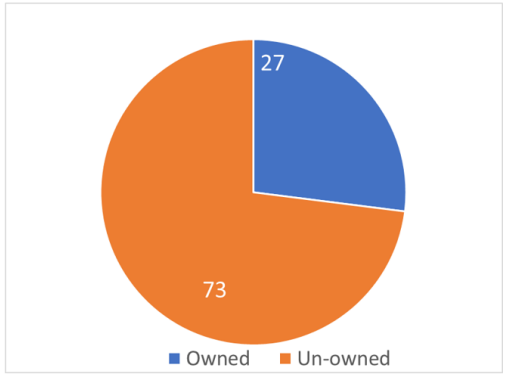
asean

Estimate of owned dog population size in Thimphu City in 2020

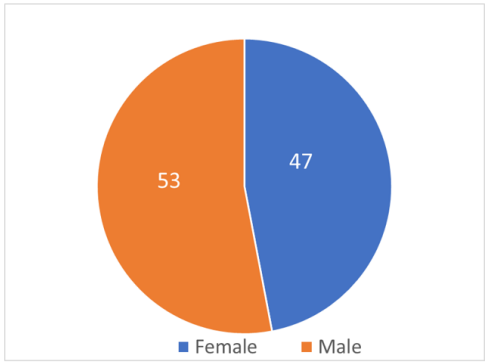
- Household in Thimphu = 25408
- Household with dogs = 15.1% (2018 survey)
- Total dogs owning HH = 3837 (25408 x 0.151)
- Average number of dogs per dog owning HH
  = 1.37
- Total owned dogs = **5257 dogs** (3837 x 1.37)

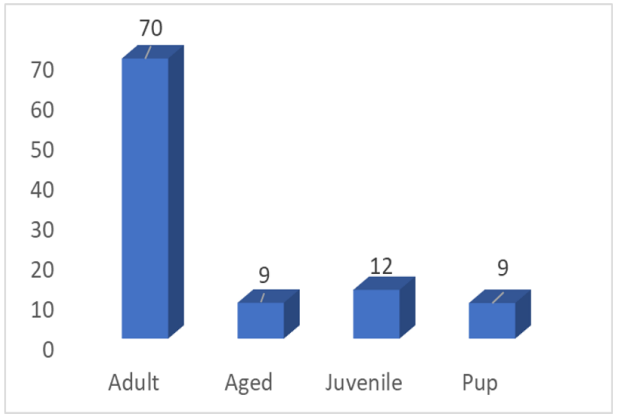
Owned dogs free-roaming – 24.3%

Roaming owned dogs = 5257 x 0.243
= **1277 dogs**



Owner status, sex and age structure of sighted dogs





World Organisation for Animal Health

Estimate free-roaming dog population size in Thimphu city in 2020

- Total roaming dogs sighted = 4507
- Detectability Rate = 72.7%
- Estimated un-owned dog population

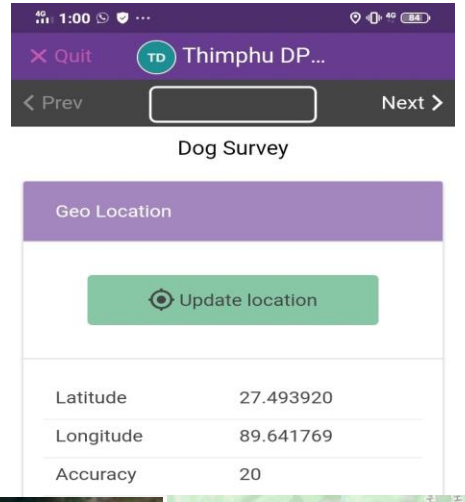
  = **6199 dogs** (4507/0.727)
- Total dogs = 6199 + 5257 = **11,456 dogs**
- Dog per household = 0.451 (11456/25408)
- Dog per person = 0.1 (11456/114551)

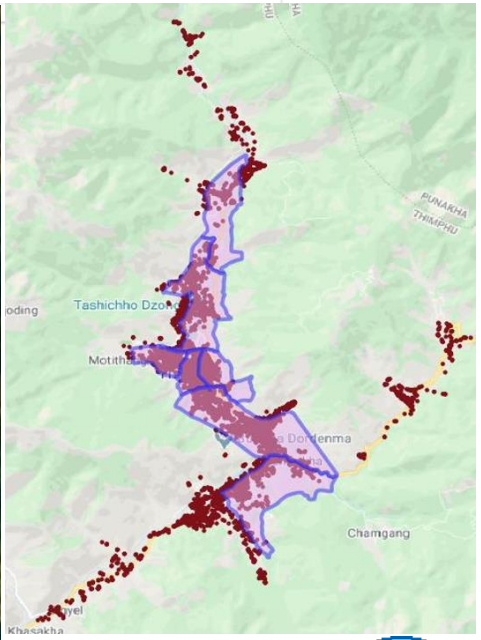
$$N = \frac{C}{p}$$

Detection Probability

$$N = \frac{m}{n_2}$$

Dogs photographed on Day 1 (n_1) and Day 2 (n_2); and; dogs photographed on Day 1 and resighted on Day 2 (m)





World Organisation for Animal Health

asean

World Organisation for Animal Health
Founded as OIE

Estimates of Roaming Dog Population in Kathmandu, Nepal

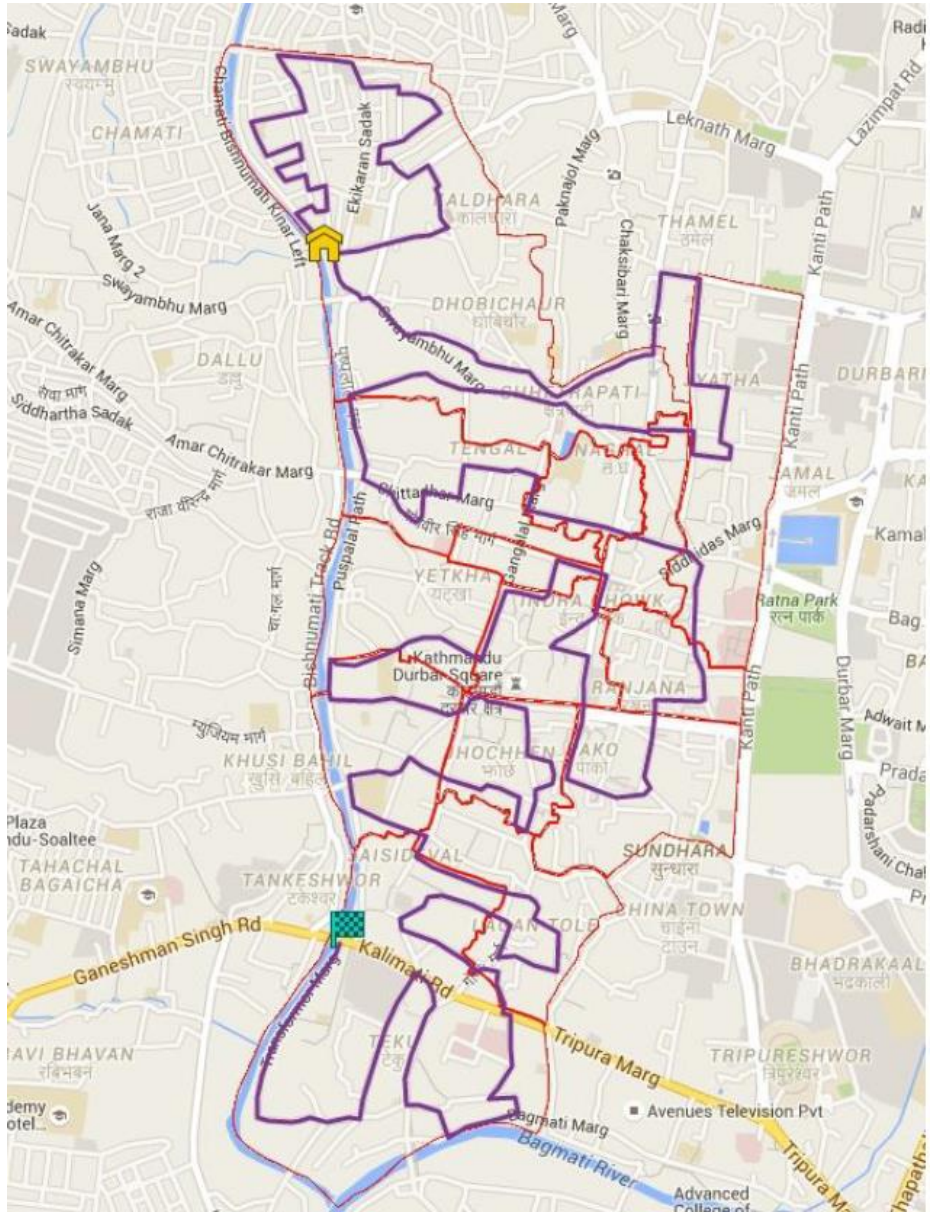
Survey Lead: Amit Kumar Chaudhari, HSI

HUMANE SOCIETY INTERNATIONAL

March 2016

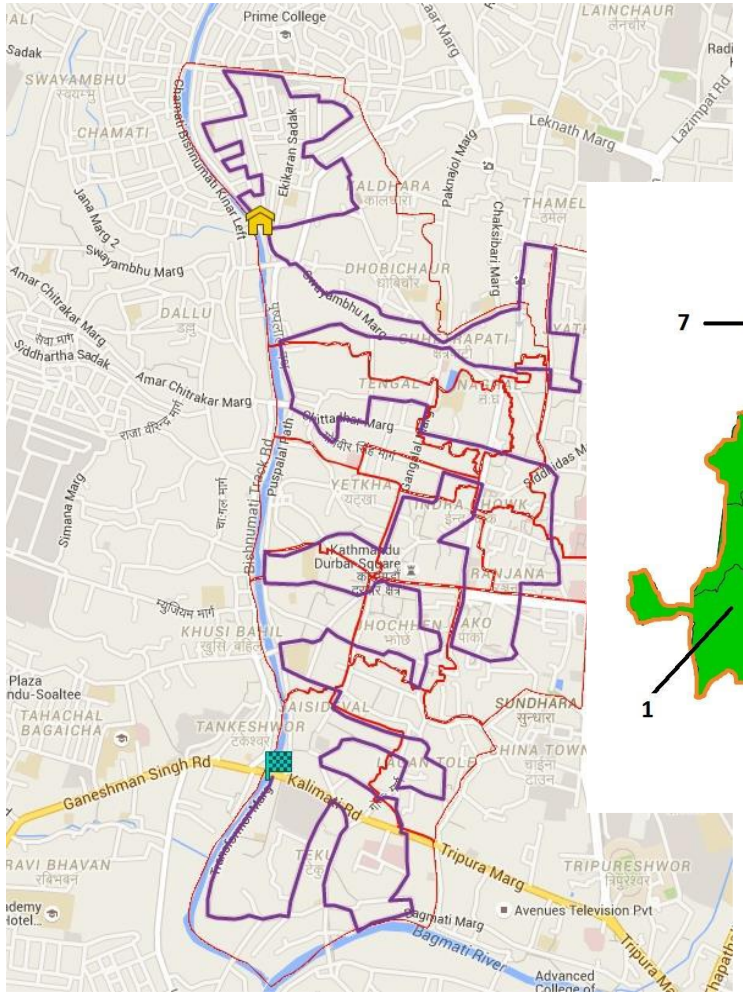
Survey routes – direct counts

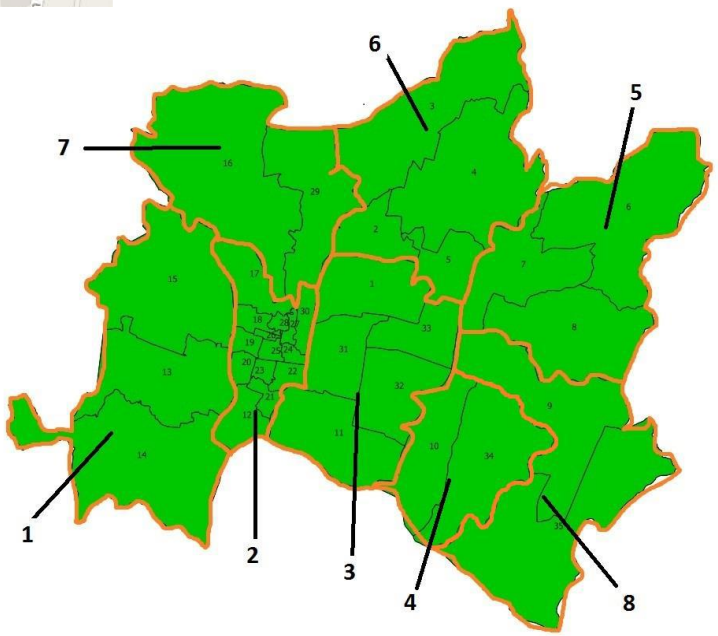
Zone	route length	total street length	% coverage
Zone 1	23.5	126.1	18.6
Zone 2	16.1	52.7	30.6
Zone 3	21.3	101.9	20.9
Zone 4	19.5	58.4	33.4
Zone 5	23.4	88.1	26.6
Zone 6	26.6	121.1	22.0
Zone 7	26.2	97.3	26.9
Zone 8	23.3	88.2	26.4

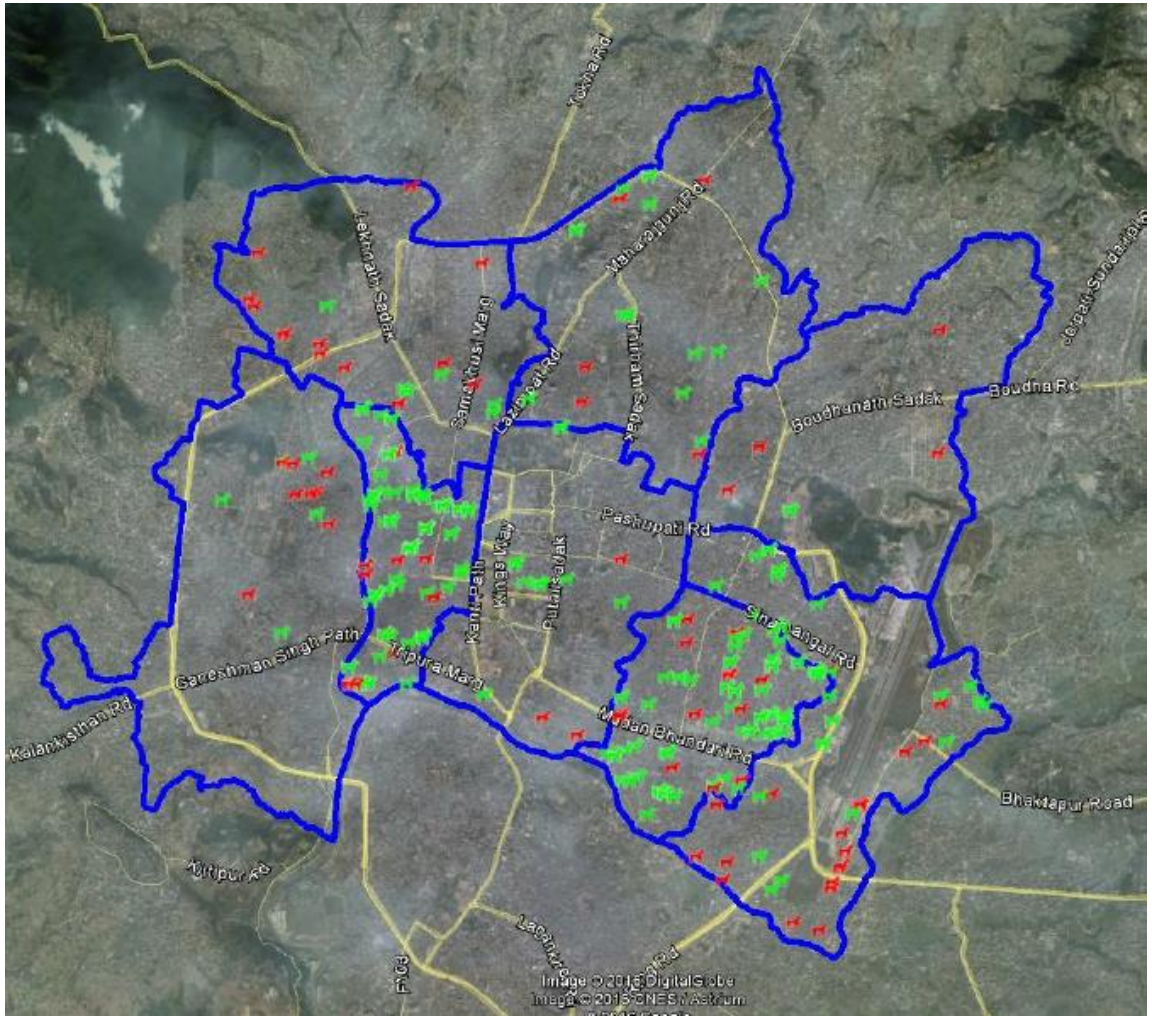


World Organisation for Animal Health

Survey routes in eight wards and Google earth display of lactating (red) and spayed (green) dogs







World Organisation for Animal Health

asean

Mark Resight survey to estimate Detectability Rate

$n_2 = m + nm$

ward	sprayed	coloured	not coloured	detectability	popest	CV	humans	dogs/100humans
1	58	27	29	0.47	120	0.10	8464	1.42
12	186	74	147	0.40	553	0.07	10313	5.37
15	214	95	160	0.44	573	0.06	32441	1.77
22	63	33	24	0.52	109	0.07	5840	1.87
34	238	60	78	0.25	544	0.08	46136	1.18
7	206	118	200	0.57	554	0.05	39530	1.40
Singha Darbar	35	25	32	0.71	80	0.08		

n_1 m nm D N

$D = m / n_1 = 27/58 = 0.47$

World Organisation for Animal Health

asean

Total Population estimates of FR dog population in Kathmandu

route	dogs counted per km	total street length	dogs on streets	total roaming
Zone 1	12.3	126.1	1551	3525
Zone 2	27.1	52.7	1431	3251
Zone 3	12.3	101.9	1252	2844
Zone 4	14.4	58.4	842	1914
Zone 5	15.7	88.1	1380	3136
Zone 6	8.4	121.1	1018	2313
Zone 7	11.4	97.3	1107	2516
Zone 8	11.8	88.2	1037	2357

A

B

C

E

D = 0.44 (Average Detectability Rate)

Average number of dogs sighted per km multiplied by total street lengths (A x B = C)

Total dogs on the street divided by average detectability rate of 0.44 (C ÷ D = E)

World Organisation for Animal Health

asean

Conclusion

- Direct count methods (Free-roaming dogs)
  - Mobile phone Apps for counting, capturing GPS locations and other parameters
  - Apply correction factor to include missing proportion by estimating Detectability rate
  - Conduct count in smaller areas/ street lengths and extrapolate to the total area/ length of street
- Mark-resight method (for estimating detectability Rate)
  - Use MR survey for estimating detection probability/ detectability rate only
  - Photographic capture/ recapture without disturbing the dogs
- Owned dogs population estimate
  - To estimate the average number of dogs per dog owning household, gather data through surveys or during vaccination campaigns.
  - Use information on number of households from National Housing and Population Census reports

DIRECT COUNTS

Mobile Phone APPS

Missing Proportion

Correction factor

MARK-RESIGHT

Detectability Rate

Geo Locations

Photography

Avg. no. of dogs per HH

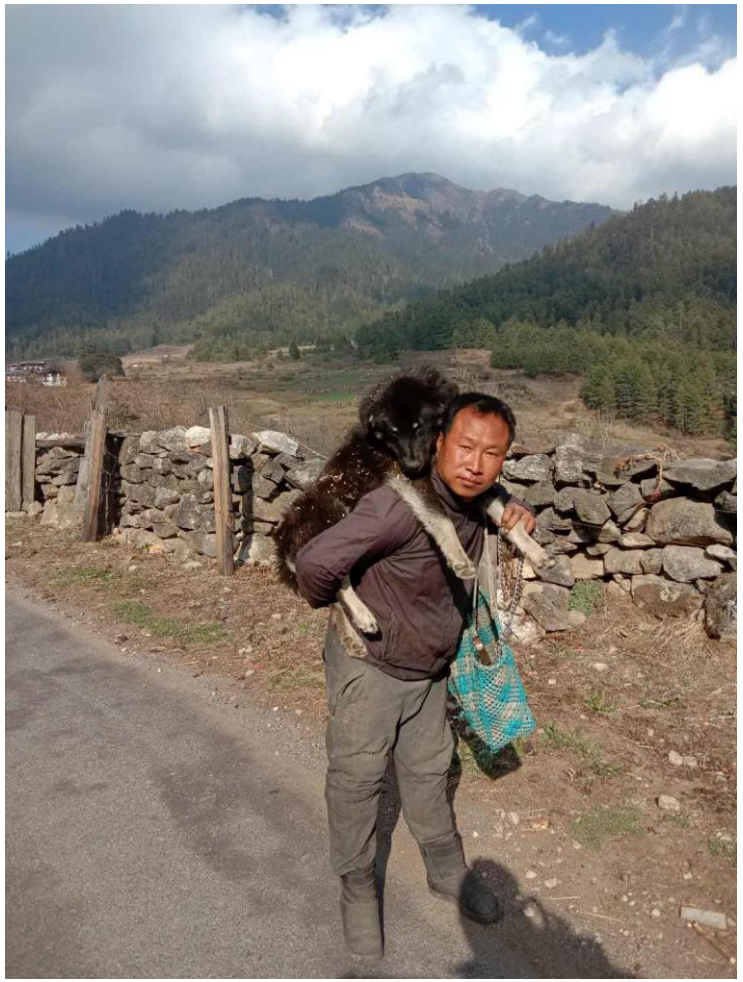
Extrapolation

World Organisation for Animal Health

Useful Resources

- WOAH (2024), Chapter 7.7. Dog Population Management, Terrestrial Animal Health Code, https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_aw_stray_dog.pdf
- Human to Dog Ratio and Dog Population Estimate Repository (https://www.unitedagainstrabies.org/toolbox/human-to-dog-ratio-and-dog-population-estimate-repository/)
- Dog vaccination - barriers and solutions (https://www.unitedagainstrabies.org/uar-best-practice/dog-vaccination-barriers-and-solutions/)
- Karma Rinzin (2015), Population dynamics and health status of free-roaming dogs in Bhutan, PhD Thesis, Murdoch University https://researchrepository.murdoch.edu.au/id/eprint/27867/1/whole.pdf
- ICAM (2019), Humane Dog Population Management Guidance https://www.icam-coalition.org/wp-content/uploads/2019/09/2019-ICAM-DPM-guidance-Interactive-updated-15-Oct-2019.pdf
- World Animal Protection (2009), Surveying Roaming Dog Population, https://www.worldanimalprotection.org.cn/sites/default/files/media/cn_files/cn_attachment/surveying_roaming_dog_populations_-_guidelines_on_methodology.pdf
- WHO/ WSPA (1990), Guidelines for Dog Population Management https://apps.who.int/iris/bitstream/handle/10665/61417/WHO_ZOON_90.166.pdf?sequence=1&isAllowed=y
- **K Rinzin,** T Tenzin, I. Robertson (2016) Size and demography pattern of the domestic dog population in Bhutan: Implications for dog population management and disease control. Preventive Veterinary Medicine. (126), 39–47

Thank You



World Organisation for Animal Health

asean