Investigating the free-roaming dog population and gastrointestinal parasite diversity in Tulum, Mexico

Michael A. Lyons[1], Rumaan Malhotra[1], Cody Thompson[1,2]
University of Michigan, [1]Ecology and Evolutionary Biology and [2]Museum of Zoology, Ann Arbor, Michigan

Introduction

- Since their domestication from gray wolves between 20,000-40,000 years ago, domestic dogs (*Canis lupus familiaris*) have been brought with people around the world.[1]
- The current estimate of the worldwide dog population is 900 million, well beyond the population size of any wild carnivore.[2]
- These dogs fall into 2 different categories: 1) confined dogs and 2) free roaming dogs.
- Free roaming dogs make up 70% of the worldwide dog population.[3]
- Around the world, populations of free roaming dogs (FRD) can play large ecological roles that impact wildlife through predation, competition, hybridization, and disease transmission.[4, 5]
- Disease transmission also poses a major threat to humans.[6, 7]

Project Goal:
To better understand the threat of domestic dogs to wildlife and people and add to the growing literature on free-roaming dog ecology by conducting a study to estimate the dog population in Tulum, Mexico and investigating the prevalence of gastrointestinal parasites in the dog population.

Hypotheses:
1. The FRD population will be higher in lower income areas.
2. The FRD population will be lower in areas with a larger tourist prevalence.
3. Gastrointestinal parasite prevalence will be higher in areas with greater dog densities.
4. Parasite prevalence will be higher in lower income areas.

Study Site

Figure 1. Map of Mexico and Tulum

- The study was conducted in Tulum, Quintana Roo, Mexico (Fig. 1) from Feb 6 to April 8, 2021
- Population: 33,374 + tourists and expats

Modified Mark-Recapture Methods

Figure 2. Map of transects sampled in Tulum, Quintana Roo, Mexico

Transect Design

- 7 transects, approx. 475 m apart were plotted across the city (Fig. 2).
- 3 transects were chosen randomly to survey (on bike) daily
- Transects were surveyed either around 9 am or 5:30 pm (alternating daily).

Modified Mark-Recapture Methods Cont.

- While biking transects, a picture was taken of every dog encountered (Fig. 3).
- With each photo, the sex, location (longitude and latitude), transect number, date, and time were recorded.
- These photos were then used to identify individual dogs through their phenotypic differences.
- Encounter histories were then created for each individual dog in each transect and then put into **Program MARK.**

Figure 3. Four dogs from the study showing some of the phenotypic variation present in the population

Model number	Model notation
Model 1	phi(t) p(t) pent(t) n(.)
Model 2	phi(t) p(t) pent(.) n(.)
Model 3	phi(t) p(.) pent(t) n(.)
Model 4	phi(.) p(t) pent(t) n(.)
Model 5	phi(t) p(.) pent(.)n(.)
Model 6	phi(.) p(t) pent(.) n(.)
Model 7	phi(.) p(.) pent(t) n(.)
Model 8	phi(.) p(.) pent (.) n(.)

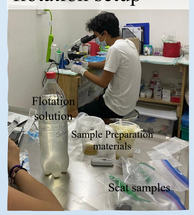
Table 1. List of all possible models for analysis of each transect with POPAN in MARK

- POPAN formulation was used in MARK
- 4 main parameters
  - phi (survival)
  - p (capture probability)
  - pent (probability of entry into population)
  - n (population size)
- 8 possible models for each transect representing the different combinations of phi, p, and pent varying by time or staying constant throughout the study (indicated by "t" or "." in the model notation) were used for each transect (see Table 1).

Scat Collection and Analysis Methods

- Scat was collected in 2 ways
  - Walking areas of the city and collecting any scat encountered
  - Offering free fecal flotation analysis to dog owners that brought scat into Alma Animal Vet Clinic
- Fecal flotations were used to identify parasite ova and quantify parasite load (see Fig. 4).
- The McMaster technique with a saltwater solution was used for fecal flotations.

Figure 4. Fecal flotation setup



Results

Transect No.	phi	95% CI phi	p	95% CI p	N	95% CI Pop. Size
2	**0.73**	0.55 - 0.87	**0.65**	0.09 - 0.97	**19.75**	15.51 - 59.58
3	**0.97**	0.79 - 1.00	**0.19**	0.10 - 0.33	**60.98**	43.82 - 103.05
4	**0.95**	0.89 - 0.98	**0.12**	0.06 - 0.21	**101.84**	62.87 - 193.39
5	**0.95**	0.82 - 0.99	**0.18**	0.09 - 0.32	**65.38**	46.14 - 110.81
6	**0.87**	0.76 - 0.93	**0.34**	0.20 - 0.52	**38.97**	30.43 - 60.91
7*	**0.95**	0.69 - 0.99	**0.22**	0.07 - 0.52	**23.45**	14.71 - 60.88
Total =	N/A	N/A	N/A	N/A	**312.18**	N/A

Table 2. Estimated values and 95% confidence intervals for *phi* (survival probability), *p* (capture probability), and N (population size) for all transects. Weighted averages for each value were calculated from multiple models for Transect 7.

Results Cont.

Transect #	Dog population per meter of transect
Transect 2	17.2923 dogs/km
Transect 3	24.9906 dogs/km
Transect 4	34.9370 dogs/km
Transect 5	26.7935 dogs/km
Transect 6	13.2148 dogs/km
Transect 7	9.8125 dogs/km

Table 3. Estimated dog population size for each transect divided by the transect length in kilometers. These values serve to control for variation in transect length when comparing the dog population size between transects.

Species	Prevalence	Parasite Loads
Ancylostoma caninum	64%	50-10,700 eggs/gram
Cystoisospora spp.	8%	50 & 2450 eggs/gram
Dipylidium caninum	8%	50 & 350 eggs/gram
Toxocara canis	4%	600 eggs/gram

Table 4. Parasite prevalence and loads found in fecal samples collected. A total of 25 fecal samples were analyzed.

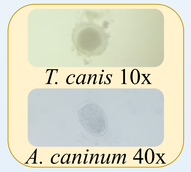


Figure 5. Parasite ova examples

Discussion

Hypothesis 1: FRD populations will be higher in lower income areas

Transect #	% of length going through La Invasión	% of dogs from Transect Encountered in La Invasión
Transect 3	48%	72.7%
Transect 4	13.3%	29.4%
Transect 5	15.2%	28.1%

Figure 6. Picture of La Invasión, a lower income area of Tulum

Table 5. A comparison of the percent of dogs found in La Invasión with the percent of length going through La Invasión for transects 3, 4, and 5, showing that dogs were more likely to be found in La Invasión than would be expected.

Hypothesis 2: More tourists, less dogs

- Lowest FRD populations in Transects 1, 6, and 7
- These transects also had high tourist presence and high levels of new construction projects

Hypotheses 3 & 4: Higher dog densities = higher parasite prevalence & more forest cover = higher parasite prevalence

- Only 25 samples were collected due to increasing levels of crime making collecting samples dangerous.

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