



## More Than Just Pets: Understanding the Risks of Vector-borne Diseases

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## Ectoparasites



### Importance

- Transmission of disease-causing organisms
  - parasites, viruses, bacteria
  - among reservoir hosts
  - from reservoir hosts to animals/humans
- Agents of disease
  - Anemia
    - estimates of 0.7 ml to 2.3 ml/adult female tick
  - Tick paralysis
    - *Dermacentor* spp – mammals
    - *Ixodes brunneus* - birds



University of Nebraska  
Department of Entomology

## Ectoparasites – dogs, cats



### Ticks

- primary pathogens
- vectors/intermediate hosts

### Mites

- primary pathogens

### Fleas

- primary pathogens
- vectors/intermediate hosts

### Lice

- primary pathogens

### Mosquitoes

- annoyance
- heartworm
- viral encephalidites

### Flies

- primary pathogens
- mechanical vectors

## Fleas and pathogens



### *Ctenocephalides felis*

- Most common flea of dogs/cats in USA
  - 61% of total fleas on dogs\*
- Vectors of several human/feline pathogens
  - *Rickettsia typhi*
  - *Bartonella hensalae*, *B. clarridgeiae*
  - Hemoplasmas
- Suspected vectors of human pathogens
  - *Rickettsia felis*

\*Durden et al., 2005, Veterinary Parasitology, 130:157-162

## Pathogens found in *C. felis*



### Collected fleas from cats in Ontario<sup>1</sup>

- PCR/sequencing to identify pathogens

	n	<i>R. felis</i>	<i>B. henselae</i>	Hemoplasmas
Fleas	50	18%	90%	66%
Stray Cats	45	0	57.7%	60%
Pet Cats		N/A	3.2% (646)	4% (742)

<sup>1</sup>Kamrani et al., 2008, Can J Vet Res, 72:411-419

## Pathogens found in *C. felis*



### Collected fleas from cats in SE US<sup>2\*</sup>

- PCR/sequencing to identify pathogens
- 92 flea pools
- 92 cats

	<i>B. henselae</i>	Hemoplasmas	Multiple	Total
Fleas	40.2%	27.2%	21.7%	65.2%
Cats	34.8%	29.3%	14.1%	60.9%

<sup>2</sup>Lappin et al., 2006, J Fel Med Surg, 8:85-90; \*SE=MD, AL, TX

## Pathogens found in AZ cats



### Feral and relinquished cats<sup>3</sup>

- PCR/sequencing to identify pathogens
- 112 cats

<i>B. henselae</i>	Hemoplasmas	Multiple	Total
12.5%	10.7%	27.7%	37.7%

<sup>3</sup>Eberhardt et al., 2006, J Fel Med Surg, 8:164-168

## Bartonella in CA cats



141 of the 205 cats were reported to be infested with fleas or were carrying fleas at the time of the blood collection

10 cats were associated with a human cat scratch disease or bacillary angiomatosis

TABLE 1. *B. henselae* bacteremia and antibody prevalences by origin among 205 northern California cats, 1992 to 1994

Cat origin	No. (%) of cats		
	Total	Bacteremic	Seropositive
Pet			
Davis	68	3 (4.4)	42 (61.8)
San Francisco	44	21 <sup>a</sup> (47.7)	38 (86.4)
Impounded, Davis	49	26 <sup>a</sup> (53.0)	42 (85.7)
Former stray, Sacramento	44	31 (70.4)	44 (100.0)
<b>Total</b>	<b>205</b>	<b>81 (39.5)</b>	<b>166 (81.0)</b>

<sup>a</sup> Includes bacteremia data published previously (11).

Bruno BC, et al., 1995. *Bartonella henselae* Prevalence in Domestic Cats in California: Risk Factors and Association between Bacteremia and Antibody Titers. J Clin Microbiol 33:2445-50.

## Pathogens found - Antech

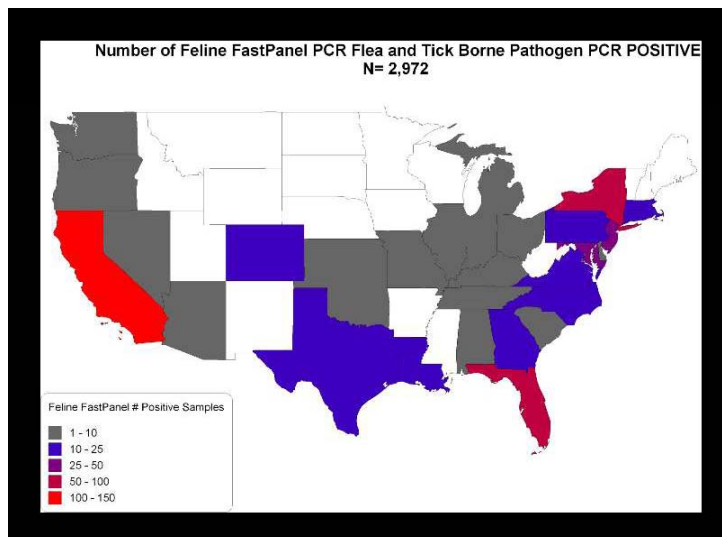


### Feline Vector-borne Profile PCR test<sup>4</sup>

- Pathogens tested for:
  - *Anaplasma phagocytophilum*
  - *Bartonella henselae*, *B. clarridgeiae*, *B. quintana*
  - Hemoplasmas
  - *Ehrlichia* spp
  - *Rickettsia felis*, *R. rickettsii*
- 2,972 samples tested
- 248 positives western US

<sup>4</sup>Data presented at 2009 ACVIM Forum

## Pathogens found - Antech

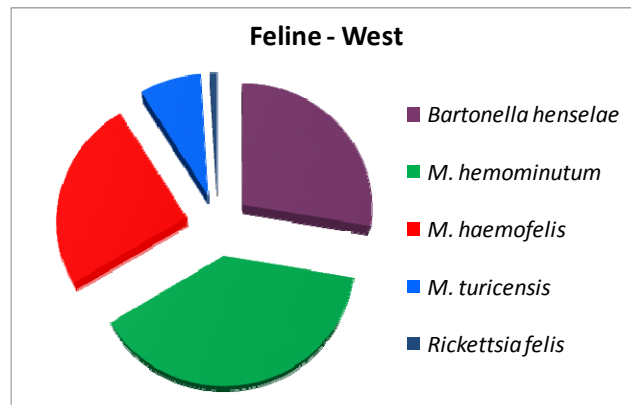


Data presented at 2009 ACVIM Forum

## Pathogens found - Antech



### Feline Vector-borne Profile PCR test<sup>4</sup>



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## Fleas and Human Health



### *Pulex irritans*, *P. simulans*

- Currently considered 2 distinct species
  - gene flow among the populations
  - very few distinguishing characteristics
    - can only identify males
- Vectors of human pathogens
  - *Rickettsia typhi*
- Suspected vectors of human pathogens
  - *R. felis*
- Georgia study
  - 13% of total fleas on dogs



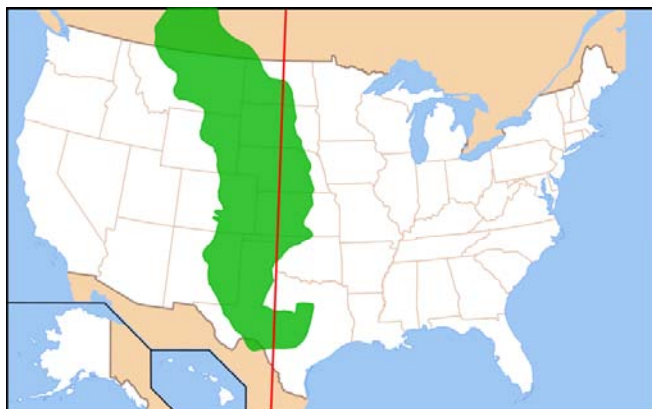
“There are no fleas in the west”

## West vs East



66 Genera / 250 species

33 Genera / 55 species



## Fleas



### What is true:

- *Ctenocephalides felis* doesn't like cold/dry (or too hot)
  - survive 10 days @ ~37 F (all stages)
  - survive 5 days @ ~33 F (all stages)
  - RH < 50% (eggs, larvae, adults)
  - 95 F for >40 hr/ month, lethal (all stages)
- alter home environment
  - tend to air-condition houses in summer
  - tend to run humidifiers/heaters in winter
  - 60-80 F, RH > 50%, eggs survive/hatch
  - 60-80 F, RH as low as 2%, pupa survive

## Fleas



### What about other fleas?

- Georgia example
  - *C. canis* = 21%
  - Bird/rodent/rabbit fleas = 5%
- Oregon example
  - ~114 species of fleas in Oregon
  - *Pulex irritans*
    - common flea biting humans
    - common on wildlife
      - wild canids, Columbian black-tailed deer, white-tailed jackrabbit
      - will infest pets
  - *Oropsylla montana*
    - plague flea

## Plague



### New Mexico Dept Health – June 10, 2009

- 3<sup>rd</sup> human case of plague in 2009
  - 56 y/o adult male
- confirmed 1 week after the 1<sup>st</sup> 2 cases
  - 8 & 10 y/o siblings
  - 1 fatality
- clinical presentations of bubonic plague
  - all 3 cases most likely exposed via fleabite

## Plague



### New Mexico Dept Health – June 10, 2009

- route of exposure cannot be definitively known
  - risk factors identified
    - **the family dog was allowed to roam and hunt and then sleep in bed with the children**
    - **no flea control products were used on the dog**
  - these risks have been identified in other human cases
  - serves as a reminder to emphasize flea control, even in dry areas
  - not the typical dog and cat fleas (*C. felis*)
    - plague-infected rodent fleas
    - various animal species
      - prairie dogs, rock squirrels, ground squirrels, deer mice

# Plague



## New Mexico

- cooler/wetter late spring
- allows infected fleas to survive longer
- move to the burrow entrances after their host rodent has died from plague
  - not prone to desiccation in the usual hot/dry environment.
- increases the risk of infected fleas infesting pets/humans

# Plague



## New Mexico

- also confirmed in 1 cat and 1 dog
  - clinical signs - cats
    - fever
    - lethargy
    - inappetance
    - submandibular lymphadenitis
  - clinical signs – dogs
    - not as susceptible as cats
    - sometimes show clinical signs
    - greatest threat is flea transport



CDC



## Fleas - Summary



### Western U.S

- Large number of fleas
  - wildlife
    - *Pulex irritans* – generalist
      - urban wildlife
      - infest pets, people
    - rodent/rabbit fleas
      - plague endemic areas
- Issues with *C. felis*
  - happy to live in various areas of the west
  - in dry, colder areas
    - travel/visitor history important
    - tend to die out in the winter
    - longevity depends on microhabitat in the house

## Ectoparasites



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- Agents of disease
  - Anemia
    - estimates of 0.7 ml to 2.3 ml/adult female tick
  - Tick paralysis
    - *Dermacentor* spp – mammals
    - *Ixodes brunneus* - birds

## Transmission of pathogens



### Mosquitoes

- most important vector except in:
  - North America
  - Eurasia

### Ticks

- >850 species / subspecies worldwide
- ~80 species of medical importance
- ~6-8 species of veterinary importance in North America

## Ticks and Pet Health Western US



Disease	Organism	Vector
Lyme Disease	<i>Borrelia burgdorferi</i>	<i>I. pacificus</i>
RMSF	<i>Rickettsia rickettsii</i>	<i>D. andersoni</i> <i>D. variabilis</i> ( <i>R. sanguineus</i> )
Babesiosis	<i>Babesia canis</i> , <i>B. gibsoni</i> , <i>B. conradae</i> <i>B. duncani</i>	<i>R. sanguineus</i>
Ehrlichiosis / Anaplasmosis	<i>Ehrlichia</i> spp / <i>Anaplasma</i> spp	<i>R. sanguineus</i> <i>Ixodes</i> spp <i>Amblyomma</i> spp
Tick Paralysis	Toxin	<i>Dermacentor</i> spp

## Ticks as vectors



### Why are ticks such competent vectors?

- 3-host ticks
  - each stage must take a blood-meal
    - each stage feeds on a different host
    - feed on 3 different hosts in it's life cycle
- feed for long periods of time
- alter host response
  - allows tick to take blood-meal

## *Ixodes pacificus*, *Ixodes scapularis*



### Larvae

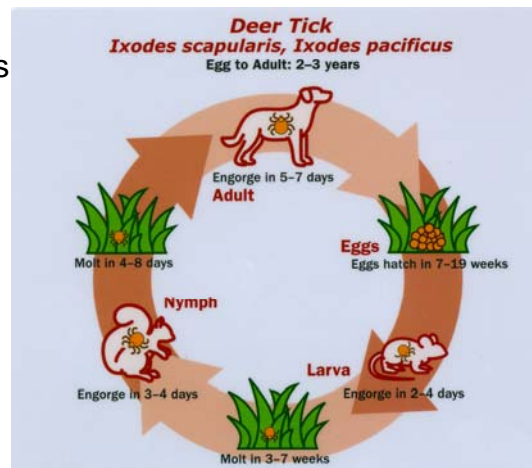
- various rodents

### Nymphs

- wildlife
- birds
- cats
- humans

### Adults

- wildlife
- cats, dogs
- humans



Dryden & Payne, 2004, Quick Reference Tick Guide

## Transmission times



*Borrelia burgdorferi*: ≤16 hrs

*Rickettsia* spp: 5 – 20 hrs

*Anaplasma* spp: 4+ hrs???

*Ehrlichia* spp: 6 – 24 hrs

*Babesia* spp: 48+ hrs

## Tick-borne diseases increasing



### Introduction of new species

- tick or pathogen
  - Ecuador, Belize



James Gathany, CDC

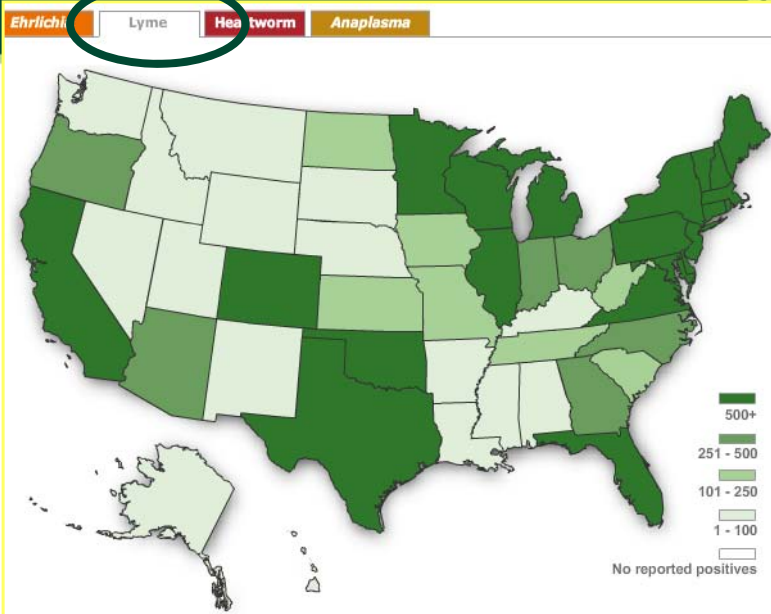
# Tick-borne diseases increasing



Paddock et al., 2008, Clinical Infectious Diseases 47:1188-1196

## Spread of existing species

- habitat modification
  - man-made or natural
- increased host populations
  - white-tailed deer
- cultural factors
  - decreased environmental pesticide use
  - increased human contact with natural areas



## National prevalence survey<sup>5</sup>



Region	<i>B. burdorferi</i>	<i>Anaplasma</i>	<i>Ehrlichia</i>	<i>Bb/Anaplasma</i> co-infection
NE	11.6%	5.5%	0.3%	1.4%
SE	1.0%	0.5%	1.3%	1.4%
MW	4.0%	6.7%	0.4%	2.0%
West	1.4%	4.5%	0.6%	0.8%
National	5.1%	4.8%	0.6%	1.3%

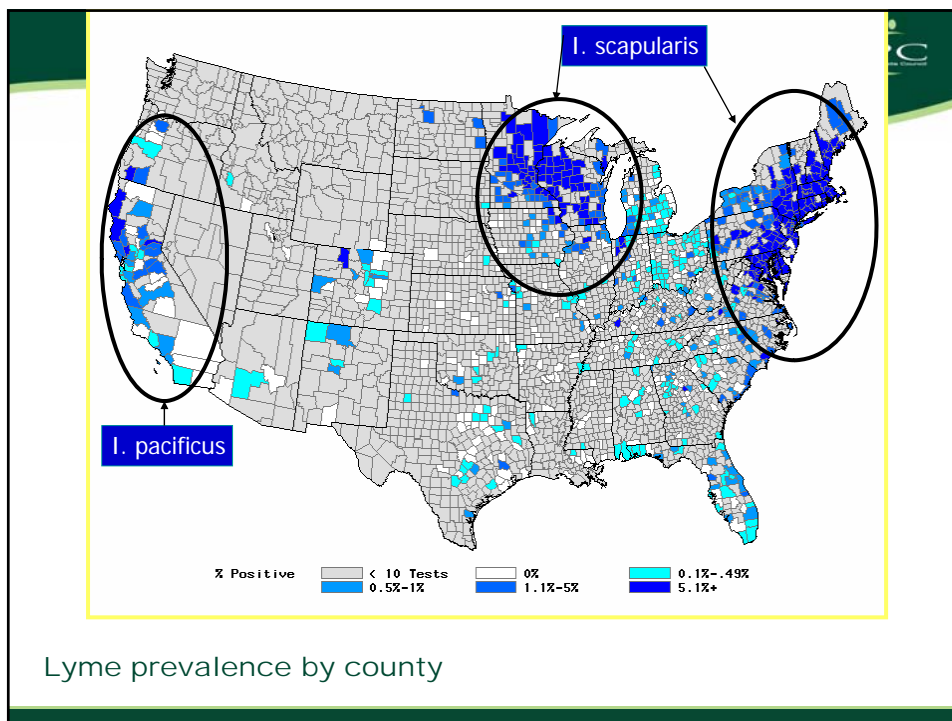
<sup>5</sup>Bowman et al., 2009, Vet Parasitol 160:138-148

## Tick-borne diseases - dog



### Lyme disease

- *Borrelia burgdorferi*
- analyte highly specific
  - does not give false-positives from vaccine
- hyperendemic regions
  - NE, upper MW, W (including western OR)

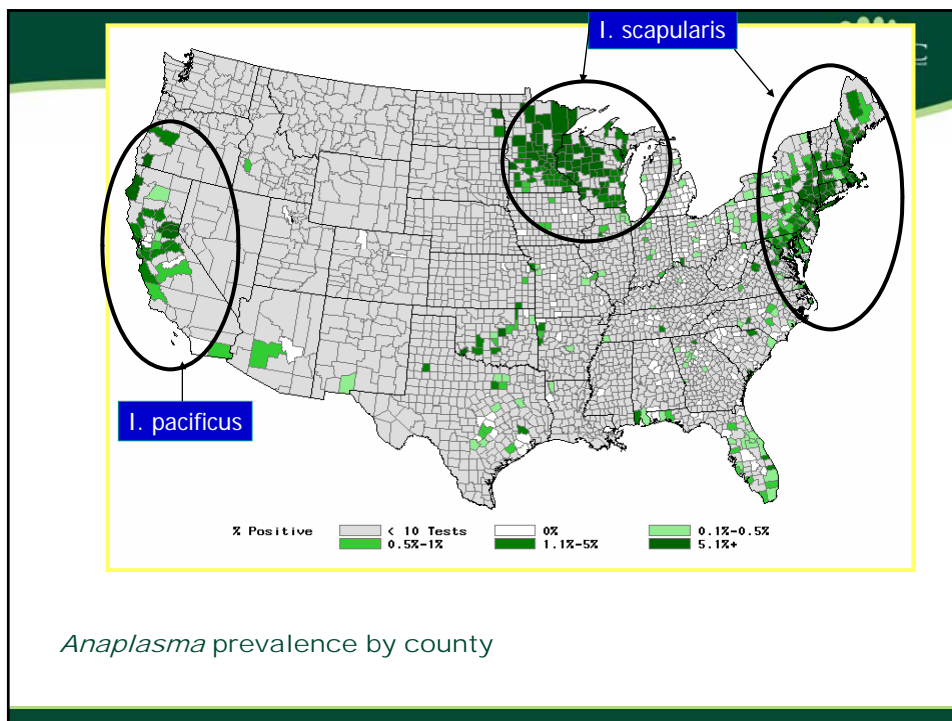


## Tick-borne diseases - dog



### Anaplasmosis

- *A. phagocytophilum*
- distribution mirrors *B. burgdorferi*
- analyte cross-reacts with *A. platys*
  - *A. platys* can cause clinical disease

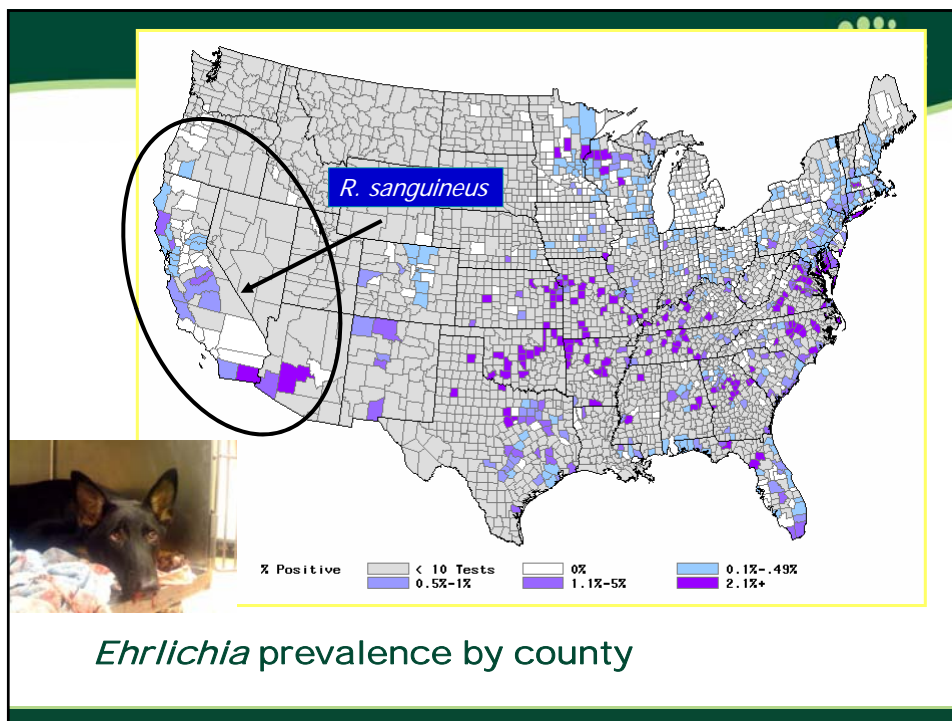


## Tick-borne diseases - dog



### Ehrlichiosis

- *E. canis*
- overall prevalence lower but more widely distributed
- analyte cross-reacts with *E. chafeensis*
  - may explain the more widespread distribution



## *Ixodes pacificus* – vector transmission

From 168 questing adult *Ixodes pacificus* ticks  
from Santa Cruz County, CA

*Bartonella henselae* in 11 ticks (6.55%)

*Borrelia burgdorferi* in two (1.19%)

*Anaplasma phagocytophilum* in five (2.98%)

Study offers additional evidence that *Ixodes* ticks  
may act as hosts and possibly vectors for *B.*  
*henselae*.

Co-detection of Bartonella henselae, Borrelia burgdorferi, and Anaplasma phagocytophilum in Ixodes pacificus ticks from California, USA.: Holden, K.; Boothby, J. T.; Kasten, R. W.; Chomel, B. B. : Vector Borne and Zoonotic Diseases : 6 : 99-102 : 2006 :



- Importantly, the diagnosis of tickborne disease was overlooked in many dogs, in part because of
  - Their failure to show clinical signs and
  - The initial choice by the clinicians to apply no or few diagnostic tests for tickborne disease rather than a comprehensive panel.
- The results of studies suggest that comprehensive testing for tickborne disease in certain cases is very important

## What to do about blue dots?



### If dog is sick

- doxycycline
- monitor

### If dog is not sick

- further tests may be warranted
  - CBC
    - thrombocytopenia
    - mild anemia
    - mild leukopenia
  - PCR
    - can differentiate *Anaplasma* species
- may empirically treat

## Preventing infections



### Comprehensive flea/tick control strategy

- year-round tick/flea control products
  - adjust based on needs of individual pet
  - numerous available
  - safe
  - effective
  - start as early as label allows
- remove attached ticks immediately
- habitat modifications
  - closely clip shrubs, grass
  - remove leaf litter
  - exclude wildlife with fencing
- prevent roaming in dogs/cats



**THANK YOU!**

[www.capcvet.org](http://www.capcvet.org)

[www.petsandparasites.org](http://www.petsandparasites.org)