Dog Tick Invasion of Alaska

Implications for risks of tick-borne diseases

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Photo by Dr. M. Dryden, KSU
1. Epidemic rise of TBDs in USA
2. Alaska’s tick fauna & SOA surveillance
3. Documented introductions & probable establishment of dog ticks into Alaska
4. Tick biology & life cycles
5. AK’s Tick-borne diseases
6. Final thoughts and considerations
**Tick-borne Diseases of Humans in the US**

- Steadily increasing human cases of TBDs reported annually

<table>
<thead>
<tr>
<th>Disease</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009§</th>
<th>2010</th>
<th>2011</th>
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</thead>
<tbody>
<tr>
<td>Lyme</td>
<td>23,763</td>
<td>21,273</td>
<td>19,859</td>
<td>21,304</td>
<td>19,931</td>
<td>27,444</td>
<td>35,198</td>
<td>38,468</td>
<td>30,158</td>
<td>33,097</td>
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<tr>
<td>RMSF</td>
<td>1,104</td>
<td>1,091</td>
<td>1,738</td>
<td>2,029</td>
<td>2,288</td>
<td>2,221</td>
<td>2,563</td>
<td>1,815</td>
<td>1,985</td>
<td>2,802</td>
</tr>
<tr>
<td>Eh/An (total)*</td>
<td>750</td>
<td>727</td>
<td>934</td>
<td>1,404</td>
<td>1,455</td>
<td>1,999</td>
<td>2,107</td>
<td>2,267</td>
<td>2,615</td>
<td>3,562</td>
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<tr>
<td>Babesiosis‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,128</td>
</tr>
</tbody>
</table>

§Reporting criteria revised in 2009

*Includes human granulocytic anaplasmosis and human monocytic ehrlichiosis

‡Babesiosis became nationally notifiable in 2010
Tick-borne Diseases of Humans in the US

- Lyme dz is most reported TBD and 6th of top notifiable diseases to CDC

<table>
<thead>
<tr>
<th>Disease/agent</th>
<th>Reported cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyme disease</td>
<td>33,097</td>
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<tr>
<td>Spotted Fever Rickettsiosis</td>
<td>2,802</td>
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<tr>
<td><em>Anaplasma phagocytophilum</em></td>
<td>2,575</td>
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<tr>
<td>Babesia</td>
<td>1,128</td>
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<tr>
<td><em>Ehrlichia chaffeensis</em></td>
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<td>Tularemia</td>
<td>166</td>
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<tr>
<td><em>Anaplasma/Ehrlichia</em> – undetermined/other</td>
<td>161</td>
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<tr>
<td>Powassan virus</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 3. Tick-borne diseases reported to the CDC, United States, 2011 [Source: CDC]
Two cases of tularemia, animal exposure implicated?

NOTE: Each dot represents one case. Cases are reported from the infected person’s county of residence, not necessarily the place where they were infected.

NOTE: During 2012, babesiosis was reportable in Alabama, California, Connecticut, Delaware, Indiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Oregon, Rhode Island, Tennessee, Vermont, Washington, Wisconsin, and Wyoming. CDC was not notified through the national surveillance system of cases in other states.

NOTE: In 2012, no cases of tickborne illness were reported from Hawaii. In 2012, Alaska reported ten travel-related cases of Lyme disease.
Possible Reasons of Increased TBDs

1. Ecological changes, climate and shift in land uses
2. Increasing deer and wildlife populations, closer associations between humans/wildlife
3. Human behavior changes led to greater exposure risks
4. Improvements in diagnosis, surveillance, and reporting practices
Why Should Alaskan’s be Concerned?

• It’s a fallacy that ‘we don’t have ticks’
  – We always have had many wildlife ticks

• Ticks exotic to Alaska are increasingly being detected
  – At least 2 dog ticks are becoming established
Why Should Alaskan’s be Concerned?

- Enzootic and exotic ticks in AK are competent vectors for TBDs (zoonotic, animal and wildlife susceptible)
  - Infected travelers a potential ‘source’ of introduction of TBDs as well as hitchhiking ticks
  - The public, physicians, veterinarians less likely to consider TBDs as a Ddx
  - Wildlife non-adapted to exotic ticks nor TBDs, potential for population-level impacts
ADF&G Initiated Targeted Tick Surveillance: Moose Winter Tick

*Dermacentor albidus*

Photos: Bill Samuels
Moose Winter Tick on the Move
How Does Winter Tick Cause Disease?

• Animals that die because of heavy infestations with Winter Ticks appear to die because they do not eat enough food to supply the energy they require. =starved to death.

• Heavy infestations with the Winter Tick both increase the amount of energy the host animal requires and cause the animal to spend inadequate amounts of time feeding.

• The ticks have these effects on the host animal in two different ways: 1) by feeding on the animal's blood and 2) by causing severe irritation of the skin.
Blood loss

• Each female tick consumes 2ml, males and larvae less but substantial.
• If $\frac{1}{2}$ of the 40,000 ticks are female, = 40L of blood
• 400kg moose has 32L of blood (8% BW)
• Thus a moose most replace its entire blood volume over 2 months!
Ultimate cause of death but what about TBDs?

- Add up to starvation
- Impact of heavy burden of ticks depends on nutritional condition at beginning of winter and food supply during Nov-Jan
Moose Winter Tick vectored animal and zoonotic diseases

- Vector of cattle Anaplasmosis (a rickettsia)
- Suspected vector of Rocky Mtn Spotted Fever
Moose Winter Tick vectored animal and zoonotic diseases

- Potential vector of Tularemia and human anaplasmosis


Transovarial transmission of Francisella-like endosymbionts and Anaplasma phagocytophilum variants in Dermacentor albipictus (Acari: Ixodidae).

_Baldridge GD^1_, _Scoles GA_, _Burkhardt NY_, _Schloeder B_, _Kurtti TJ_, _Munderloh UG_.

Moose Winter Tick potential vector for Lyme Disease?

Borrelia infection rates in winter ticks (Dermacentor albipictus) removed from white-tailed deer (Odocoileus virginianus) in Cheatham County, Tennessee. 2007. J Tenn Acad Sci

White-tailed deer, *Odocoileus virginianus*, are significant reservoir hosts of *Borrelia burgdorferi*, the causative agent of Lyme disease. Hard ticks serve as vectors of both *B. burgdorferi* and *Borrelia lonestari*, a species reported from the southeastern United States and associated with Southern Tick Associated Rash Illness or STARI. Winter ticks, *D. albipictus*, were collected from hunter-killed deer in Cheatham County, Tennessee in October and November of 2005. Six of 18 (33%) pooled tick samples tested positive for *Borrelia* species; two of six were identified as *B. burgdorferi* and four as *B. lonestari*. This investigation demonstrates that both *B. burgdorferi* and *B. lonestari* are present in *O. virginianus* populations in Cheatham County, Tennessee. It is noteworthy that *D. albipictus* is capable of harboring Borreliae from infected white-tailed deer. This is the first report of *Borrelia* detection in *D. albipictus* in Tennessee.
SOA Tick Surveillance
June 2011-May 2014 Results

Fifty-eight infestations detected, >100 ticks examined from:

• 25 dogs
• 8 humans
• 3 cats
• 1 hare and 3 martens

Submitted to OSV and ADF&G
All identifications confirmed by Dr. Lance Durden, Georgia Southern University
Most common enzootic tick

Squirrel or Lemming tick, *Ixodes angustus*

- 21 cases from dogs, cats, people and a single hare
- Reported vector of Lyme disease (case report in WA) and Babesiosis
Second common enzootic tick

Rabbit or Hare tick

_Haemahysalis leporispalustris_

- 2 dogs, 1 human
- Primary vector for _Tularemia_, competent for Q-fever
Less commonly detected enzootic tick fauna

Seabird ticks

*Ixodes auritulus*

- Previously reported on birds in Alaska but recently found on a dog in Sitka
Enzootic or exotic?

Raccoon tick

*IXODES TExANUS*

- Not previously reported in Alaska until found on a marten near Ketchikan
- Common on dogs and raccoons elsewhere...sign of expanding geographic range?
Ticks Exotic to Alaska

Invasive Dog Ticks Detected

• *Rhipicephalus sanguineus* - Brown Dog Tick 15 cases
• *Dermacentor variabilis* - American Dog Tick 12 cases
• *Dermacentor andersoni* - Rocky Mountain Wood Tick 2 cases
• *Amblyomma americanum* - Lone Star Tick 2 cases
American Dog Tick Establishing in Alaska?

- *Dermacentor variabilis*

12 cases: Dogs and people in North Pole Fairbanks, Anchorage, Denali NP, Juneau, Valdez, Willow, Sitka, Chugiak

Dogs that had never traveled from Valdez or JNU. Documented tick-free dog infected in Potter’s marsh. Another just arrived in Sitka airport last week! Dog in Chugiak last week (owner returned from hunting in NE).

- Tularemia
- Rocky mtn spotted fever
- Tick fever and tick paralysis
- Q-fever
- Human monocytic ehrlichiosis
- Anaplasmosis
- Canine babesiosis
- Canine granulocytic ehrlichiosis
- Canine ehrlichiosis
- Feline theileriosis

**Larvae:** voles, mice

**Nymphs:** cats, dogs, rabbits

**Adults:** Cats, coyotes, dogs, large mammals, people
Brown Dog Tick
Established in Interior AK

- *Rhipicephalus sanguineus*

- 15 cases: Dogs and people in North Pole, Fairbanks, Anchorage, and Sitka

- Dogs that had never traveled from Fairbanks, Sitka, Anc. Documented 3 boarding kennel transmission and 2 infested homes in Fairbanks

Worldwide distribution except polar regions

- **Larvae:** Dogs, rodents
- **Nymphs:** Dogs, rabbits
- **Adults:** Dogs, bears, coyotes, large mammals, rodents/rabbits, people

- **Tularemia**
- **Rocky mtln spotted fever**
- **Q-fever**
- **Mediterranean spotted fevers**
- **Tick paralysis**
- **Anaplasmosis**
- **Canine babesiosis**
- **Canine infectious cyclic thrombocytopenia**
- **Canine ehrlichiosis**
- **Canine hepatozoonosis**
Rocky Mountain Wood Tick

- *Dermacentor andersoni*

2 cases: Dogs in Anchorage and Sitka

Dogs Returning from OR and CA, 2 wks previous (latter in Jan)

- Rocky mtn spotted fever
- Colorado Tick fever
- Tick paralysis
- Tularemia
- Q-fever
- Anaplasmosis
Lone Star Tick

- *Ambylomma americanum*

  - 2 cases: Dogs from Fairbanks and Eagle River

  - Dog from Fairbanks (returned from Tx, FL and PA) and Eagle River dog never travelled nor out of fenced yard

- Tularemia
- Human monocytic ehrlichiosi
- Tularemia
- Tick paralysis
- RMSP
- **STARI**: southern tick-associated rash illness (Borrelia lonestari?)
Changing tick ecology worldwide

• Tick species occurring in locations where they previously did not exist.
  – Tick-transmitted diseases are diagnosed in locations they previously did not exist.
  – New tick-transmitted diseases are being discovered
• Ticks are active throughout the year in many locations.
  – Due to natural climate fluctuations and introduction of different tick species.
• Tick densities are significantly higher in many locations.
• Ticks are now common in many suburban areas.
• It’s not just an Alaska problem
More Ticks In More Places...
...and likely even more to come!

- *Ixodes pacificus* (Western-Blacklegged tick)
- *Ixodes scapularis* (Blacklegged ticks or Deer tick)
- *Amblyomma maculatum* (Gulf Coast tick)
- *Amblyomma americanum* (Lone Star ticks)

CLIMATE CHANGE
Expansion of Tick Ranges

- Climate change: increases tick ranges, shortens life cycle, increases densities
  - Only a 2-3 degree increase in mean temp April to Sept was speculated to allow Brown dog ticks to establish outdoors in Northern temperate climates (already established indoors)
  - Humidity also important for deer tick survival
Introduction and Expansion of Dog Tick Ranges

- Tourists/visitors, pets and imported animals
- Alaskans traveling and returning, esp. w/ animals (Sitka example May 7, 2014). Chugiak couple brought back ticks from NE that transferred to dog.
- Migratory birds and mammals transporting ticks
- Increased human contact with natural areas increasing risk of tick encounters
  → recreation, occupation, housing developments in wooded areas.
**Tick Biology 101: Saliva**

- Anticoagulant, anesthetic, anti-inflammatory
- Secrete cement to attach, dissolves after feeding
- Saliva transmits diseases but 24-36hr of feeding needed to transmit
- Host response to saliva determines host specificity

Photos by Dr. M. Dryden, KSU
3-Host, 2yrs to complete in northern climates

American Dog Tick
- **Adult**
  - Engorge in 4 – 13 days
- **Larvae**
  - Activity peaks in early summer
  - Engorge in 3 – 7 days
- **Nymph**
  - Peak activity late summer
  - Engorge in 3 – 11 days

- **Eggs**
  - Hatch in ≈35 days
  - Engorge in 4 – 13 days
  - Molt in 6 – 250 days
  - Molt in 3wk to several months, adult overwinters or feeds on host

Adapted from Dr. M. Dryden, KSU
American dog ticks can take from 2 to 3 yrs to complete their lifecycle and adults can live 2 to 3 years.

- During that time they will feed for
  - 2 to 7 days as larvae
  - 2 to 11 days as nymphs
  - 3 to 15 days as adults

→ <2% of the life of an adult tick is on an animal thus ~99.5% of their life not on an animal.

Dryden MW, Payne PA. Biology and Control of ticks infesting dogs and cats in North America Vet Ther 2004;26:2-16.
Brown Dog Tick *Rhipicephalus sanguineus*
Only tick in North America to inhabit buildings
currently a problem primarily in boarding kennels and some Fairbanks area households

Photo by Dr. M. Dryden, KSU
Dog Tick-vectored zoonotic diseases

- Endemic diseases, Tularemia (and Q-fever) prevalence likely to increase with increased tick vector density, survival and diversity (esp w/ increased human host preferences)

- Tularemia cases will increase in pets and subsequent exposure risk for humans increases (direct and indirect)
Tularemia in Alaska

• Agent
  – Bacteria
  – *Francisella tularensis*
  – Select agent’ → potential use in biowarfare

• Natural Hosts
  – Snowshoe hare
  – Muskrat
  – Beaver
Tularemia - Transmission

- Terrestrial cycle
  - Tick feeds on the blood of infected hare
  - Hare dies, tick drops off and attaches to differ hare
  - Tick transmits bacteria to second hare
  - Hare mortalities only seem to occur May to September (tick activity?)
  - Pet & human cases May-August
Tularemia

- Human implications
  - Biologists and trappers get infected when skinning or gutting infected hares, muskrats, beavers
  - Human exposure via pets:
    → Dogs and cats catch sick hares and quickly become severely ill with high fever, die if untreated.
    → Bite of pet with contaminated mouth can infect people.
    → Pet saliva into a pre-existing wound.
    → Annual outbreaks in pets in Interior Alaska esp. with high hare populations
  - Tick, fleas or biting fly transmits to man

- Symptoms in humans-
  - Ulcerating papule
  - Swollen lymph nodes
  - Weakness, fever, headache, nausea
  - Pneumonia, septicemia

- Reportable disease
- Treatment-
  - Streptomycin or gentamicin
Reports of Human cases of Tularemia in AK

- 1995-1999  5 cases
- 2000-2004  2 cases
- 2005-2009  4 cases
- 2010-2013  2 cases

- Eight Interior, three Anc/Mat-Su, two Southeast
Figure 1: Number of human tularemia cases in Alaska reporting animal exposure.
Coxiella burnetii = Q Fever

- *Coxiella burnetii* in sheep, Q- Fever in man
  + Select agent' → potential use in biowarfare
  - Gram negative, obligate intracellular rickettsia with worldwide distribution
- Transmission: aerosol, contact, and vector (ticks)
- Wide host range-including most wild and domestic mammals, birds, and man
  - Small ruminant: reservoir and suffer disease
    → Seropositive in AK: Dall’s sheep, Mtn goat, Muskox, CB, moose, bison, deer, fox, bear, wolf.
  - Often asymptomatic: abortions after intro
- Marine mammals: zoonotic potential?
  - Harbor seal (1999), Steller sea lion (2010), Northern Fur seal (2010-2011, 3% prevalence of lesions, 75% positive COM1)
Coxiella burnetii = Q Fever

- Large numbers of organisms present in infected placenta and fetal membranes; organisms also present in wool (pelt?), feces, and milk
- Resistant to heat (pasteurization temperature targeted to kill this organism), drying, and to physical and chemical agents; survives for long periods (months to years) in dust/soil
Q-Fever, Coxiella

- **Transmission to humans** – skin contact or inhalation exposure to infected animals or contaminated (e.g. urine, feces, milk, birth fluids/placenta) environments, tick bite
- **Symptoms**- Acute to chronic (<5%) illness in humans although half of humans infected show no symptoms
  - Acute symptoms develop 2-3 wks after exposure: high fever, severe headache, malaise, myalgia, chills/sweats, cough, nausea/vomiting, diarrhea, abdominal and chest pain
  - Complications: hepatitis, pneumonia, endocarditis. Fatality <2%
- **Treatment**- doxycycline
- **Prevention**- wear gloves, don’t handle placentas or fetuses w/ bare hands, tick prevention.
Final thoughts and considerations

• Hitchhiking ticks on pets and human travelers are not so uncommon and are a potential source of TBDs introductions to AK

• To date we’ve not detected *Ixodes scapularis* or *I. pacificus* but for how long?
Final thoughts and considerations

- Dog ticks as well as some wildlife ticks are competent vectors for TBDs not currently endemic to AK, are we just a blood meal away from an infected person or pet to introduce Lyme Disease, RMSF, etc. to Alaska?
Final thoughts and considerations

- Climatic changes are likely to favor increases in endemic ticks as well as newly established & introduced ticks.

- What will it take and how long for TBDs to become established considering how quickly TBDs and ticks are spreading across North America?
What needs to be done

• Public awareness of tick prevention and treatment needs to be increased
• Veterinarians should to dispense appropriate products to at risk pets (Advantix II best, alternative Frontline Plus)
• Physicians, veterinarians be altered to consider TBDs in Ddx