The cattle tick: biology, ecology, distribution and control

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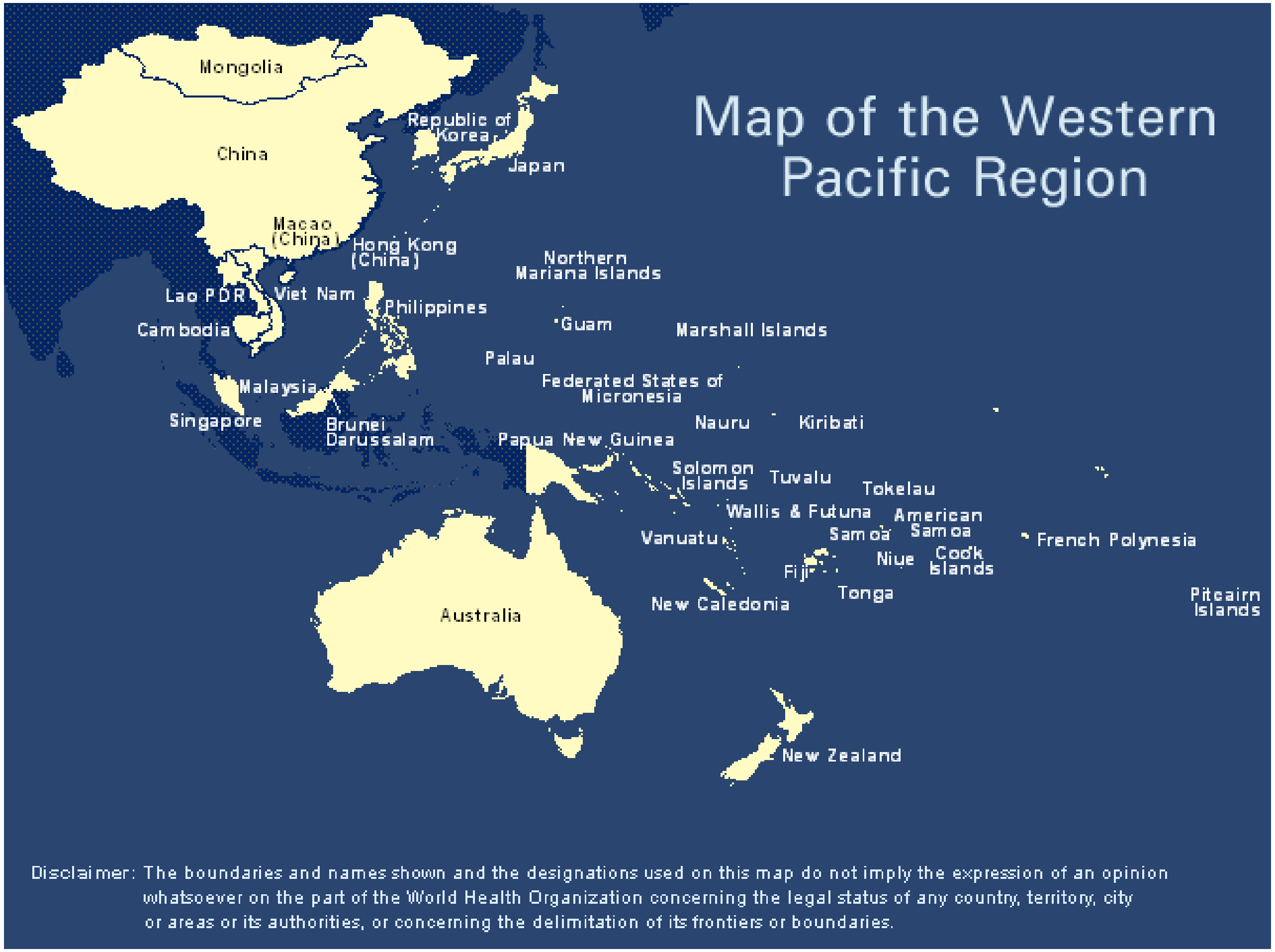
New Zealand cattle tick, *Haemaphysalis longicornis*

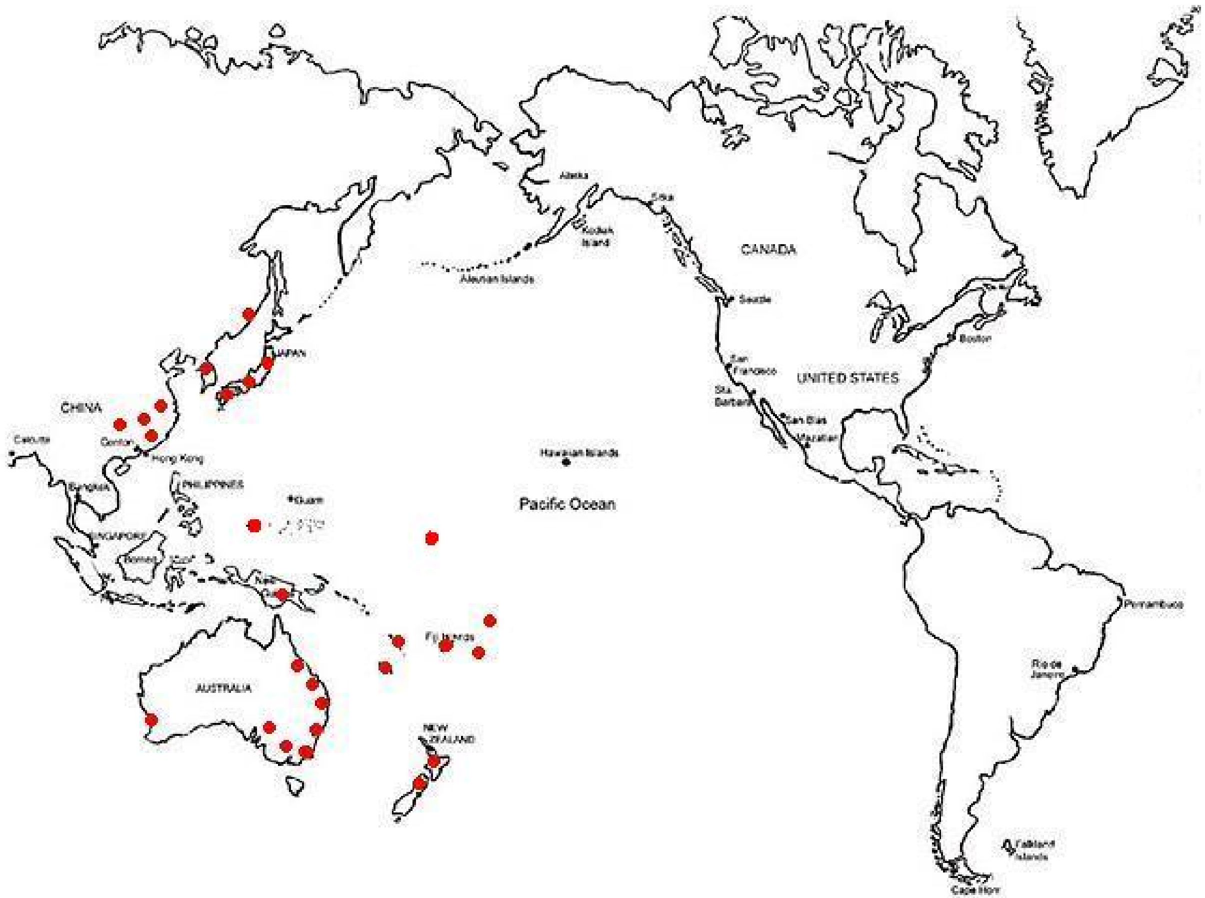
The Basics

- A parthenogenetic/bisexual species of ixodid (hard) tick
- A bisexual race occurs in Japan, Korea and China in conjunction with the parthenogenetic race
- First discovered in NZ in 1911
- A three host tick
- Life cycle in NZ completed in 12 months
- May be possible to have more than one generation annually
- Most Northern Hemisphere populations have 2 to 3 year life cycle and 4 to 8 month activity period annually

Western Pacific tick areas

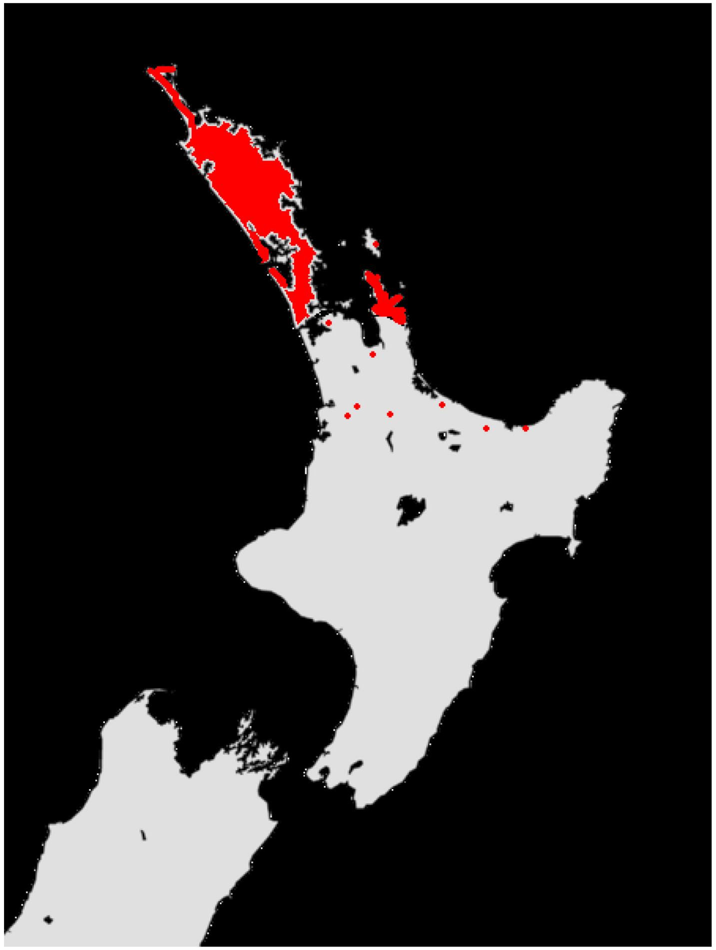


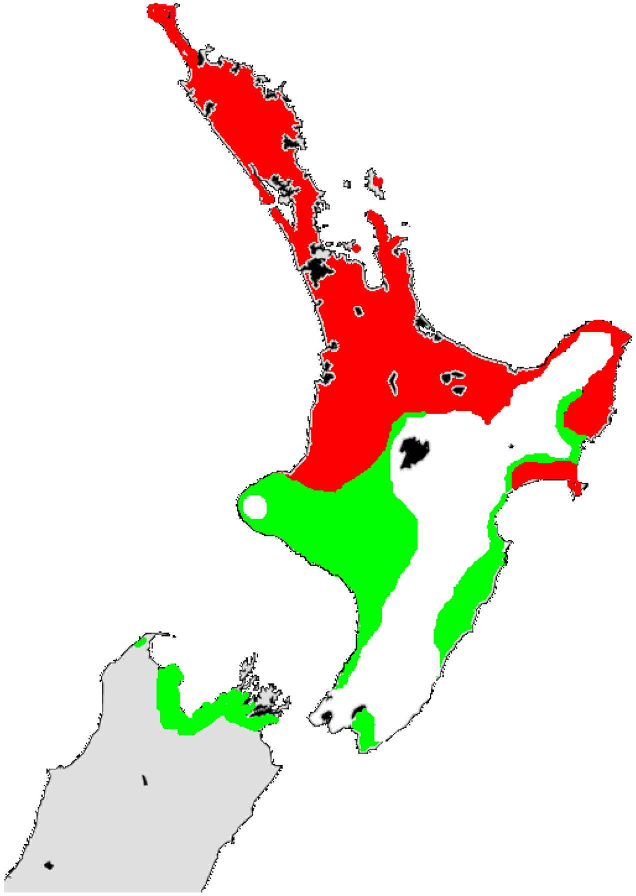
World distribution of *Haemaphysalis longicornis*



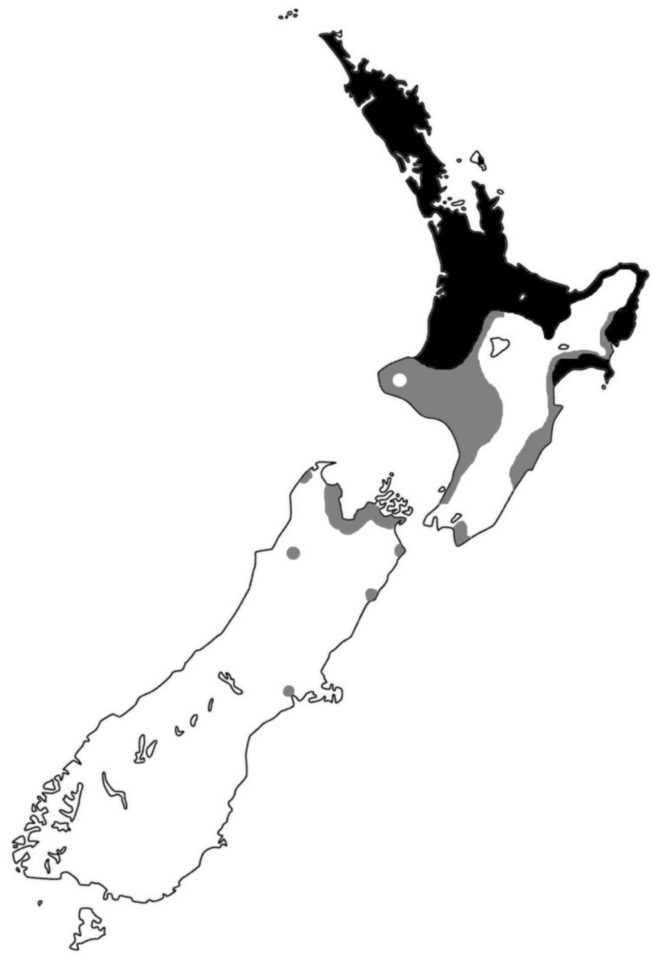
Adapted from *Greyhounds of the Sea The Story of the American Clipper Ship* Carl C. Cutler (New York:G.P. Putnam's Sons, 1930)

Cattle tick distribution 1924 & 2014

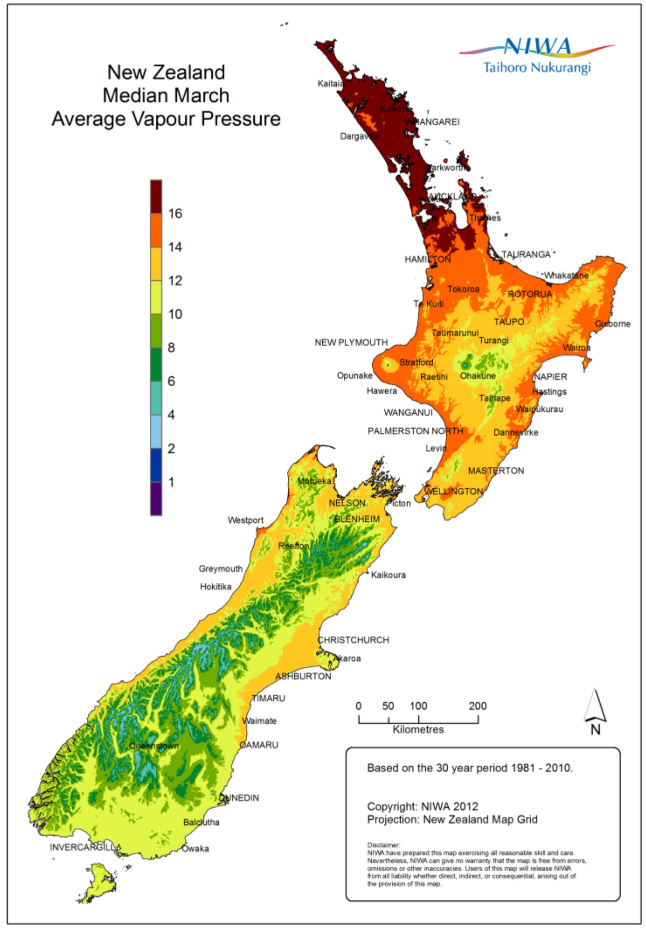




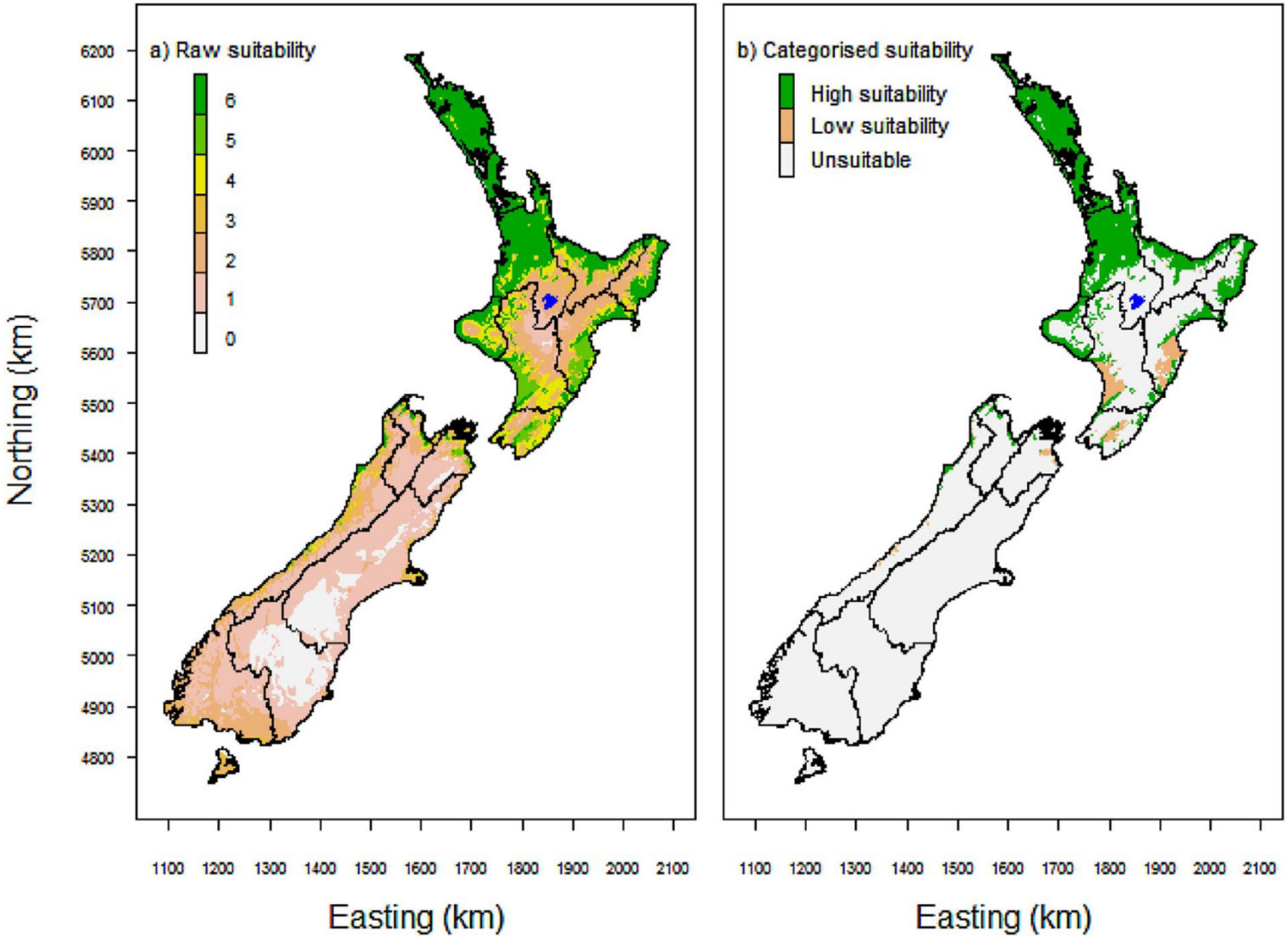
Distribution 2018



Weather parameter with good fit



Predicted distribution (Lawrence *et al*. 2017)



How is range achieved and defined?

- Favourable temperatures
- Favourable humidity/soil moisture levels
- Suitable hosts
- Suitable vegetation
- Farming systems, e.g., deer
- Free-ranging hosts to further distribute ticks

Haemaphysalis longicornis, all stages

写真1　フタトゲチマダニの卵，幼虫（吸血幼虫），若虫（吸血若虫），成虫（吸血成虫）（[illegible]原図）

Feeding times

- Larva: 3-9 days
- Nymph: 3-8 days
- Female: 7-14 days

The longer feeding times can occur during heavy infestations or with hosts that have experienced long-term exposure to ticks

Hosts for *H. longicornis*

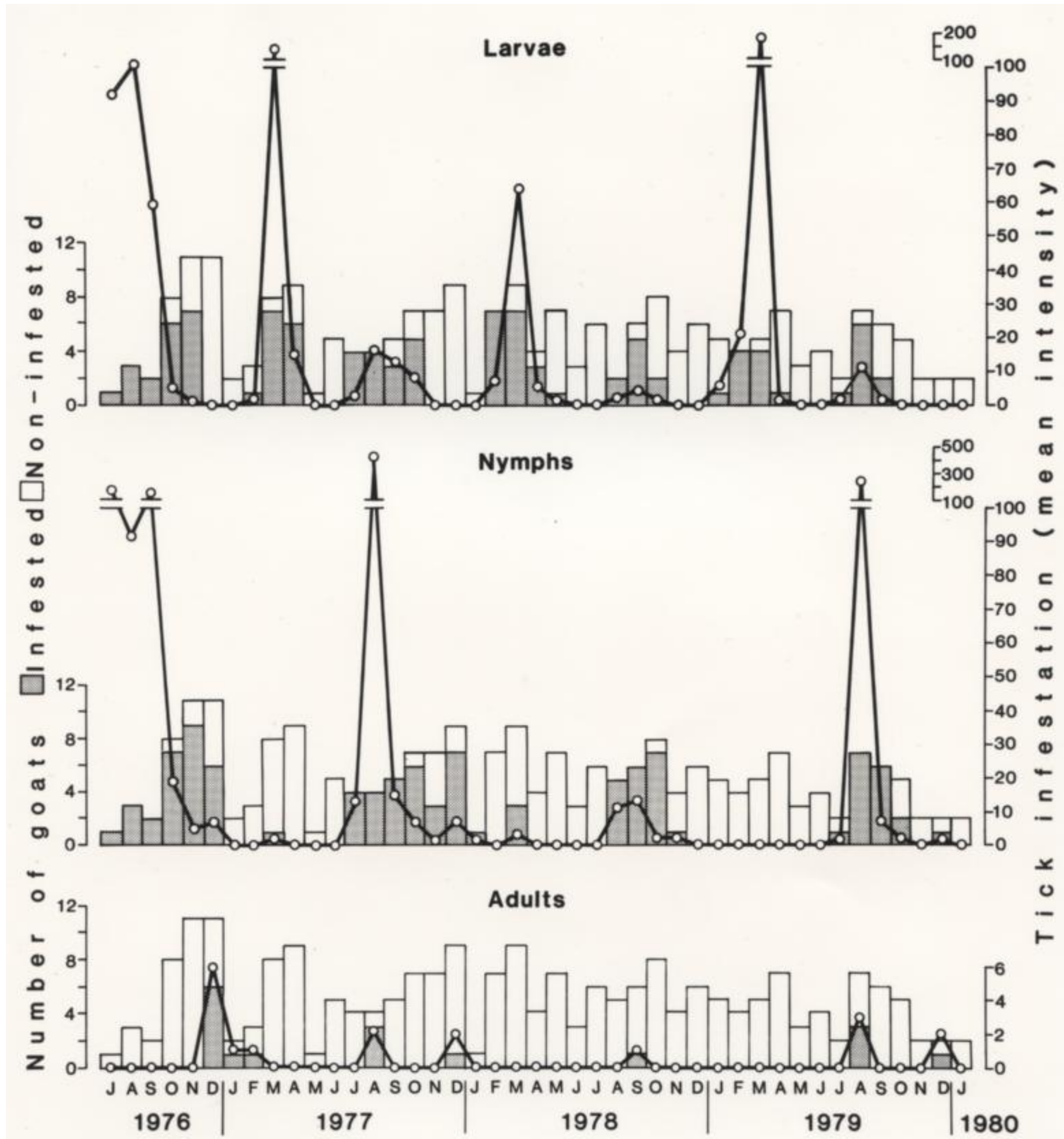
- All classes of livestock
- Companion animals
- Wild and feral mammals
- Numerous bird species
- Humans

Infested hosts

Seasonal cycle

- Each tick stage shows relatively discrete, synchronized activity
- Some overlap seen with other stages and age cohorts
- Deferred feeding most likely explanation
- Delayed development can occur because of low temperature or moisture levels
- Newly-moulted nymphs and some unfed females enter behavioural diapause
- Entrained by short day length in mid March
- Further control under temperature and humidity

Seasonal activity on goats



Seasonality, diagrammatic

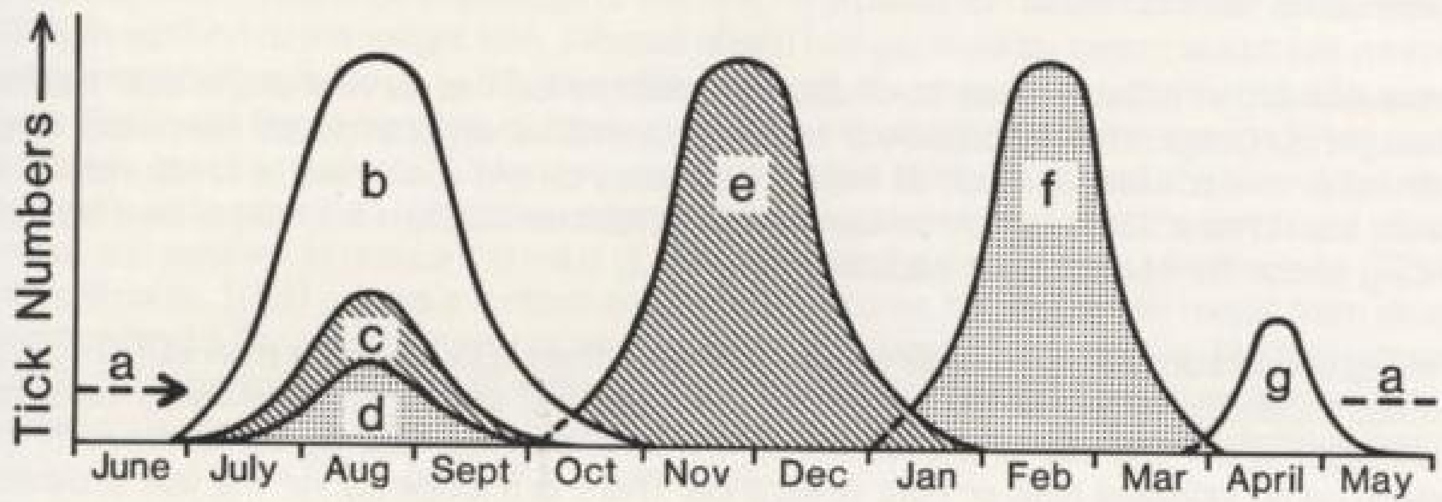


Figure 4.2 Diagrammatic representation of the seasonal pattern of activity of *Haemaphysalis longicornis* in warmer regions of New Zealand.

For simplicity, only major peaks are shown and the diagram should be interpreted using the key below. The troughs between peaks do not indicate a total absence of ticks on animals but show when ticks that comprise the main population cohorts for the year are undergoing development on the ground.

Key:

- [a] overwintering eggs, larvae, nymphs and adults.
- [b] main nymphal peak derived from overwintered unfed nymphs; gives rise to [e].
- [c] early adult peak derived from overwintered engorged nymphs; gives rise to larvae in early to mid-summer and nymphs in mid to late summer [g].
- [d] early larval peak derived from overwintered eggs or unfed larvae; gives rise to nymphs active in late spring to early summer and adults in late summer to autumn.
- [e] main adult peak derived from [b].
- [f] main larval peak derived from [e].
- [g] subsidiary nymphal peak derived from larvae feeding and moulting mid-late summer; these nymphs give rise to [c].

TEMPERATURE EFFECTS

Preferred temperature range*

*various authors

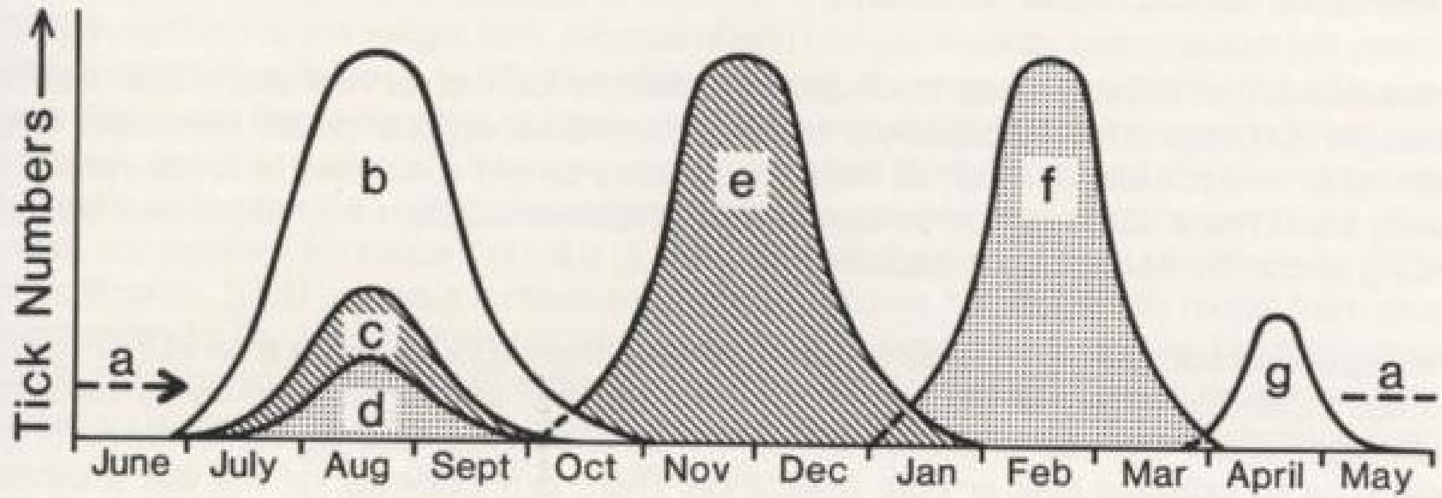
- Estimated threshold for development (all stages) 9-12°C [eggs will not hatch at ≤12°C and fed stages will not moult at <15°C].
- Interstadial development and incubation takes place between 15 and 38°C
- Rate of development slower at low temperatures but not linear throughout preferred range

Female and eggs

Developmental times

- **Female**: mean pre-oviposition period at 18°C, 16 days; 25-38°C, 4-5 days]
- Duration of oviposition can be up to 2 weeks
- **Egg**: mean incubation period at 15°C, >100 days; 18°C, 70 days; 25°C, 31 days; 28-35°C, 22 days

Seasonality, diagrammatic



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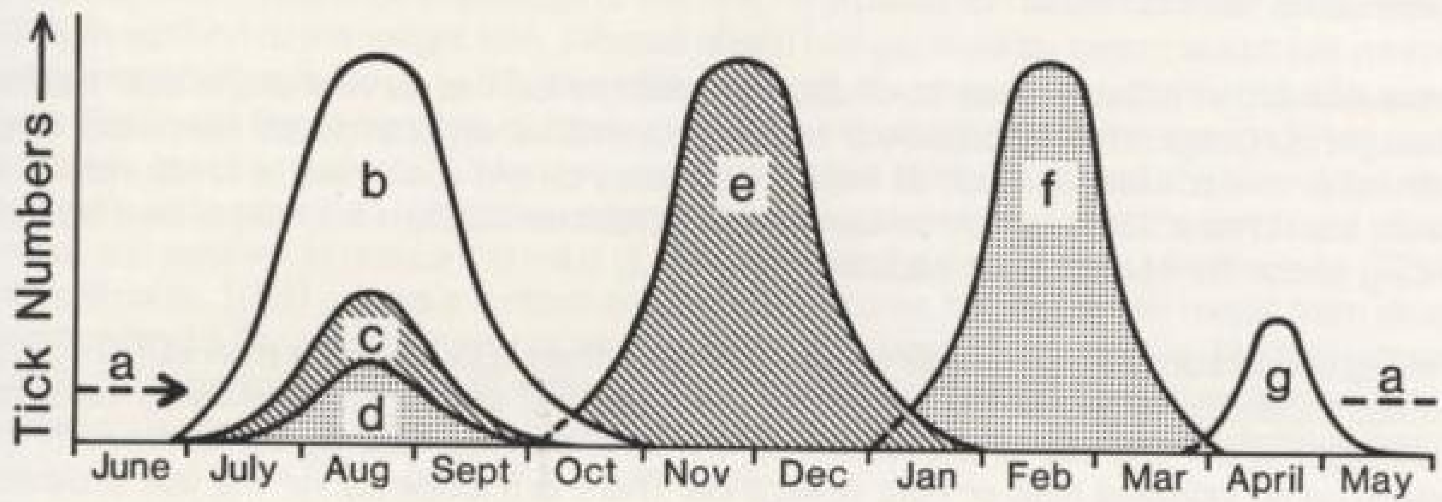
Engorged larva and nymph

Interstadial developmental times

- **Larva**: mean pre-moult at 15°C, 31 days; 18°C, 24 days; 28-35°C, 9 days
- **Nymph**: mean pre-moult at 18°C, 34 days; 25°C, 17 days; 28-38°C, 12 days

Low (sub-threshold) temperatures are not necessarily lethal, but by prolonging development expose ticks to diminishing food reserves and risk of dehydration

Seasonality, diagrammatic



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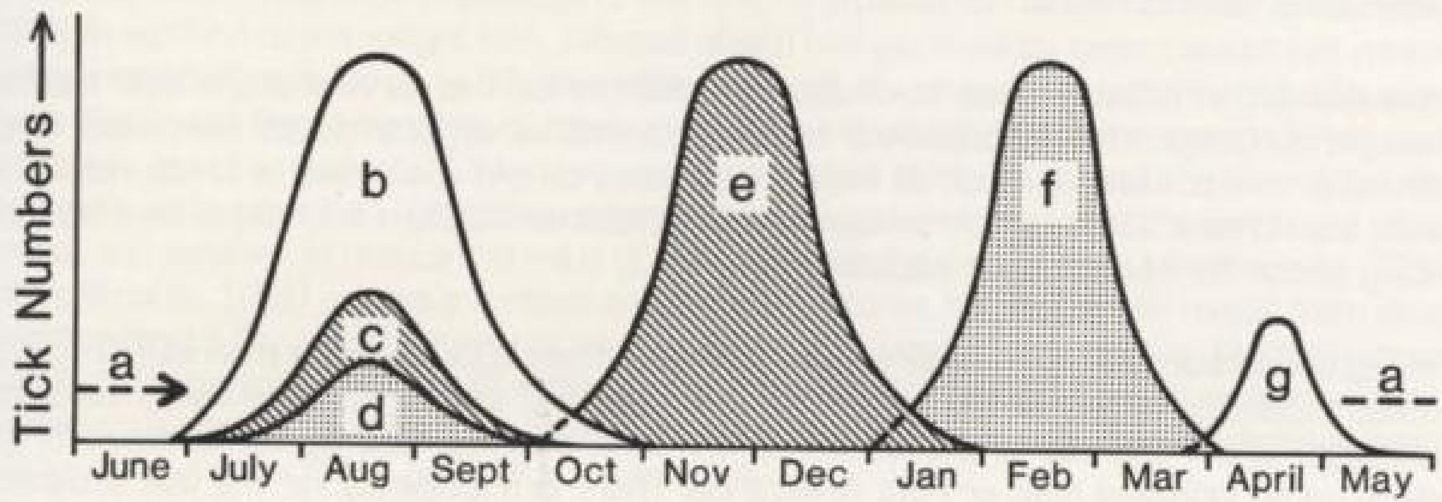
Photoperiod and diapause

- Mid March sees the ‘turnover’ from long days to short days
- Decreasing day length entrains behavioural diapause in most unfed nymphs from April onwards
- Do not quest again until July
- Low temperatures in June may break diapause
- In Northern Hemisphere populations other stages diapause as well
- Unfed females may diapause in NZ

Seasonality, diagrammatic



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HUMIDITY EFFECTS

Maintaining water balance

- Ticks can regain water and survive as long as no more than *ca* 35% of weight is lost
- Fed and unfed stages can absorb water from the air, the latter stage more so
- The further interstadial development and embryogenesis has proceeded at a high humidity, the more a dehydrating atmosphere can be tolerated
- Eggs and fed stages lose water more slowly than unfed stages
- Eggs cannot redress water loss, must rely on yolk and cuticle to slow evaporation
- Unfed nymph>egg>larva>female
- Fed nymph>female>egg>larva

Water vapour in air

- Relative humidity (RH%) is the percentage of the maximum water content in air at a given temperature
- Identical RH values do not indicate identical atmospheric moisture conditions unless temperature is the same

The drying power of air

- Saturation deficit (SD) measures drying power of air as mm Hg
- Same SD applies across a range of temperatures; makes them comparable, which RH% does not
- SD is same as vapour pressure deficit, VPD, [kPa]

Range of suitable humidity conditions for *H. longicornis**

(*various authors)

- Egg: 1-8 mm Hg SD
- Fed larva: 2-10 mm Hg SD
- Fed nymph: 2-20 mm Hg SD
- Fed adult: 2-20 mm Hg SD

At any given temperature the nymph can withstand more dehydration than can egg and larva yet, paradoxically, female can oviposit at humidities lethal to eggs

Response to dryness; near upper survivable limit

Egg at 8mm Hg SD

- 9% hatched after 21 days [22% weight loss; 1.1%/day]

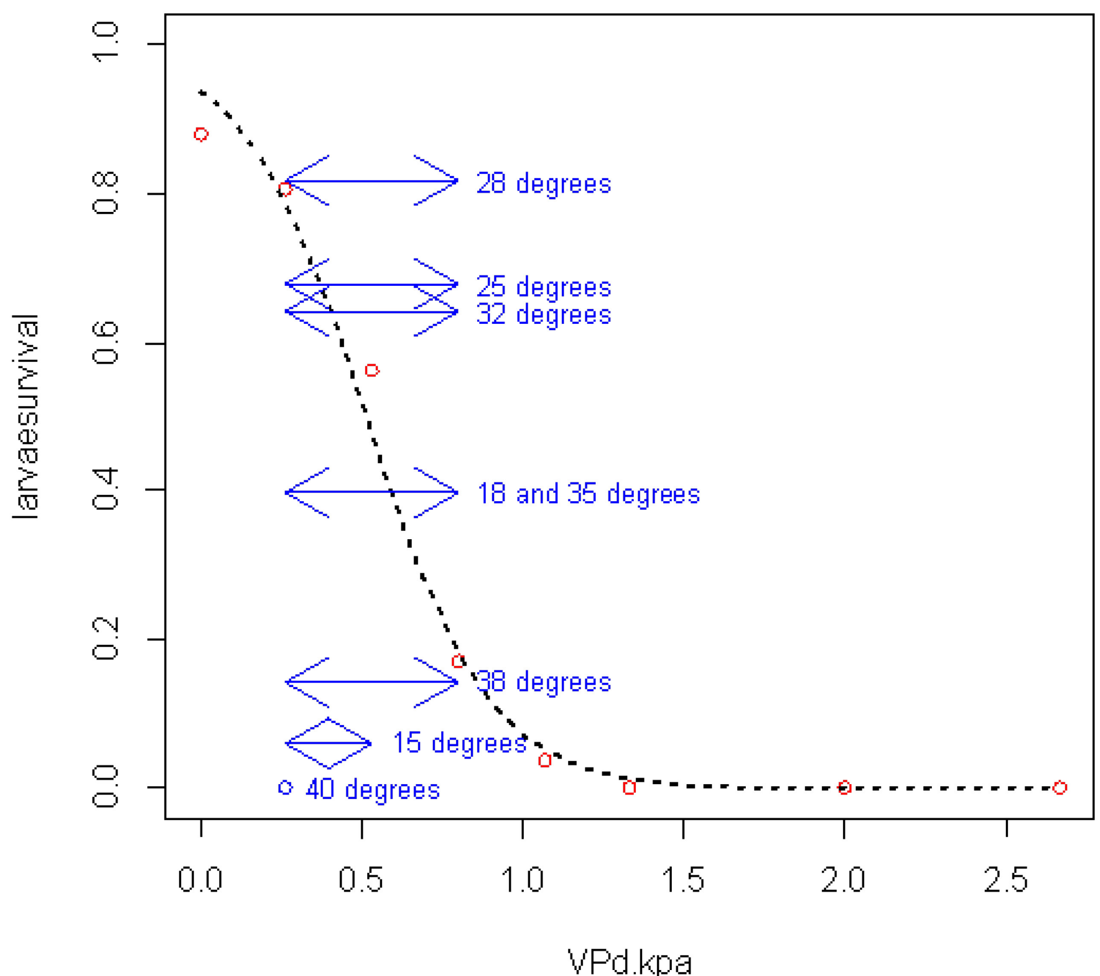
Fed larva at 8mm Hg SD

- 4% survived to moult after 12 days [*ca* 30% weight loss; 2.5%/day]

Fed nymph at 20mm Hg SD

- *ca* 15% survived to moult after15 days [30% weight loss; 2%/day]

Relationship between larval survival and vapour pressure deficit* (*graph by K. Lawrence)



Water balance

(Neilson 1980)

- **Unfed larva**: lost 11% weight after 4hr at *ca* 22mm Hg and 28°C
- Lived for 6-8 days when placed at 6mm Hg but lost more weight
- Regained weight at >2-3mm Hg
- **Unfed nymph**: lost 11-17% weight after 24 hr
- Regained weight at *ca* 6-9mm Hg

Water balance

- **Unfed female**: Lost 9% of weight over 48 hr at *ca* 22 mmHg (Neilson 1980)
- All died after 6-8 days when later placed at 6mm Hg
- Regained weight at >2-3mm Hg
- Lost 12.4% of weight at 4-5mm Hg and survived for 56 days (Kang 1981)

Redressing water balance

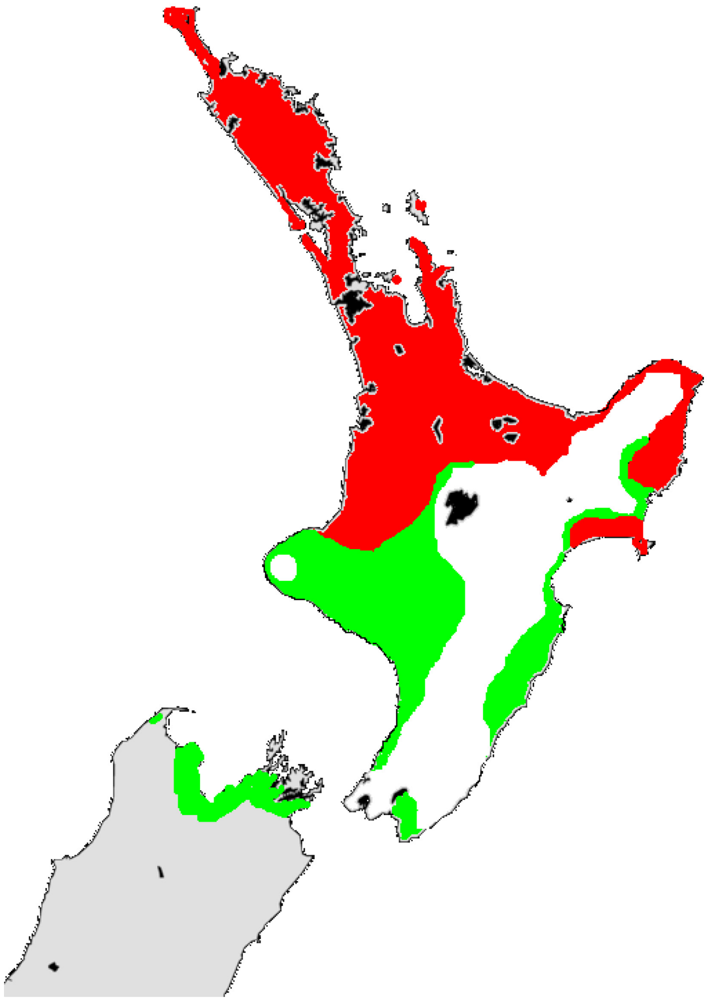
- Unfed stages can seek favourable moisture levels
- Eggs and fed stages are hostage to fluctuating humidities
- Pasture mat offers humidity higher than air above
- The moisture requirements of the larva and its relatively poor water retention capability (compared with other stages) limit where *H. longicornis* can survive and flourish

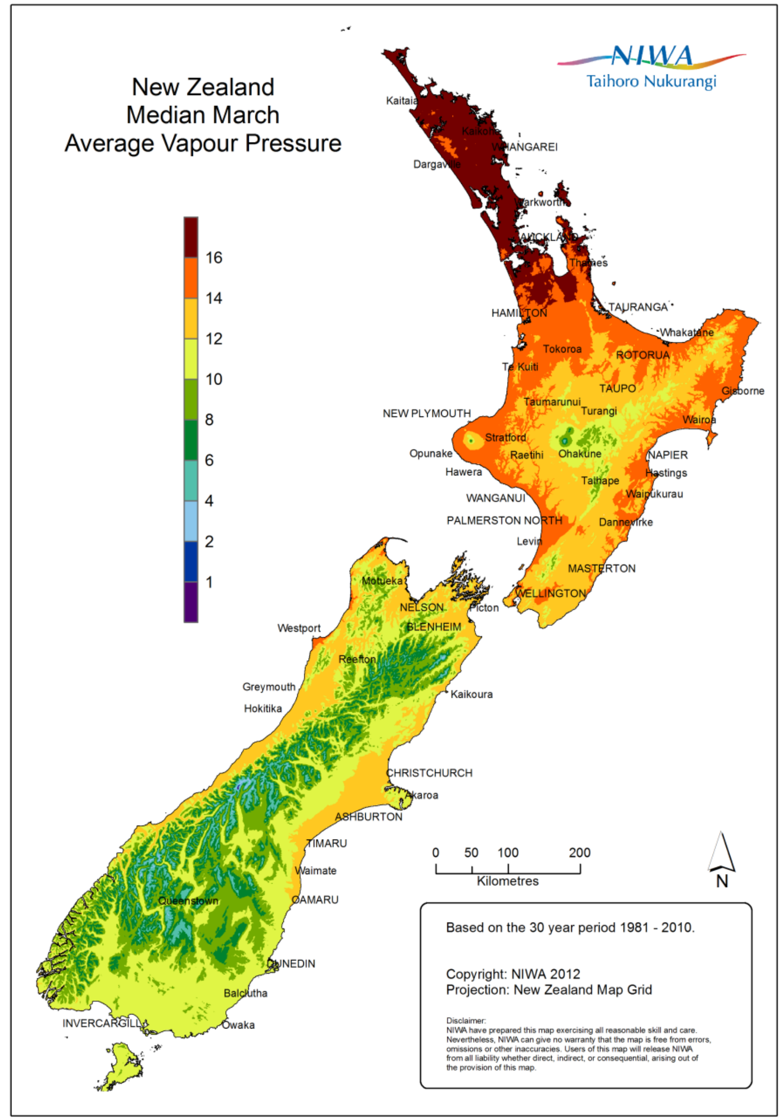
How likely is seasonal exposure to water stress?

- Nymph diapauses unfed in winter in grass mat; metabolic rate slowed; conditions are moist when it is active
- Adult active at warm, moist time of year, so not exposed to severe water stress anyway
- Egg is less able than adult and nymph to survive dehydration (cannot absorb water from air), but exposed to same conditions as female and loses water slowly
- Larva is most susceptible to dehydration in unfed state. Active at hottest, potentially driest time of year, but in grass mat when in pre-moult phase
- Periods of drought biggest threat

Matching distribution with climate

Cattle tick distribution and vapour pressure (hPa)

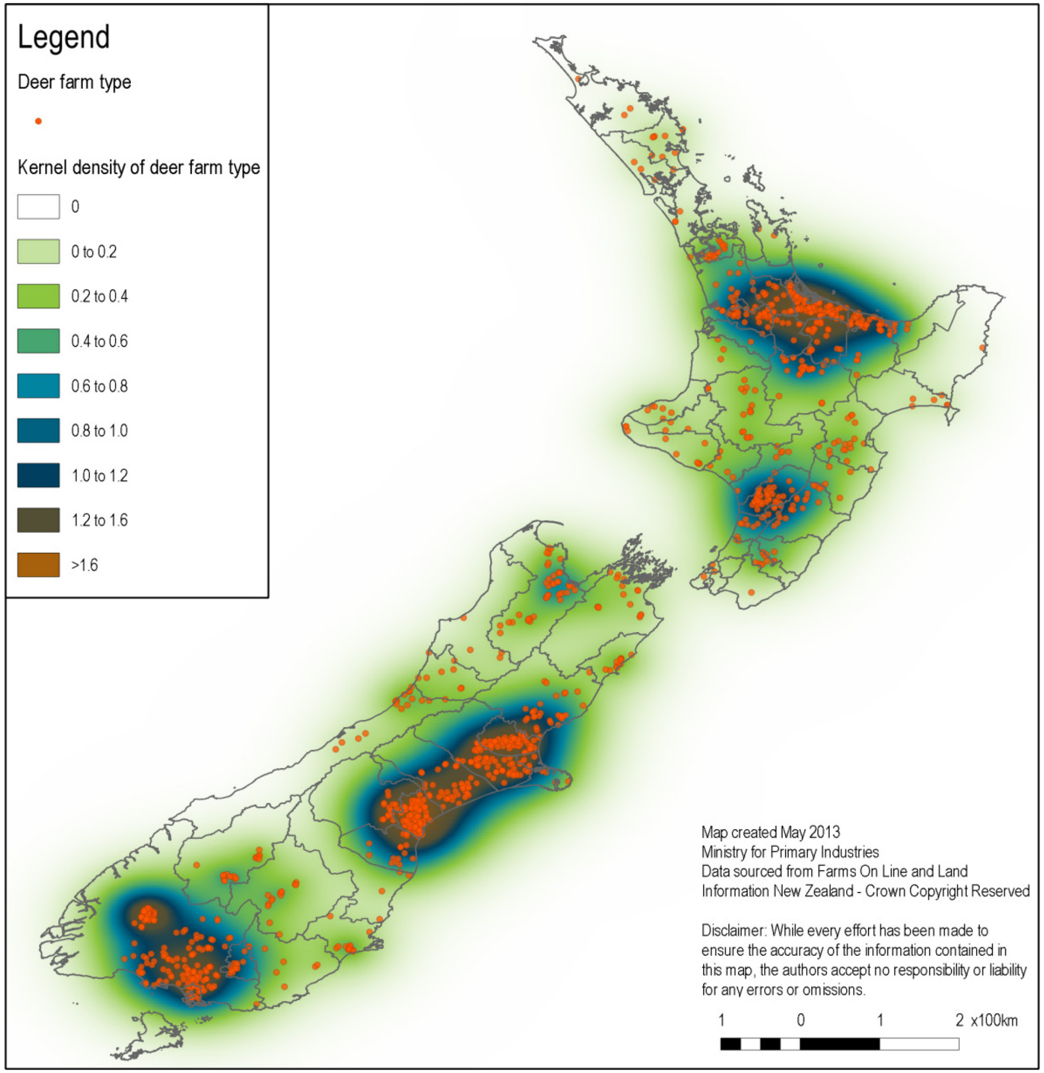




Future possibilities

- Climate change could produce wetter western areas and drier eastern and northern areas
- Climate change could produce warmer southern areas
- Irrigation and deer farming could provide suitable environments where these do not currently exist
- Unfettered movement of tick-infested stock and any other infested host provide ‘invasion’ opportunities

Deer farm density



Conclusions

- Current tick distribution can be matched adequately with some averaged climate parameters
- Some fit better than others
- Physiological needs of larva best indicator of tick's limits
- Possible to predict potential increase in range of tick today and with future climate change

Vector control

- **Control is a misnomer; population suppression or diminution is more accurate.**
- **Repeated, high rotation acaricide use can reduce numbers of larvae (susceptible stage); fewer larvae can or should mean fewer infective nymphs.**
- **Maintenance of acaricide pressure throughout nymphal and adult activity phases reduces risks to naïve stock; also reduce numbers of females that eventually lay eggs**

Vector control

- **Flumethrin touted as 'sterilizing' ticks, but only *Hyalomma* and *Rhipicephalus in vitro*. Hardly simulates field experience**
- **Surest way is to ‘vacuum clean’ or mop up ticks from pasture using low-value stock that can be saturation-dipped**
- **However, wild, mobile, wide-ranging hosts will in time contribute to replenishment of tick numbers**
- **Use cattle resistant or refractory to ticks; selective breeding**
- **Pasture spelling may have limited value**

Acknowledgements

- Kevin Lawrence for useful discussion and provision of some maps
- Many veterinarians and colleagues for information on tick distribution
- The internet for any unattributed photos or figures
- Various unattributed authors
- AgResearch funding partly supported this work