# A VECTOR FOR ALL SEASONS

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# Climate Influences Infectious Disease

- Possible environmental influences on:
  - Vectors = organisms that can transmit infectious agents between humans or from animals to humans
  - Hosts = animal or person infected by infectious agent
  - Pathogens = infectious agents
  - Human exposure = interactions with environment

# Environmentally Sensitive Diseases in WA

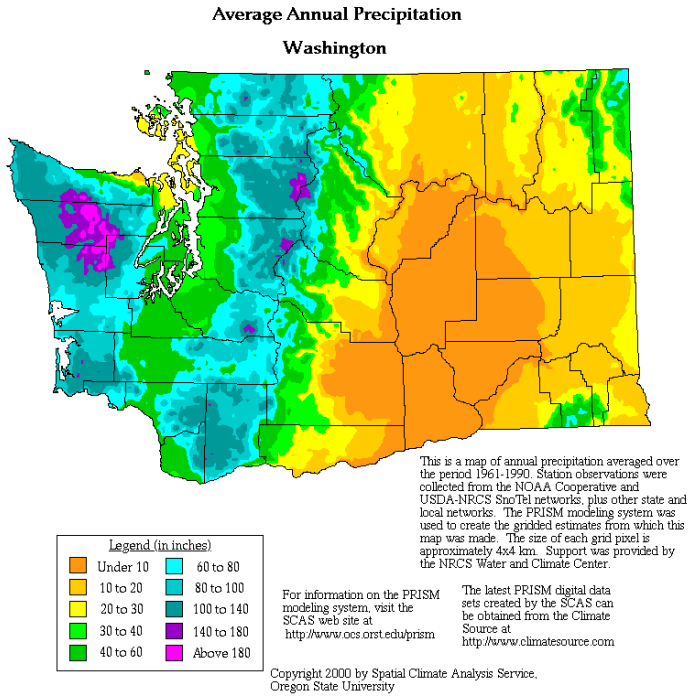
1. **Coccidioidomycosis (Valley Fever)**
   Environmental fungus impacted by weather, soil conditions
2. **Cryptococcosis (C. gattii)**
   Environmental fungus impacted by weather
3. **Hantavirus**
   Complex interactions between deer mice populations & environment
4. **Rabies, suspected rabies exposures**
   Bat populations affected by weather, climate
5. **Leptospirosis**
   Changes in rodent populations, flooding
6. **Plague**
   Changes in rodent and vector populations

# Vector-borne Disease in WA

- Main disease vectors of concern are mosquitos and ticks
- Vector-borne diseases found/potentially found in WA include:
  - West Nile virus
  - St Louis Encephalitis
  - Lyme disease
  - Anaplasmosis
  - Babesiosis
  - Rocky Mountain Spotted Fever
  - Relapsing Fever
  - Tick paralysis
  - Tularemia
  - Q fever

# Disease Prediction

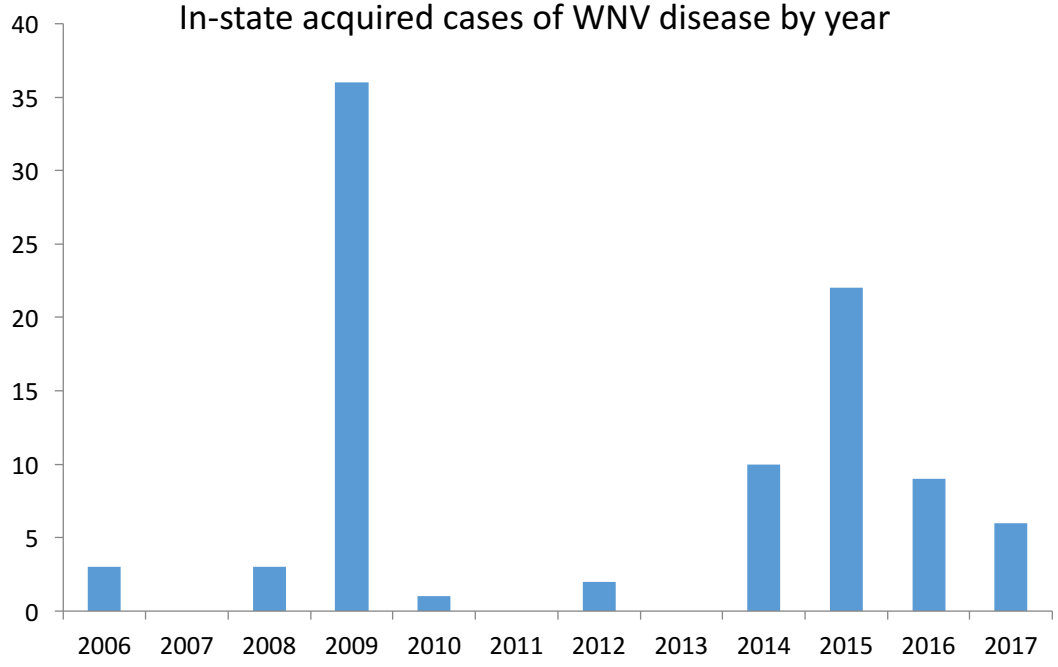
- Predictive models often require years of data, many variables
- Complex interactions between environment, reservoir and vector species, and hosts
  - Microclimates
  - Disease clustering
- How to develop pragmatic solutions to assist in predicting changes?
  - Distribution
  - Burden
  - Seasonality
  - Introductions/emergence

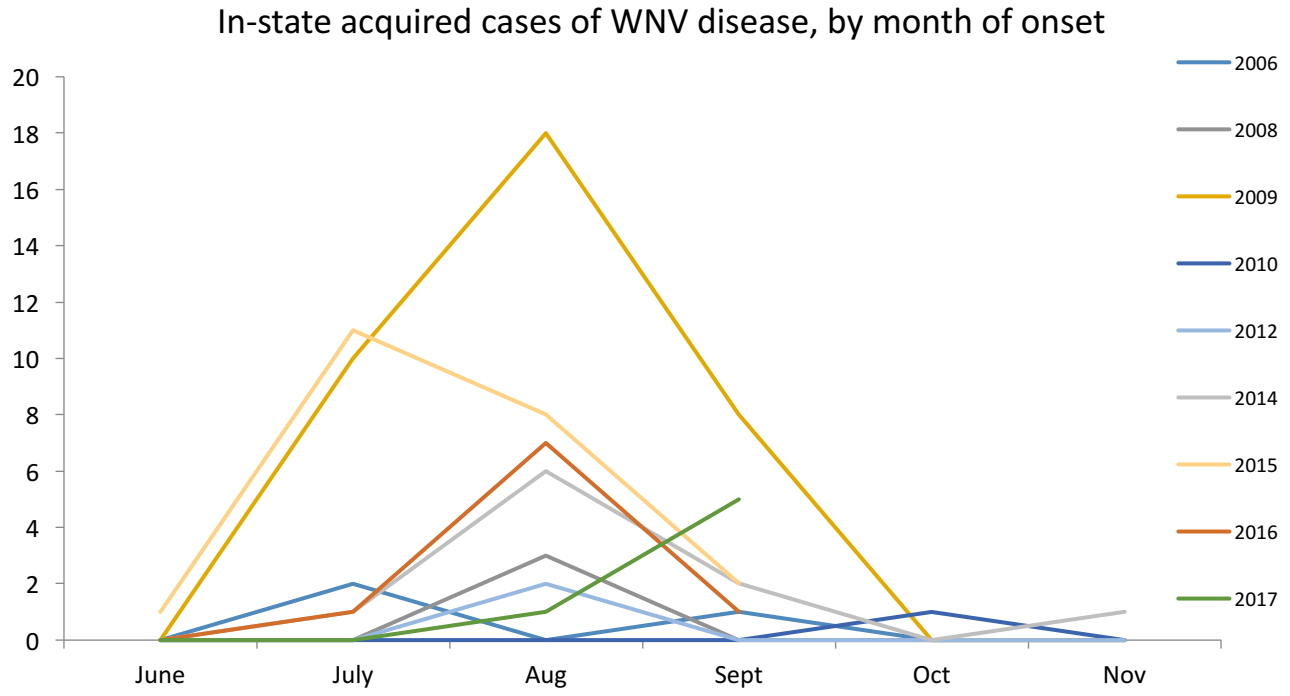


# Disease Modeling

## We are interested in both short-term and long-term disease modeling

Short term: WNV severe season versus no disease season, seasonal shifts

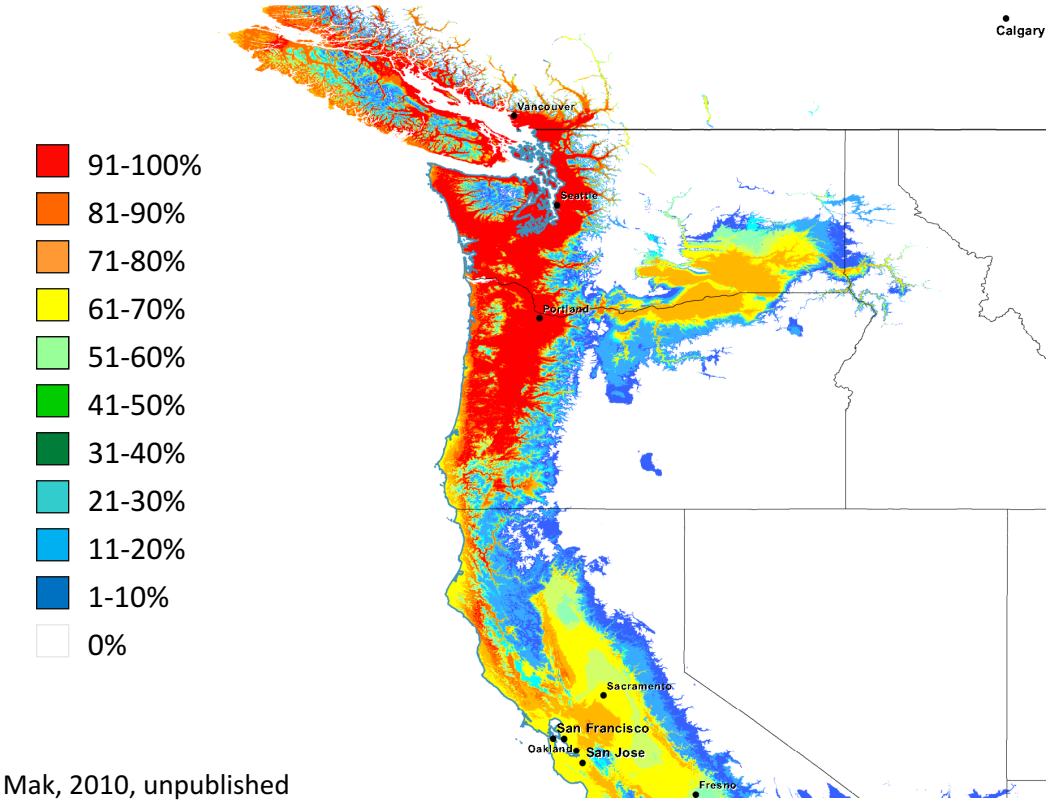


# Disease Modeling

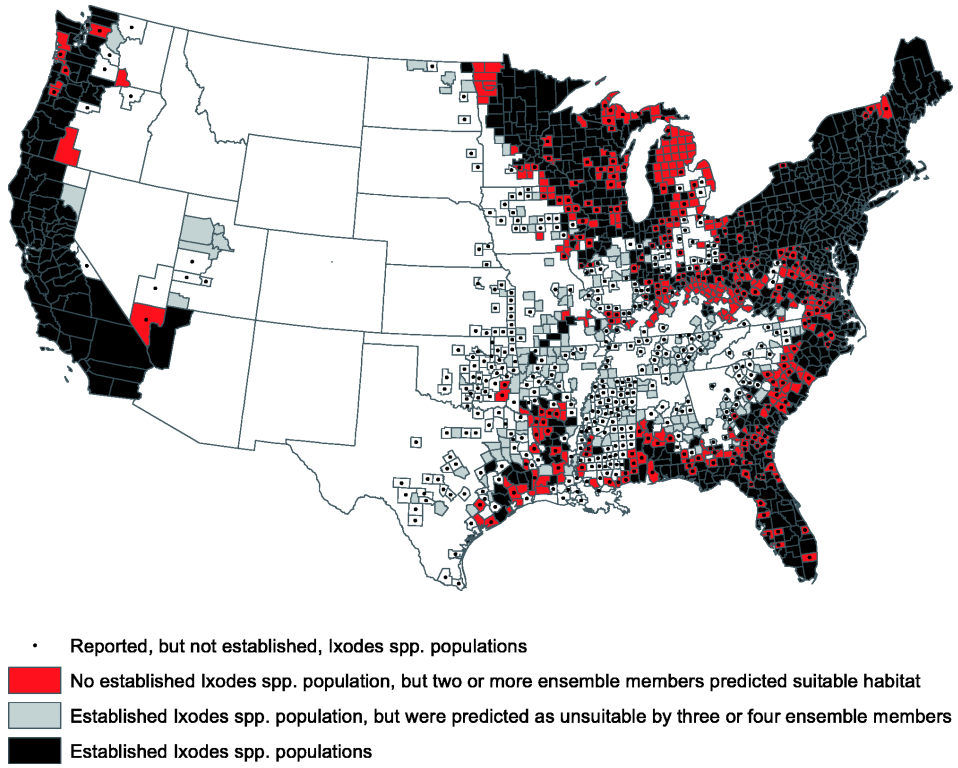
Long term: expansion/contraction of pathogen or vector range, seasonal expansion/ contraction or shifts

Ecological niche modeling of *Cryptococcus gattii* occurrence




Harris & Mak, 2010, unpublished

*Ixodes spp.* expansion




Hahn, et al 2016, Journal of Medical Entomology

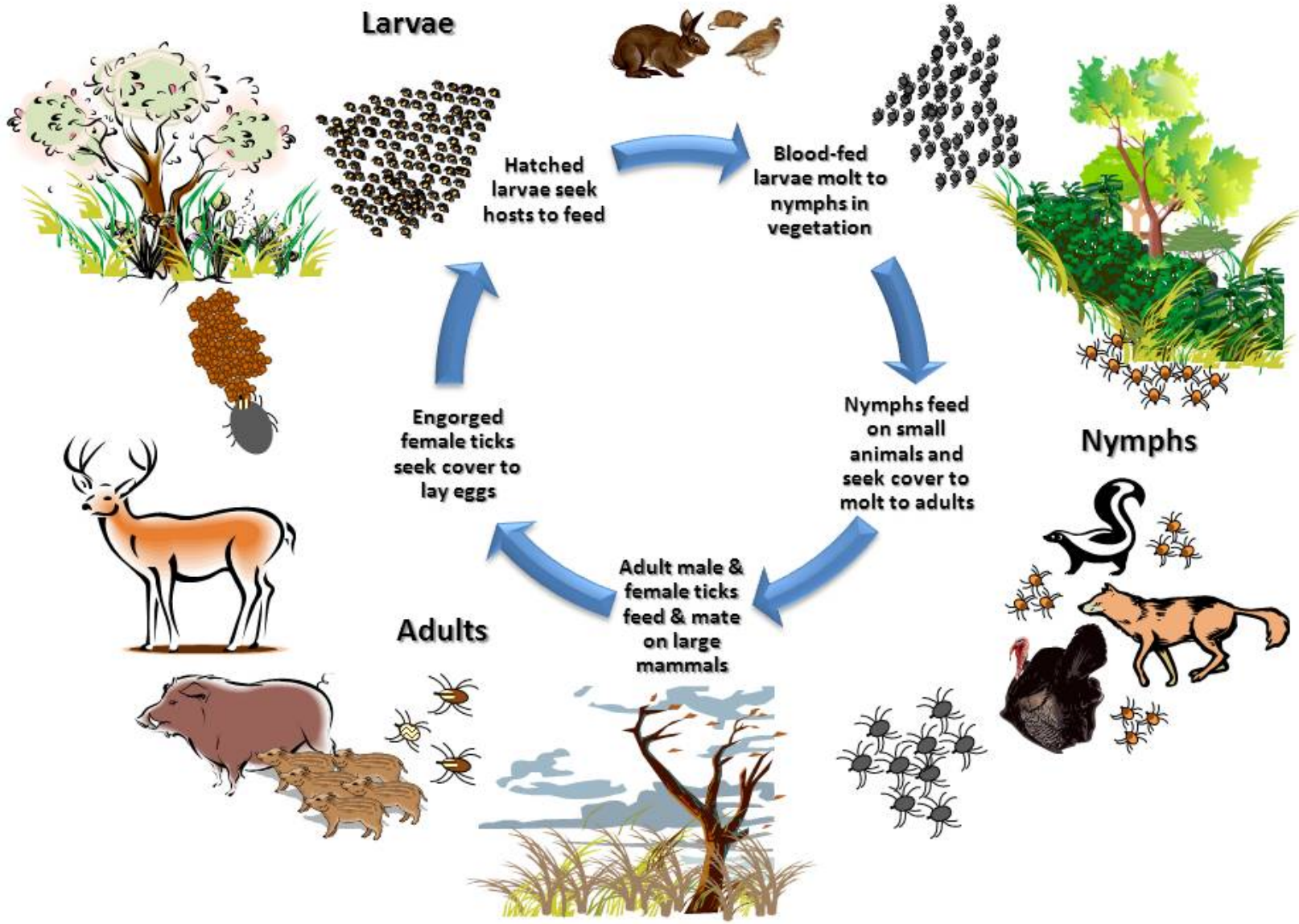
# Challenges and Opportunities

1. Many endemic diseases, finding predictors for each will take time
2. Many opportunities to use climate/weather data to assist public health decision-making
3. Need for pragmatic solutions for early prediction to lead to usable data for health alerts, program planning, etc.

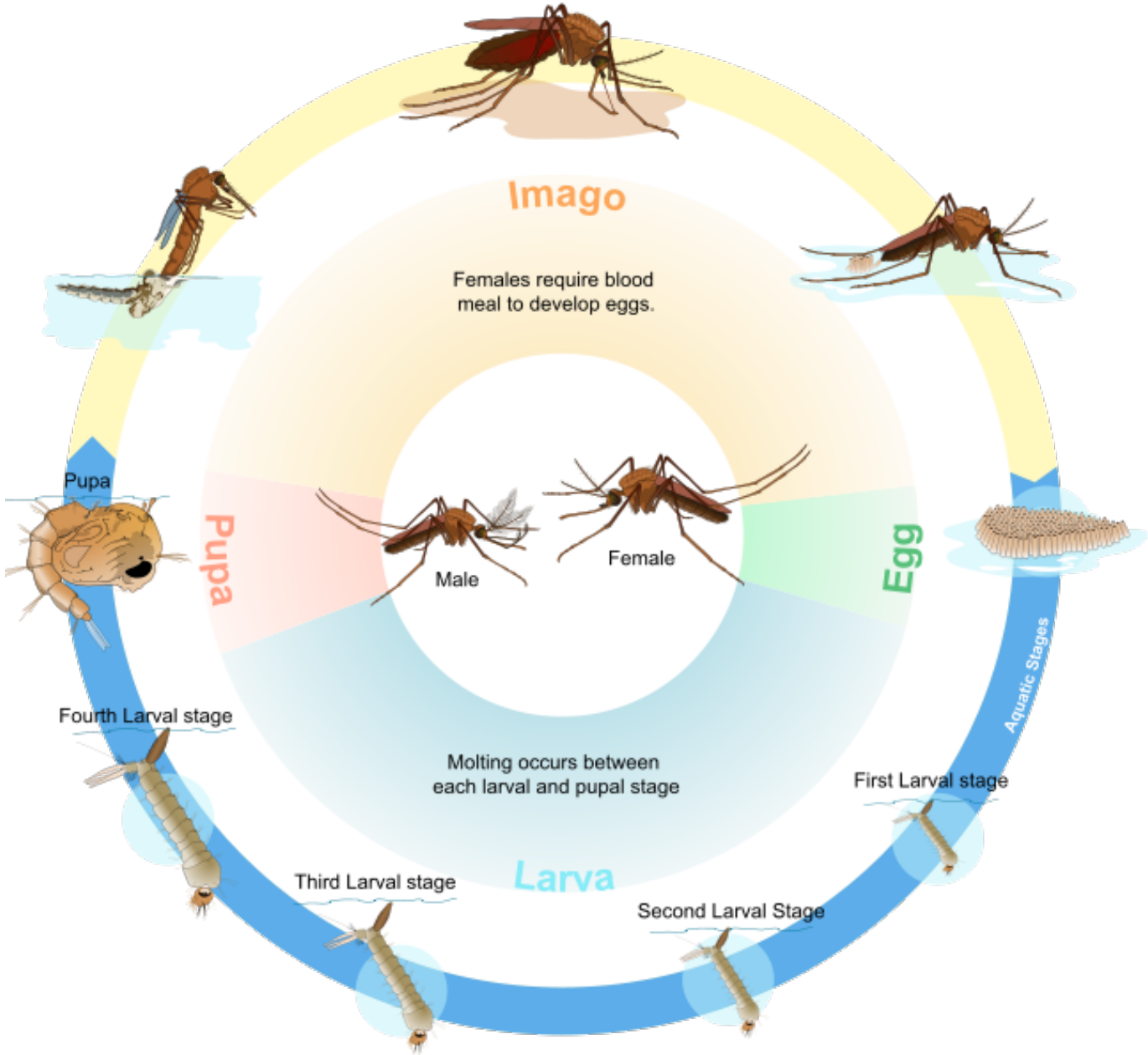
# WA DOH Vector Surveillance Projects

1. **Mosquito Surveillance**
   - Targeted towards West Nile Virus detection
   - Secondarily track species distribution trends

2. **Tick Surveillance**
   - Targeted towards pathogen detection and tick species distribution in WA
   - Collect weather data just before and immediately following field surveillance activity
     - Temperature
     - Relative Humidity
     - Wind Speed and Direction

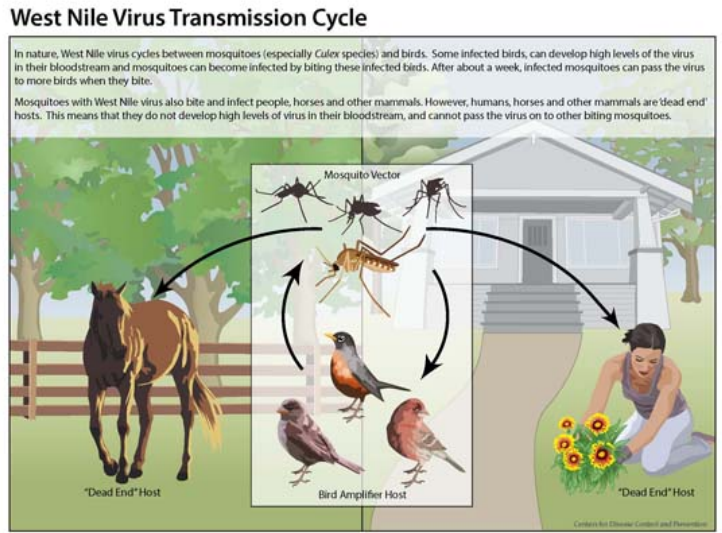



Typical three-host tick life cycle


Imago
Females require blood meal to develop eggs.
Male
Female
Egg
Aquatic Stages
First Larval stage
Second Larval Stage
Third Larval stage
Fourth Larval stage
Larva
Molting occurs between each larval and pupal stage
Pupa
Pupa

# Example: West Nile virus (WNV)

1. Arthropod vectors = *Culex pipiens* and Cx. *tarsalis* mosquitos
   a. Require sufficient rainfall/irrigation for habitats
   b. Habitats influenced by evapotranspiration and other hydrological processes
   c. Temperature affects the length of the gonotrophic cycle
   d. Temperature affects the extrinsic incubation period of the virus
2. Avian hosts
   a. Land use differences - impact on bird reservoir community composition or viral prevalence.
   b. Migration patterns
3. Human exposure
   a. Human activities are affected by climate
4. Mosquito – Vertebrate Host Interactions
   a. Seasonal shifts in mosquito feeding preferences from amplifying bird hosts to humans following bird migration
   b. Human interventions



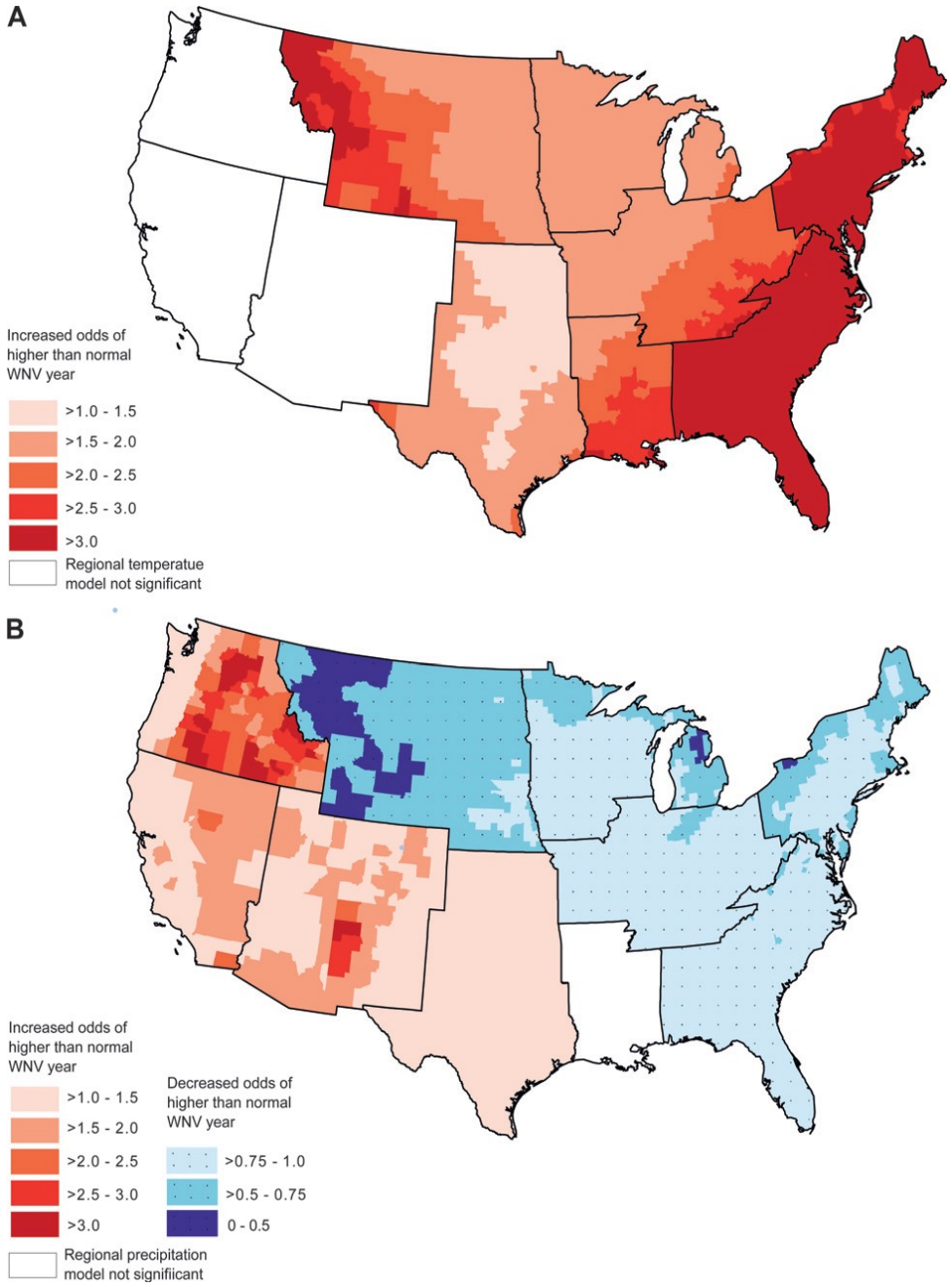
# Meteorological Conditions Associated with Increased Incidence of WNV

Odds of experiencing a higher than normal West Nile virus (WNV) year if the

A) annual average temperature in a county is 1 °C warmer than normal or

B) B) the total annual precipitation is 100 mm more than normal.

- Drier than normal conditions in wetter mountain west may favor *Cx. pipiens* breeding
- Precipitation anomalies in either direction may provide ideal breeding sites for one species or the other.



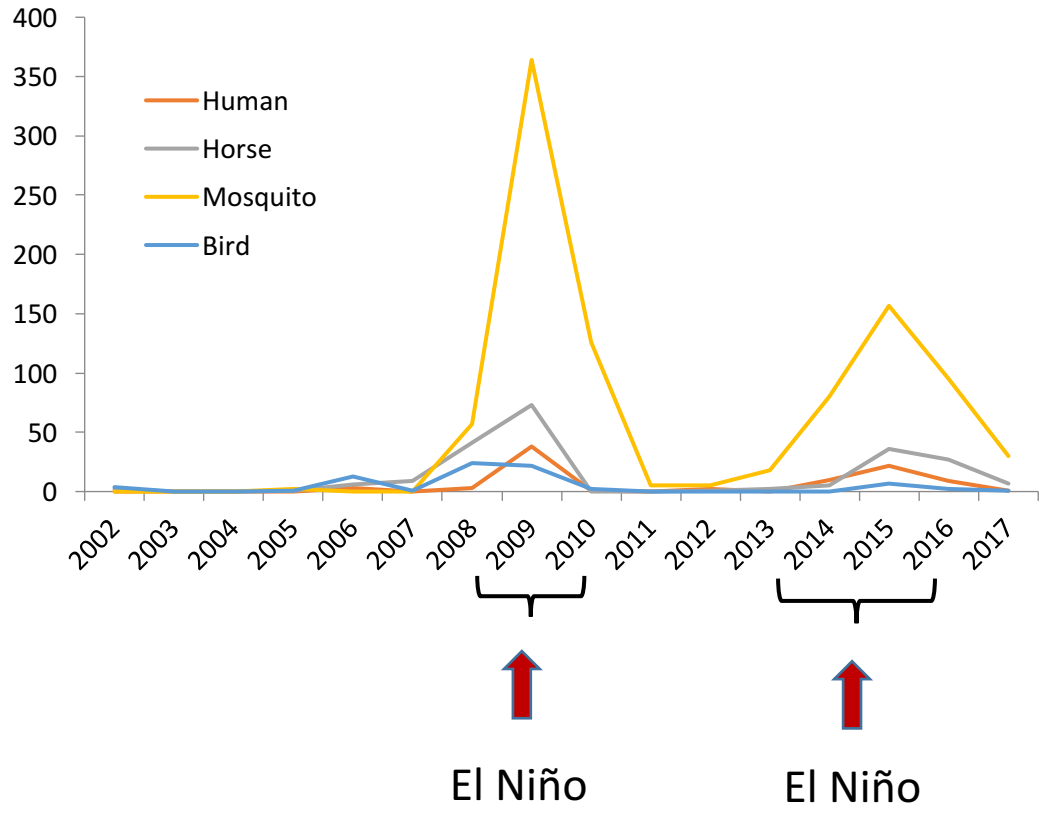

Hahn et al. 2015, American Journal of Tropical Medicine & Hygiene

# Understand risk and exposure retrospectively

1. What climate factors are important in WA environment?

2. What climate factors are usable predictors
   a. Ease of access
   b. Early warning

- Apply possible predictors to past data to understand application in WA
- Test with prospective data



# Inform early detection and response systems

Use climate factors to:

a. Forecast risk by season

b. Plan budget and workforce capacity needs

c. Plan mosquito-control and other prevention measures

d. Improve health promotion and protection messaging

*Help tame the unpredictable*

# Challenges and Opportunities

1. Broad range of environments studied, but limited/specific area with endemic disease in WA
    a. Finding granular data for our areas of interest

2. Opportunities for collaborations between climate scientists and disease experts

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