Impact of Climate Change on Vector-Borne Diseases

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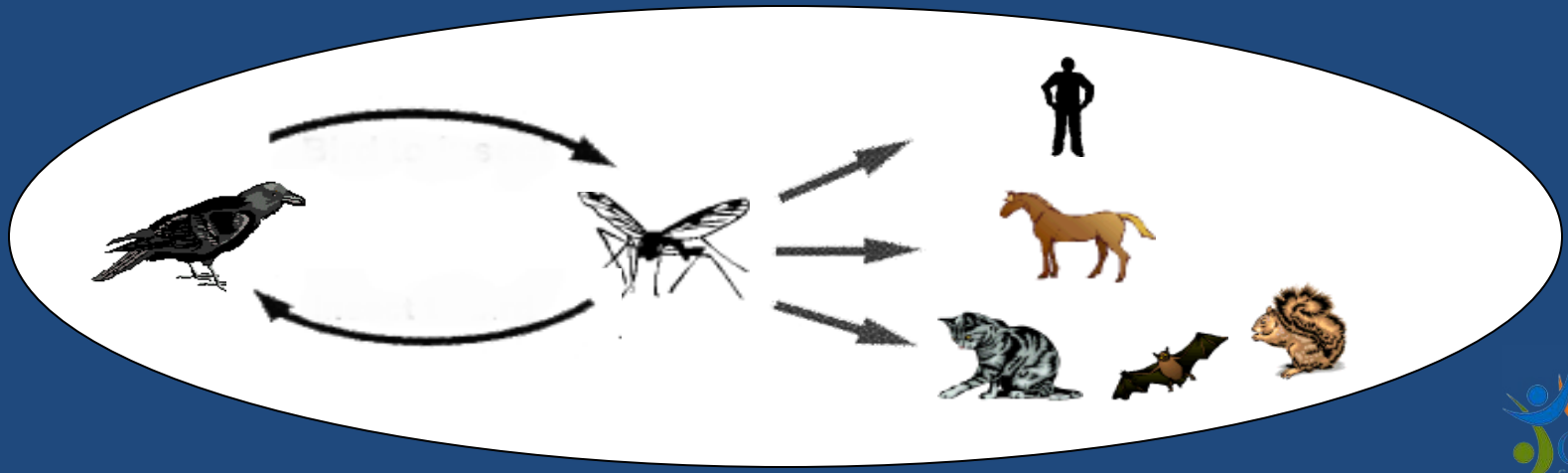
Important Diseases/Vectors in CA

- West Nile virus (WNV)
- Invasive *Aedes* mosquitoes
- Lyme disease
- Hantavirus

Many factors influence the level of West Nile virus activity

- Climate
  - Temperature, precipitation
- Mosquito abundance and type
- Number and types of birds
  - Level of immunity; survive previous infection



Temperature

- Warm spring temperatures prompt early season mosquito activity and a longer virus amplification period
- Hot temperatures = increased WNV activity
  - Increase mosquito development rate (egg to adult) so greater population size
  - Increase viral replication rate within the mosquito
  - Increase the speed the virus reaches the salivary glands
  - Increase the speed mosquitoes are able to digest blood so they feed more often (thus spreading infections more quickly)

Precipitation

- The role of rainfall is less clear cut than temperature
- *Culex* mosquitoes need pools of standing water to breed and develop, but too much rainfall can wash away the developing mosquitoes
- In general, drought has been associated with increased WNV activity
  - Prevents the "washing out" of underground mosquito populations in urban waste water systems or other water sources
  - More stagnant water sources earlier in mosquito "season"
  - May force birds and mosquitoes into closer proximity as both seek out limited sources of water, especially in urban areas, resulting in virus amplification

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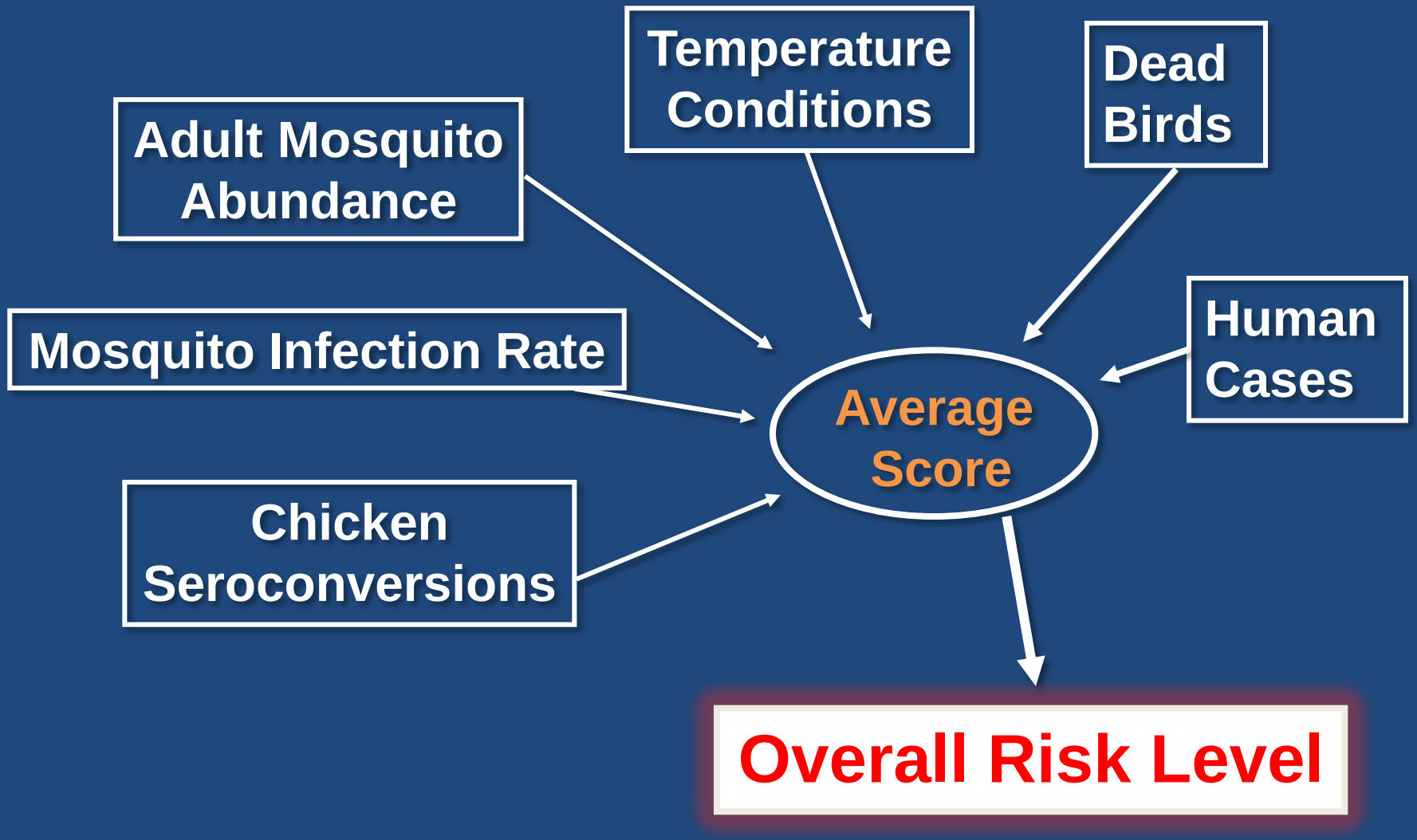
CA WNV Surveillance Program

1. Dead Bird Testing
2. Mosquito Testing
3. Sentinel Chicken Testing
4. Human Case Surveillance

CA Mosquito-borne Virus Surveillance and Response Plan

WNV Risk Assessment Model



Climatic Conditions 2014
Record WNV Activity

- Warmest year on record (avg. temp of 61.5°)
- Drought
- WNV records in 2014
  - Number of West Nile neuroinvasive disease cases
  - Number of fatal cases
  - Proportion of infected mosquitoes
  - Prevalence of infected dead birds

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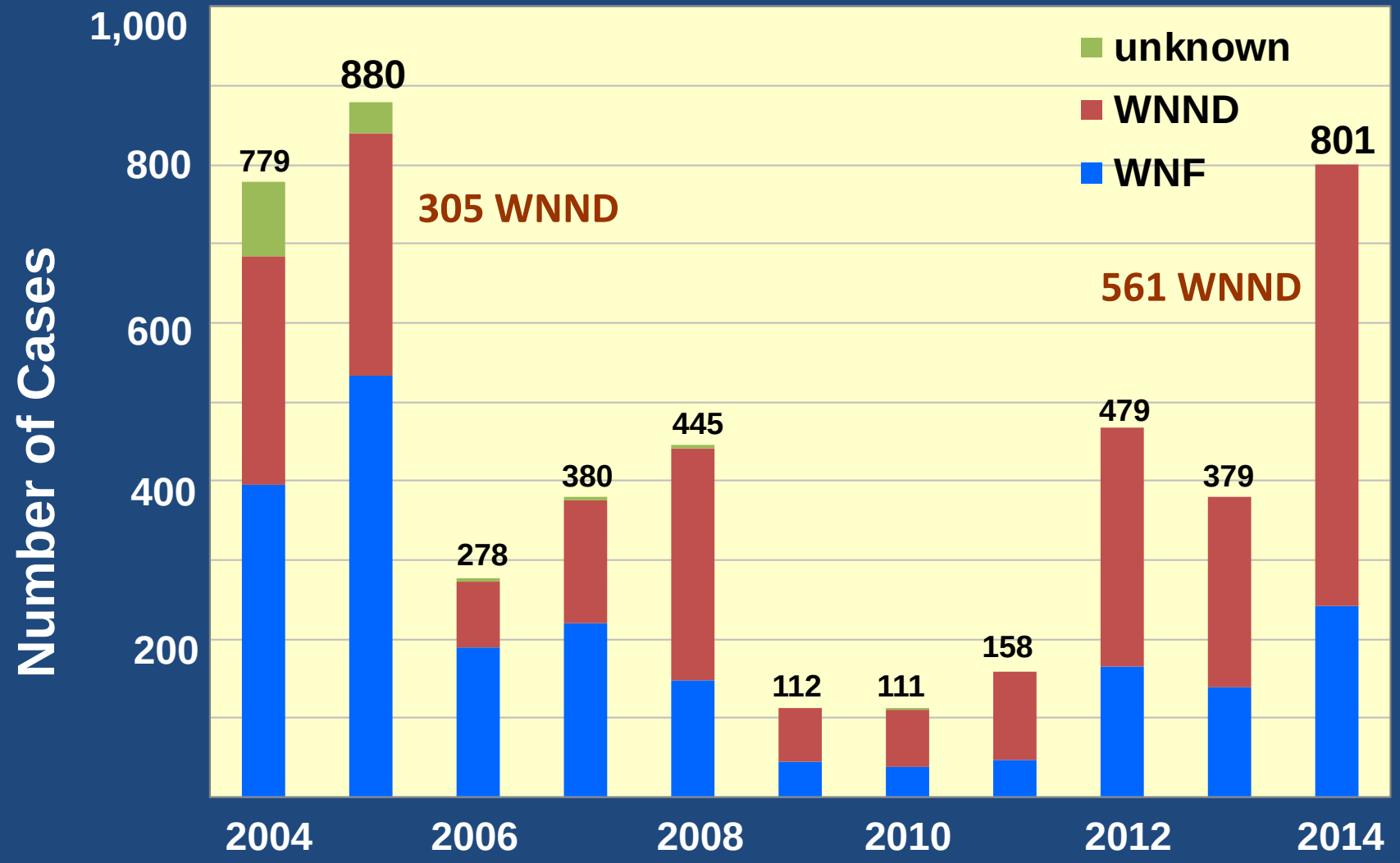
Human WNV Cases in CA, 2004 – 2014

4,802 cases (176 fatal)



CDC: Each WNND case equates to 30-70 non-neuroinvasive cases

2014: Up to 40,000 cases

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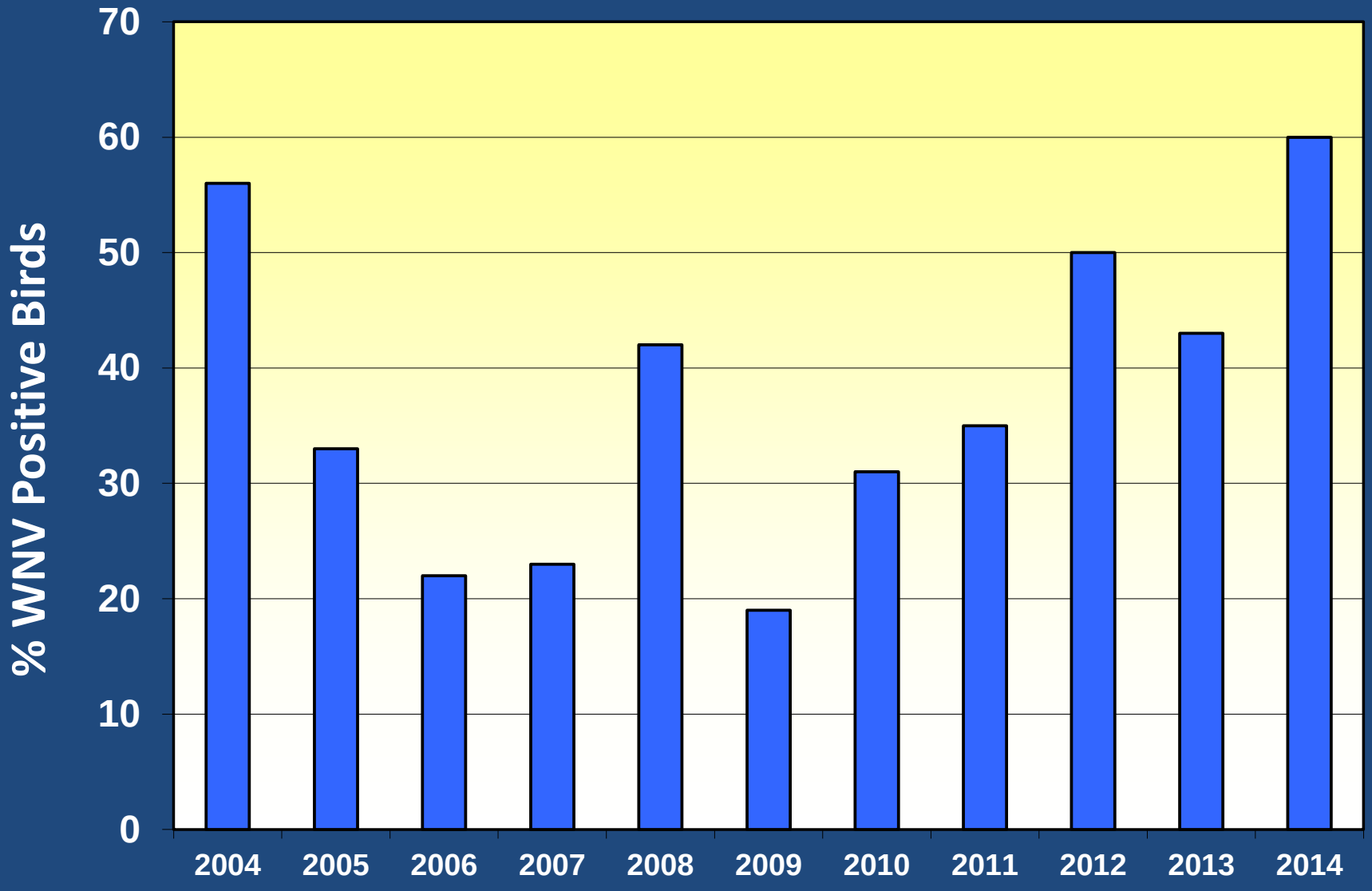
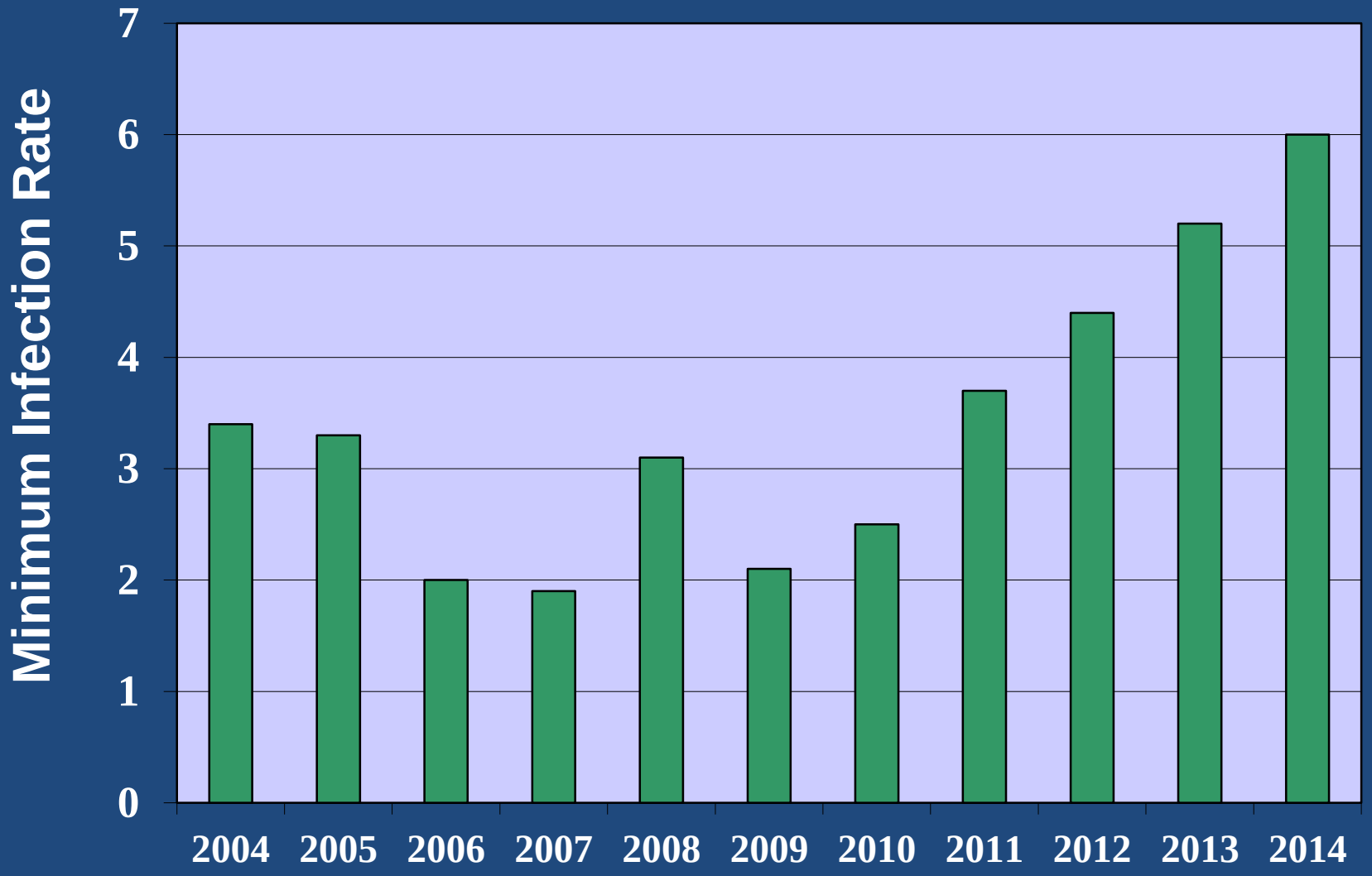
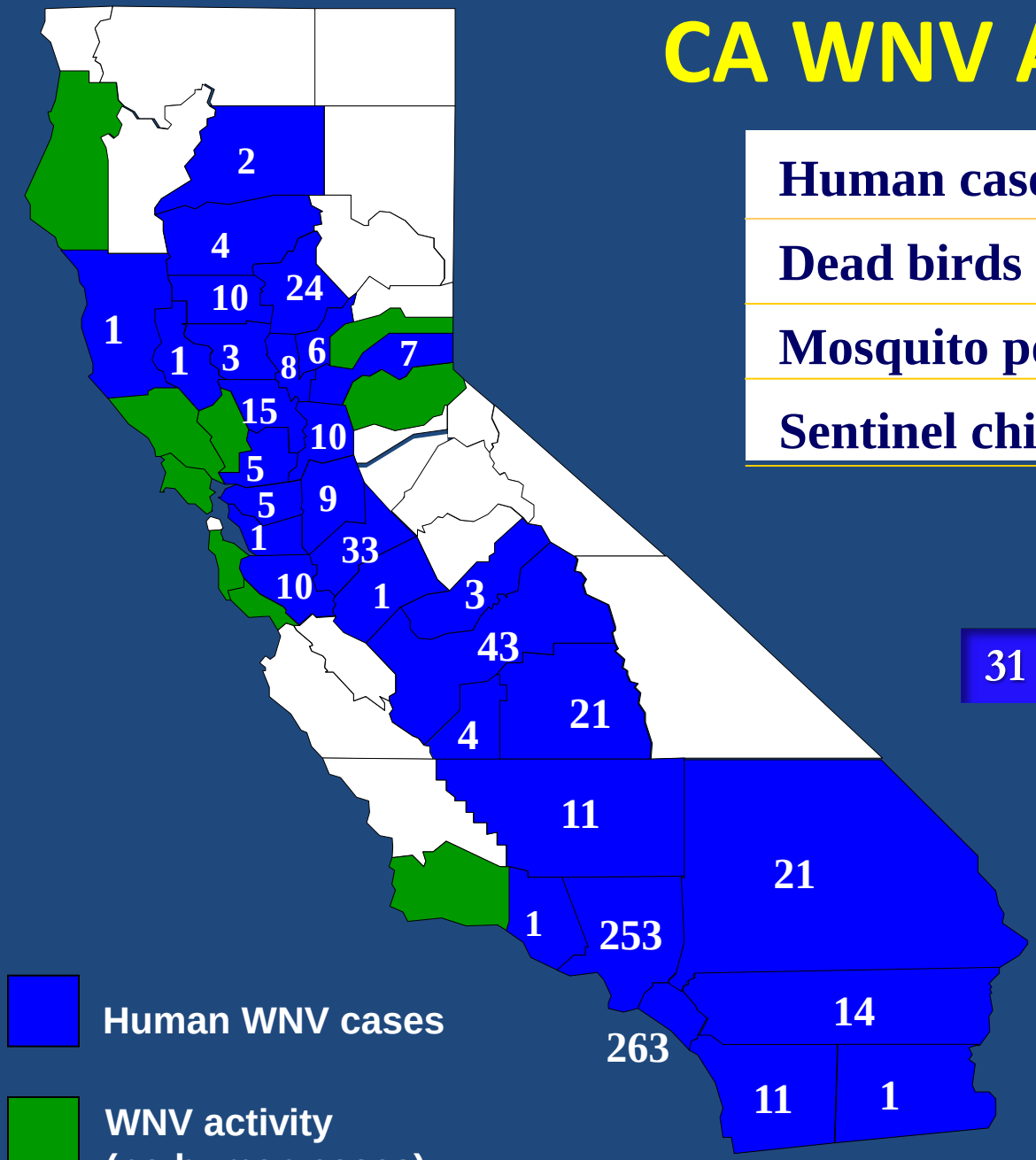
Prevalence of WNV in Dead Birds CA 2004 - 2014



Minimum Infection Rates in *Culex* Species July – September, 2004 - 2014



CA WNV Activity, 2014



Human cases	801 (31)
Dead birds	2,442
Mosquito pools	3,340
Sentinel chickens	443

31 counties with human cases

Human WNV cases

WNV activity
(no human cases)

Climate Change and WNV Activity

- Hot temperatures affect the intensity, duration, and geographic scope of WNV infection
- Drought may also contribute to elevated WNV activity, especially in urban areas
- Potential climate change indicators include WN prevalence in mosquitoes, dead birds, sentinel chickens, and humans
- Impact of climate change on WNV in California can be monitored through the comprehensive WNV surveillance program

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Aedes albopictus and *Aedes aegypti* have arrived and become established in CA

Aedes albopictus
Asian tiger mosquito
2011: Los Angeles County

Aedes aegypti
Yellow fever mosquito
2013: Madera, Fresno, San Mateo Counties

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Public Health Importance

- Vector: Dengue, chikungunya, and several encephalitis viruses
- Increased risk of introduction of exotic mosquito-borne viruses
- Aggressive day-biting mosquitoes
- Prefer to bite people (rather than birds or other animals)
- Difficult to control: Breed in containers

Invasive *Aedes* Mosquitoes Detection Sites in California, 2011-2015

Climate Change and Invasive *Aedes* Mosquitoes in CA

- Tropical species
  - Warm weather enhances survival, reproduction, and spread
- Drought: unintended consequence
  - Residents store water in backyard buckets, containers, and rain barrels
  - Do not maintain swimming pools
- *Aedes* establishment and spatial distribution may serve as indictors of climate change

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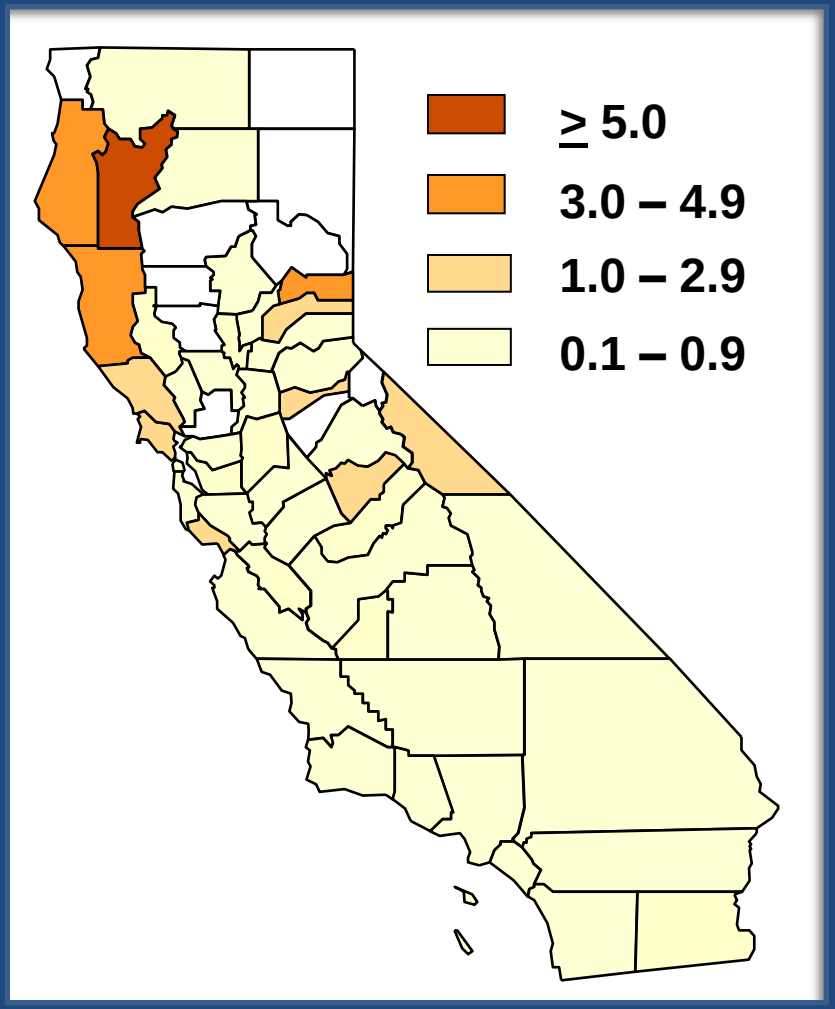
Lyme Disease and Climate Change

- Tick distribution is affected by temperature, rainfall, and humidity
- Tick abundance is greatest in moist, humid environments
- Tick numbers decline during hot, dry periods
- Tick numbers may also be affected by abundance of animal hosts, such as rodents and deer, which in turn are affected by climate

- Climate change could affect tick abundance and distribution in CA
- Alter Lyme disease transmission risk in some regions

Reported Lyme disease cases per 100,000 person-years, 2005-2014



Hantavirus and Climate Change

- Deer mice transmit Sin Nombre virus, the causative agent of hantavirus pulmonary syndrome (HPS)
- Climate affects the food and water supply for deer mice
- Deer mice populations typically increase when vegetation is abundant, often the year after above average precipitation
- Climate change may affect the distribution and abundance of deer mice in California which could alter hantavirus transmission risk

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Conclusion

Climate affects vector-borne diseases on an annual basis and in the long-run, climate change will likely alter the distribution and occurrence of West Nile virus, Lyme disease, hantavirus, and other insect or animal transmitted diseases in California.

- Surveillance is critical to monitor changing patterns and mitigate public health risk
- Disease incidence in vectors, reservoirs, and humans serve as potential indicators of climate change