Mosquito Diseases

1. Viruses
   - Eastern (EEE)
   - Western (WEE)
   - Japanese (JE)
   - Cache Valley (CVV)
   - Rift Valley (RVV)
   - West Nile (WNV)
   - St. Louis (SLV)
   - La Crosse (LCV)
   - Venezuelan (VEE)
   - Yellow Fever (YF)

2. Protozoans
   - Malaria (human and non-human)
     - Avian, reptile, rodent, primate

3. Nematodes (filariaisis)
   - Canine heartworm

Mosquito transmitted encephalitic viruses

- Eastern equine encephalitis (EEE)
- Western equine encephalitis (WEE)
- Venezuelan equine encephalitis (VEE)
- West Nile virus (WNV)

Eastern equine encephalitis (EEE)

- Two variants: North America, South and Central America
- NA variant is more pathogenic
- Occurs in states east of the Mississippi River
- Birds are the principal reservoir
- Enzootic/epidemic vector is Culex melanura
- Possible bridge vectors: Aedes vexans,
  - Coquillettidia perturbans, Ae. sollicitans
- How virus overwinters is unknown:
  - Persistence in reptiles
  - Vertical transmission in mosquitoes
- EEE mainly causes disease in horses
- As a result of vaccination, no longer occurs regularly in US
**Venezuelan equine encephalitis (VEE)**
- VEE virus is a complex of serotypes
- Disease found in South and Central America, spread to the U.S. (Texas 1971)
- Enzootic cycle: Aedes aegypti vector, sylvatic rodents as reservoir and amplifier, illness in humans not equines
- Epizootic cycle: Aedes, Culex spp. vector, bats, birds, ticks reservoirs, horses amplifiers, illness in humans and equines
- Changing climatic patterns may favor establishment of the virus in wild rodents in warmer areas of the United States.
- VEE vaccine licensed for use in horses in the U.S., human vaccine – military and lab personnel

**Western equine encephalitis (WEE)**
- Enzootic and epizootic strains
- Occurs in states west of the Mississippi River
- Birds are the usual reservoir hosts for WEEV
- Culex tarsalis most important vector
- Secondary cycle involves jackrabbits and floodwater Aedes species
- Horses that recover from WEE have a high incidence of residual deficits
- It is possible that WEEV overwinters in reptiles, infectives reported in snakes, frogs, and turtles
- Last reported in MT in 1995
- WEE vaccine in combo with other vaccines

**WEST NILE VIRUS**
- Flaviviridae (Flavivirus)
  - Yellow fever, dengue, SLE, JE
- Zoonotic disease (i.e., animal disease that infects humans)
- Virus replicates in vertebrate and invertebrate cells
- Virus causes infection with symptoms ranging from fever to inflammation of nervous system (encephalomyelitis)
- > 300 species of birds killed, large variety of mammals, horses especially susceptible
West Nile Virus

**Historical**
- **1937**
  - Isolated from West Nile Region of Uganda, Africa
- **1999-2004**
  - Invasive phase, explosive outbreaks
- **2002**
  - 1st entered plains states
- **2003**
  - Massive epidemic
  - U.S. approximately 10,000 human cases
  - Montana 228 cases, 4 deaths

**West Nile Virus U.S.**
- Invasive phase
- Virus entered numerous ecosystems, variety of habitats
- Continental U.S.
  - 3,108 county jurisdictions
  - 2,096 human WNV infections
  - 895 non-human WNV
  - 117 no reported activity
West Nile Virus U.S.

- Equilibrium phase, 2005 – present
- Overall equine and human cases declined in U.S.
- Dampening of infection in birds and mammals
  - Recovery and survival
  - Focal outbreaks
  - 2012 >5,000 human cases

West Nile Virus Transmission Cycle

Mosquito Vectors in Montana

**Primary (bridge) vectors**
- *Culex tarsalis* (rural)
- *Culex pipiens* (urban)

**Secondary (bridge) vectors**
- *Aedes vexans*
- *Culiseta inornata*
**Culex tarsalis**

- Widely distributed in mid-west and western US
- 15% of collections in Montana
- Particularly abundant along riparian habitat
- Eggs deposited in sunlight pools with vegetation
- Prefers clear standing water - permanent/temporary sloughs, wetlands, oxbows, irrigated land
- Feed on a variety of vertebrates, especially birds
- Overwinter as adults
  - We don’t know where!
- Highly competent vector of WNV

**WNV**

- Birds are amplifying host and serve as reservoirs
- Corvids, raptors, passerine birds (perching birds), colonial nesting birds (American white pelican)
- Very high mortality in certain species
  - American white pelican
  - Greater sage grouse
- WNV does not appear to overwinter in Montana
- Migrating birds source for re-introduction
Montana Equine Cases 2002 - 2009

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Horse cases 2013

Case summary
19 counties
27 cases

WNV Equine Symptoms

- Lack of muscular coordination
- Ataxia - difficulty standing, moving
- Menace reflex - lack of awareness
- Paralysis in hind legs
- Facial, muzzle twitching
- Droopy lip, difficulty swallowing
American White Pelican

- Concerns from wildlife perspective
  - Short-term and long-term impact of WNV on individual colonies
- Concerns from public health perspective
  - Pelican deaths may increase human risk of WNV infection in surrounding communities.
Adult Mosquito Surveillance

- Employ traps baited with attractant
- Light trap + CO₂
- Gravid traps (not for Cx. tarsalis)
- Traps run weekly or bi-weekly
- Catches sorted, counted, identified
- Information added to database
  - WNV testing
  - Biological data

Mosquito & Arbovirus Surveillance

1. Determine species presence and seasonal abundance
2. Early detection of virus in epidemiological studies
3. Identify disease "hot spots"
4. Effectiveness of control tactics
5. Develop vector/disease distribution and prediction models

WNV Sentinel Chickens

- 6 flocks of 5 birds
- 1 pre- and 5 post-exposure bleedings
- 180 blood samples
WNV Timeline 2005

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Equine Protection

- **WNV vaccines**
  - WNV, WNV + EE + WEE, WNV + VEE + EE + WEE
  - Two series vaccination, followed by annual booster
- Mosquito repellents
  - Some relief, requires frequent handling
- Move animals indoors
  - Maybe impractical

Repellents for humans

- DEET
  - Off!, Cutter, Sawyer, and Ultrathon
- Picaridin
  - Cutter Advanced, Skin So Soft Bug Guard Plus
- Oil of lemon eucalyptus (OLE)
  - Repel
- IR3535
  - Skin So Soft Bug Guard Plus Expedition

Web sites for disease occurrence


http://www.cdc.gov/ncezid/dvbd/