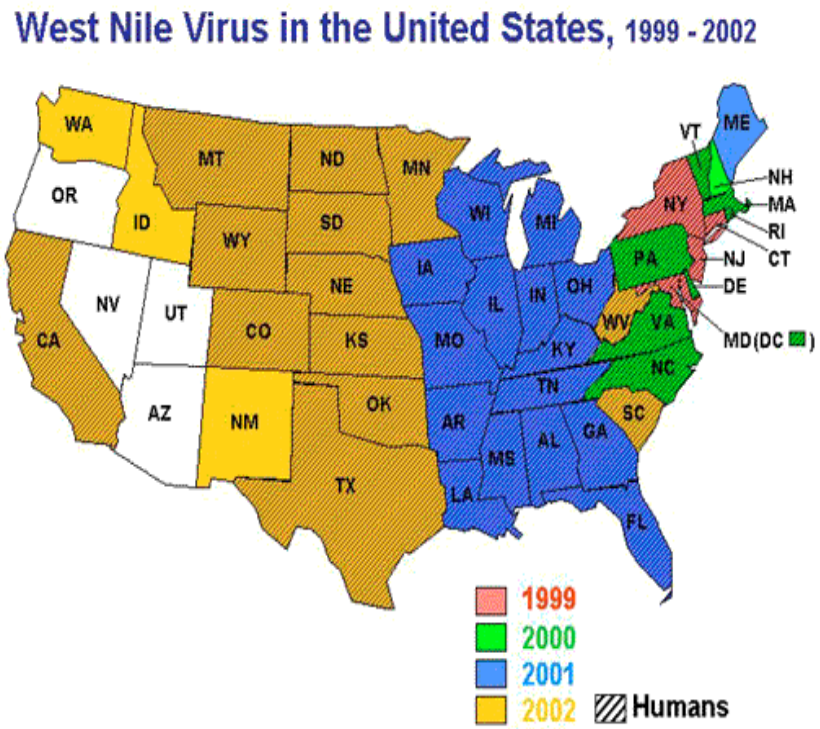
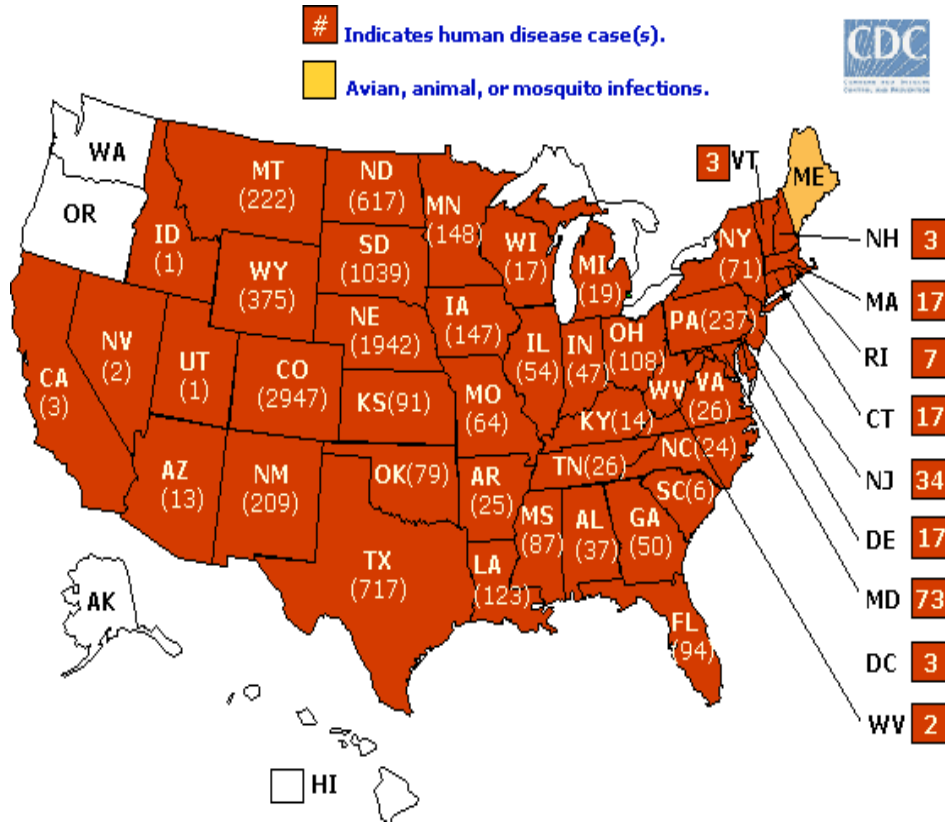
West Nile Virus

- Uganda 1937
  - Little effect on people
- Romania, Russia, US 1996 – 1999
  - Outbreaks with unprecedented human deaths
    - >300 in US from 1999-2003
  - US outbreak associated with large number of bird deaths
    - Arrived in NYC in 1999, apparently from Middle East
    - Especially virulent strain

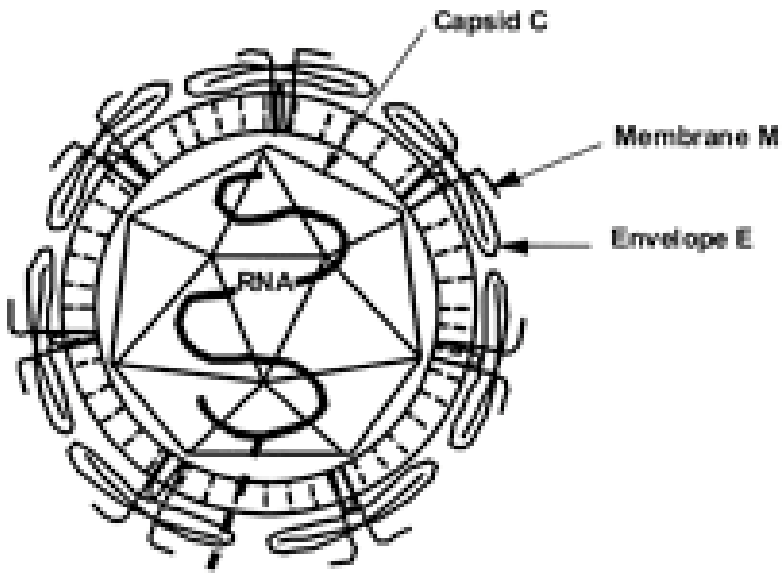
Rapid Spread of WNV in US

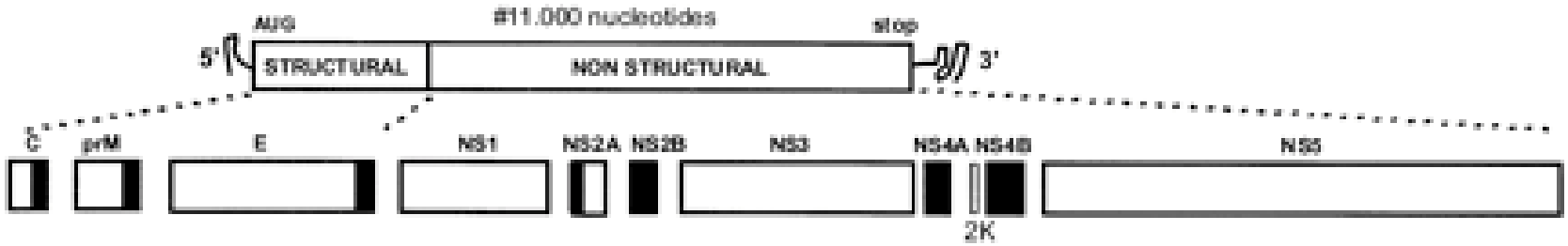


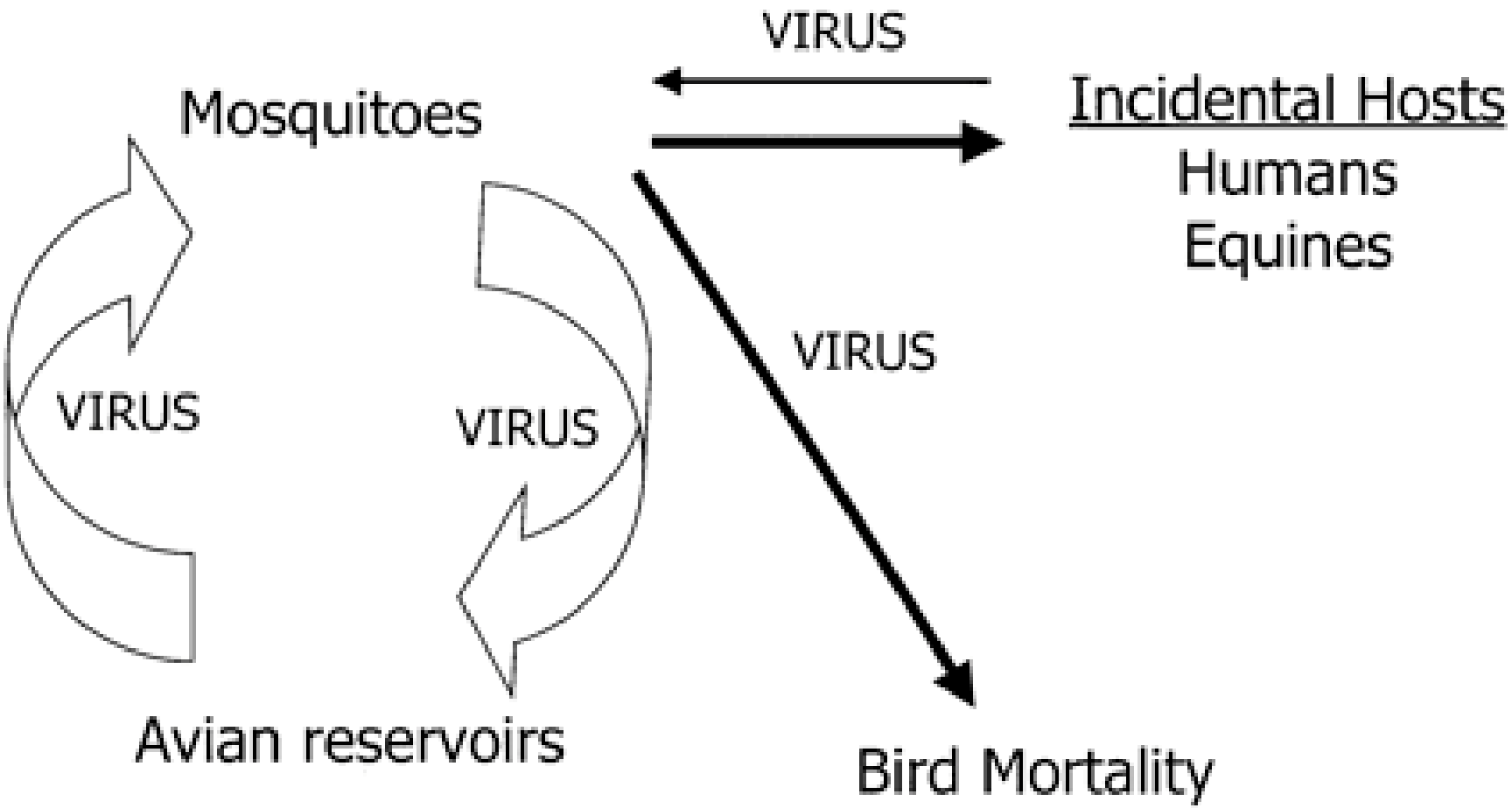


A Little RNA Can Kill You

- Enveloped Virus
  - 50nm diameter
- Single strand of RNA
  - 12 Kb long







Occurrence of vectors is fairly well known, but the role of particular birds as primary and secondary reservoir hosts versus incidental hosts is poorly known

Keys to Understanding Ecology of WNV

- Vectors
  - Environmental conditions suitable to breeding
    - Temperatures for transmission and overwintering (10 – 20^{o}C)
    - Role of rainfall
  - Movement, biting, and hybridizing behaviors
- Hosts (>200 birds, reptiles, mammals)
  - Virus-amplifying, primary reservoirs
    - House Finch, American Robin, Ring-billed Gull, House Sparrow
  - Secondary or incidental
    - Incompetent species (Rock Pigeon, Starlings, Many Native Songbirds)
    - Species with high mortality (Corvids, Parids, Raptors)

West Nile Vector Mosquito Species Occurring in Washington State

Proven Enzoonotic Vectors	Culex pipiens Culex tarsalis Culex restuans* Ochlerotatus japonicus#
Proven Bridge Vectors	Aedes vexans Aedes cinereus Culiseta inornata
Potential or Inefficient Vectors	Ochlerotatus canadensis† Coquillettidia perturbans Anopheles punctipennis

* only found in Island County, # only found in King County, † only found in Eastern Washington

TABLE 1. . Mortality at The Owl Foundation during the West Nile outbreak period [a] and results of real-time RT-PCR testing on tissues from dead birds.

Species [b]	At Risk [c]	Died	Tested [c]	Positive Number	%	Crude MR [d] %	WNV-related MR [d] %	WNV-rela Deaths
Snowy Owl	20	20	11	11	100.0	100.0	100.0 [e]	20 [e]
Northern Hawk Owl	26	26	17	17	100.0	100.0	100.0 [e]	26 [e]
Great Gray Owl	27	27	23	21	91.3	100.0	91.3 [e]	25 [e]
Boreal Owl	11	11	11	10	90.9	100.0	90.9	10
Northern Saw-whet Owl	13	12	12	12	100.0	92.3	92.3	12
Northern Pygmy Owl	6	1	1	1	100.0	16.7	16.7	1
Short-eared Owl	16	2	2	2	100.0	12.5	12.5	2
Flammulated Owl	9	1	1	1	100.0	11.1	11.1	1
Barred Owl	8	1	1	0	0.0	12.5	0.0	0
Burrowing Owl	10	0	0	-	-	0.0	0.0	0
Eastern Screech Owl	36	0	0	-	-	0.0	0.0	0
Elf Owl	1	0	0	-	-	-	-	0
Spotted Owl	1	1	1	1	100.0	-	-	1
Tawny Owl	2	1	1	1	100.0	-	-	1
American Kestrel	2	0	0	-	-	-	-	0
Peregrine Falcon	2	0	0	-	-	-	-	0
Total:	235	108	85	79	92.9	46.0	43.0	101

Certainties

- WNV is a new source of mortality for NSO
- WNV is in WA and southern CA
- Vectors are present in NSO range
- Amplifying hosts are present in range, but details of relative importance are not well known
- Many owls are susceptible to WNV

Uncertainties

- Heightened mortality may only last a few years after outbreak
- Adults may develop immunity after initial exposure to WNV
- Barred Owls may suffer less than NSO
- Northern Goshawks may suffer as much as NSO
- Small mammal prey may indirectly pass WNV to NSO

Scenarios

- 1. Localized centers of increased owl mortality for 1 – 2 years after outbreak; juvenile mortality increased where virus exists; increase in Barred Owls is offset by reduction in NSO predators
  - range-wide population viability remains intact
    - Shown by common raptors in east and midwest
- 2. Localized centers of increased owl mortality for 1 – 2 years after outbreak; continued high mortality of juveniles without resistance; increased competition from less affected Barred Owls is greater than reduction in predators
  - Range-wide population viability erodes
    - Long-lived species with low reproductive output are sensitive to increased mortality
    - Rare species may already be in an “extinction vortex” and each additional reduction of viability is disproportionately severe.