Wildlife Population Impacts of West Nile Virus and Progress on an Avian Vaccine

Patrick T. Redig DVM, PhD
The Raptor Center
College of Veterinary Medicine
University of Minnesota

Overall Impact of West Nile Virus

- Human Infections: 2470 in 2004; total - 6,637
- Human Deaths: 90 in 2004; total - 654

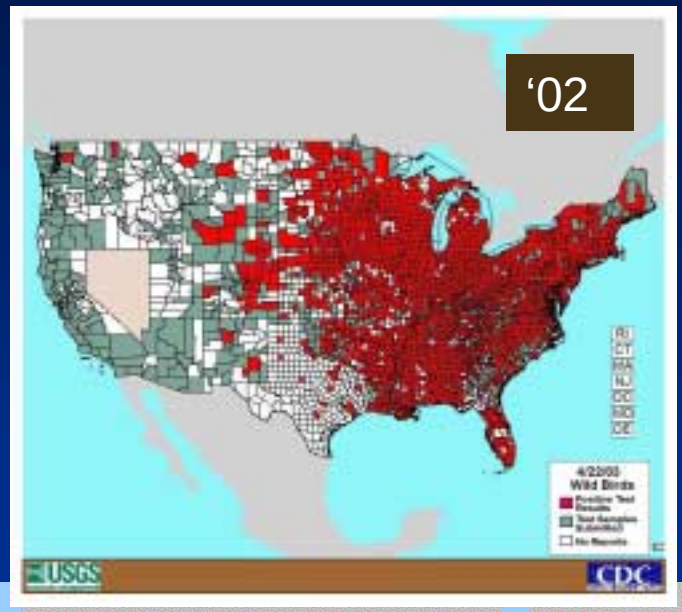
- Bird Deaths: >57,053 crows; others?
  - No systematic reporting system for birds
- 29 species of mammals, as well as amphibs and alligators c/ reported infections
- Population Impacts – potential exists, but details are unknown

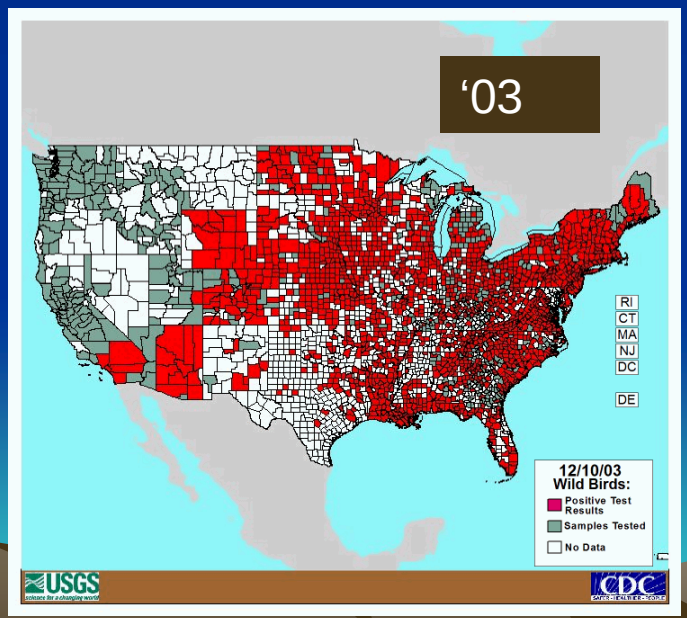
(Komar, 2004; Marra et al, 2004)

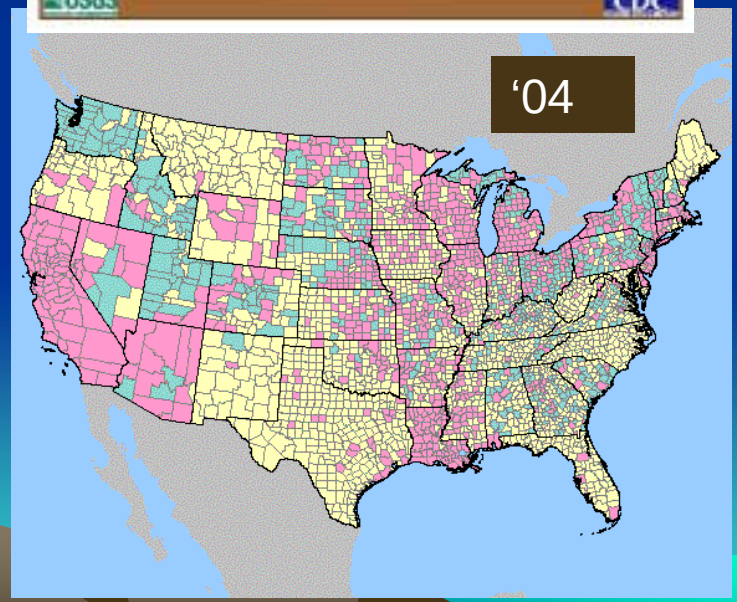
Effects of WNV on Bird Populations

- Mortality reported in 294 species
- Number of deaths estimated at tens of thousands to millions
- Anecdotal decreases for some passerines
- Mortality rates & population impacts are unknown

WNV in Birds: ’01-’04







Species of Raptors Occasionally Affected

- Kestrels (11)
- Merlins (2)
- Bald Eagles (10 at TRC)
- Golden Eagles (appear highly sensitive)
- Peregrine falcons (2 isolated cases to date)
- Andean Condors (2)
- Osprey
- Screech Owl
- Barred Owl
- Spotted Owl?

Principal Raptor Species Affected

Great Horned Owl

Coopers Hawk

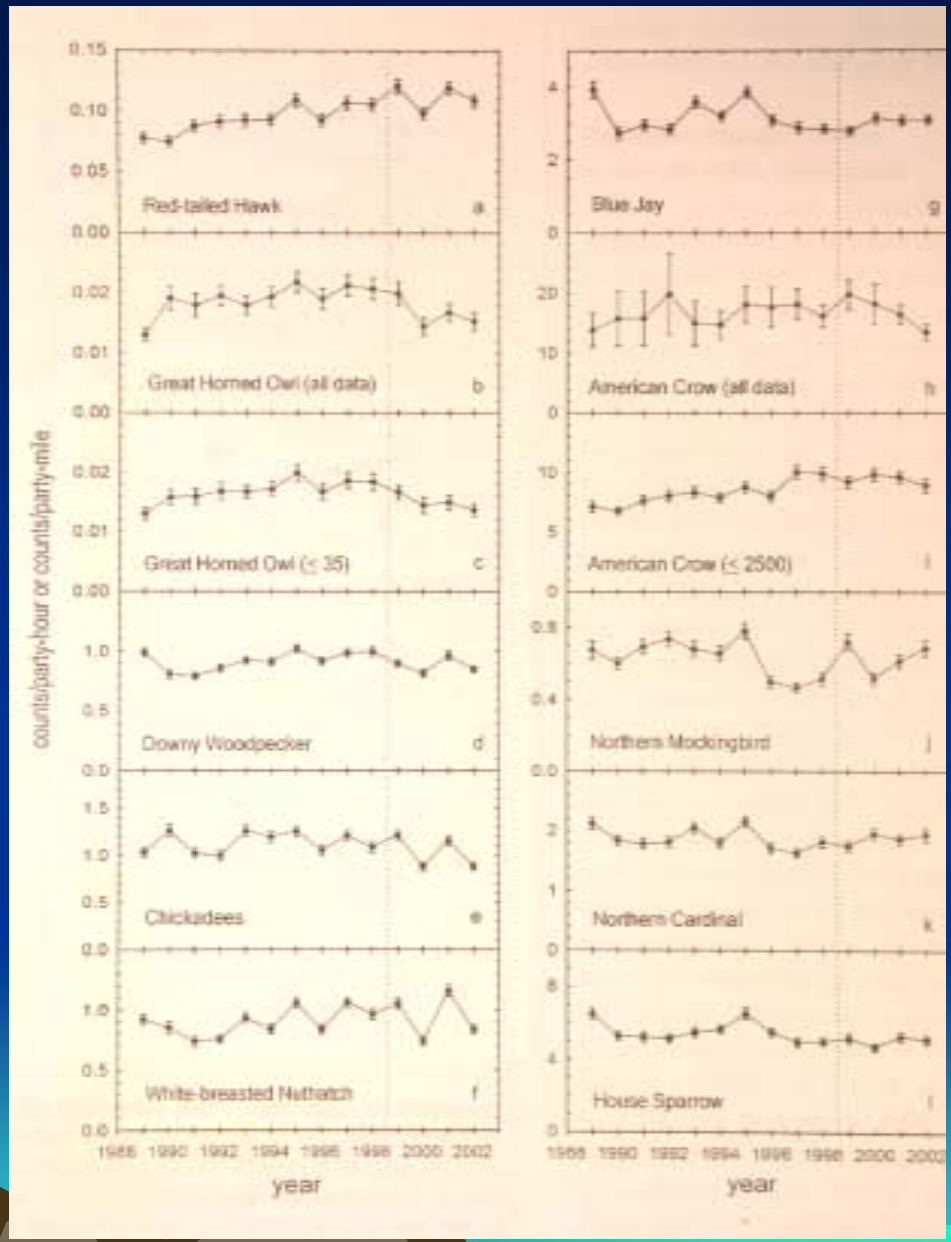
Red-tailed Hawk

Population Impacts

- **Corvids**
  - Crows – several studies c/ marked birds
  - Jays
    - Blue – no data at population level
    - Florida Scrub (Archbold Biological Station, Lake Placcid, FL)
- **Raptors** – no studies c/ marked birds; some rehab data
  - Great Horned Owls (GHOWs)
  - Red-tailed Hawks (RTHAs)
  - Coopers Hawks (COHA)
  - Eastern Screech Owls (EASO)
- **Greater Sage Grouse** – ongoing studies c/ marked birds

Coarse Assessment of Population Impact

Christmas Bird Count Data in NE U.S.



Caffrey & Peterson, 2004

Coarse Assessment

- 2004: Christmas Bird Count Data Analysis (Caffrey, ’04 Am. Birds) – 10 species examined over a 20 year period (1988 – 2003) including WNV event (1999 – 2003).
- Slight declines in Crows and GHOWs in local populations
    - No discernable regional impact!!

Detailed Assessment: Corvids

- 1999 – 2002: marked crow populations - 33% - 40% mortality in NE U.S.I
- Overall, infection/mortality rate 40 – 72% (Caffrey et al ’05 -New York, Oklahoma; Yaremych et al ’04- Illinois) from marked bird studies
- Oklahoma: 56/78 marked crows disappeared in one season (2003)
- Local Devastation suggested – loss of population structure
- Presently, about 4% of sampled crows are seropositive

Conclusion Regarding Crows

(Caffrey, Smith & Weston, 2005)

- Total continental mortality is most likely an order of magnitude higher than known mortality (c. 60,000)
- Extreme sensitivity to virus – 100% mortality
- Little evidence of immunity
- Fracturing of social structure
- Possibility for wide geographical area population decrease exists

Raptors

- Basically no information at population level
- CBC Analysis for GH0Ws & Red-tails
- No discernible impact – yet
- 61/61 Screech Owls disappeared from an Ohio study area in 2002
  - (T. Grubb)
- 4 species of northern owls exhibited high sensitivity in Ontario outbreak – captive birds
  - No EASOs died (36)

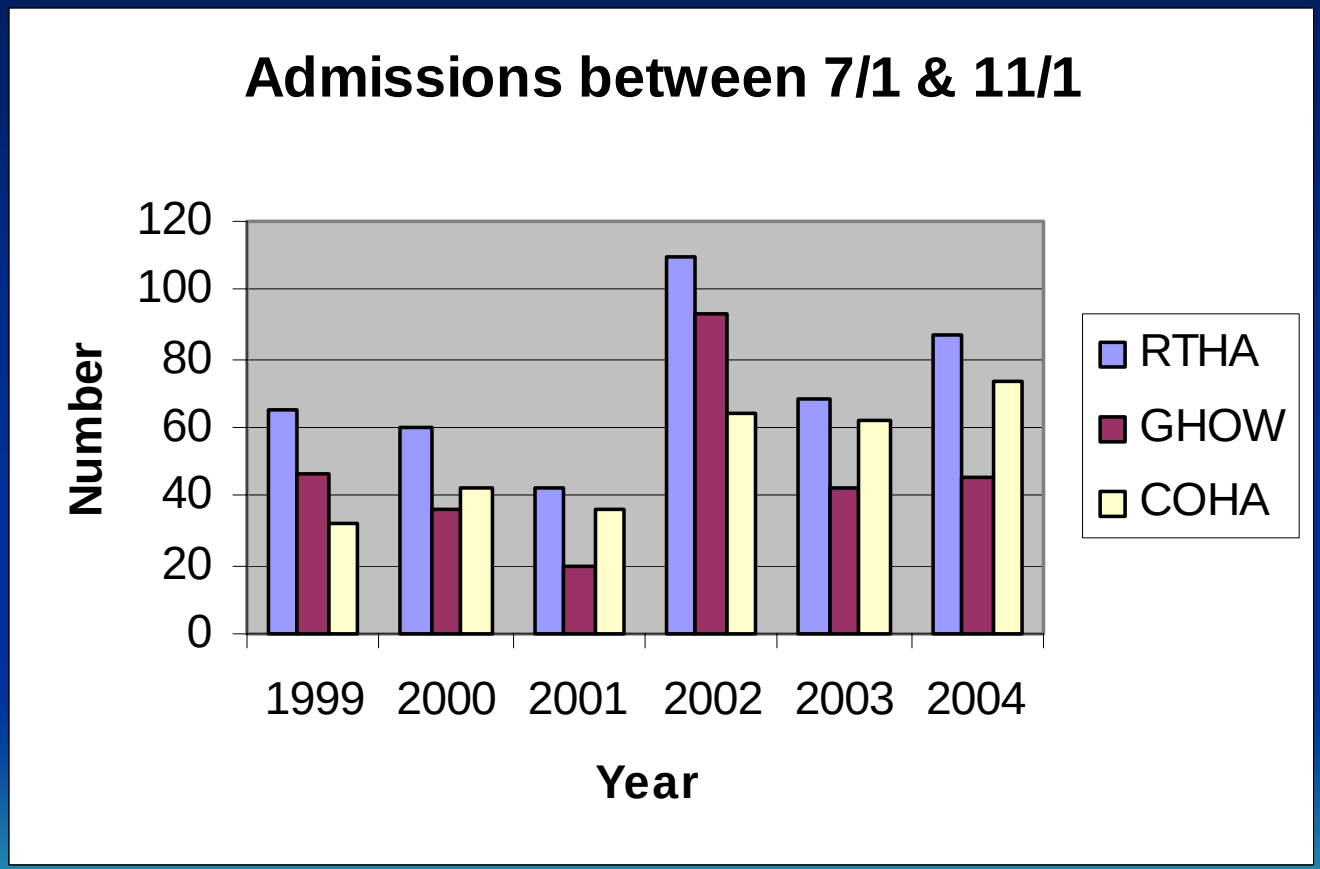
Mona Rutger, Back to the Wild, Ohio

Great Gray, Boreal, Snowy, & Hawk Owl

TRC Data on WNV

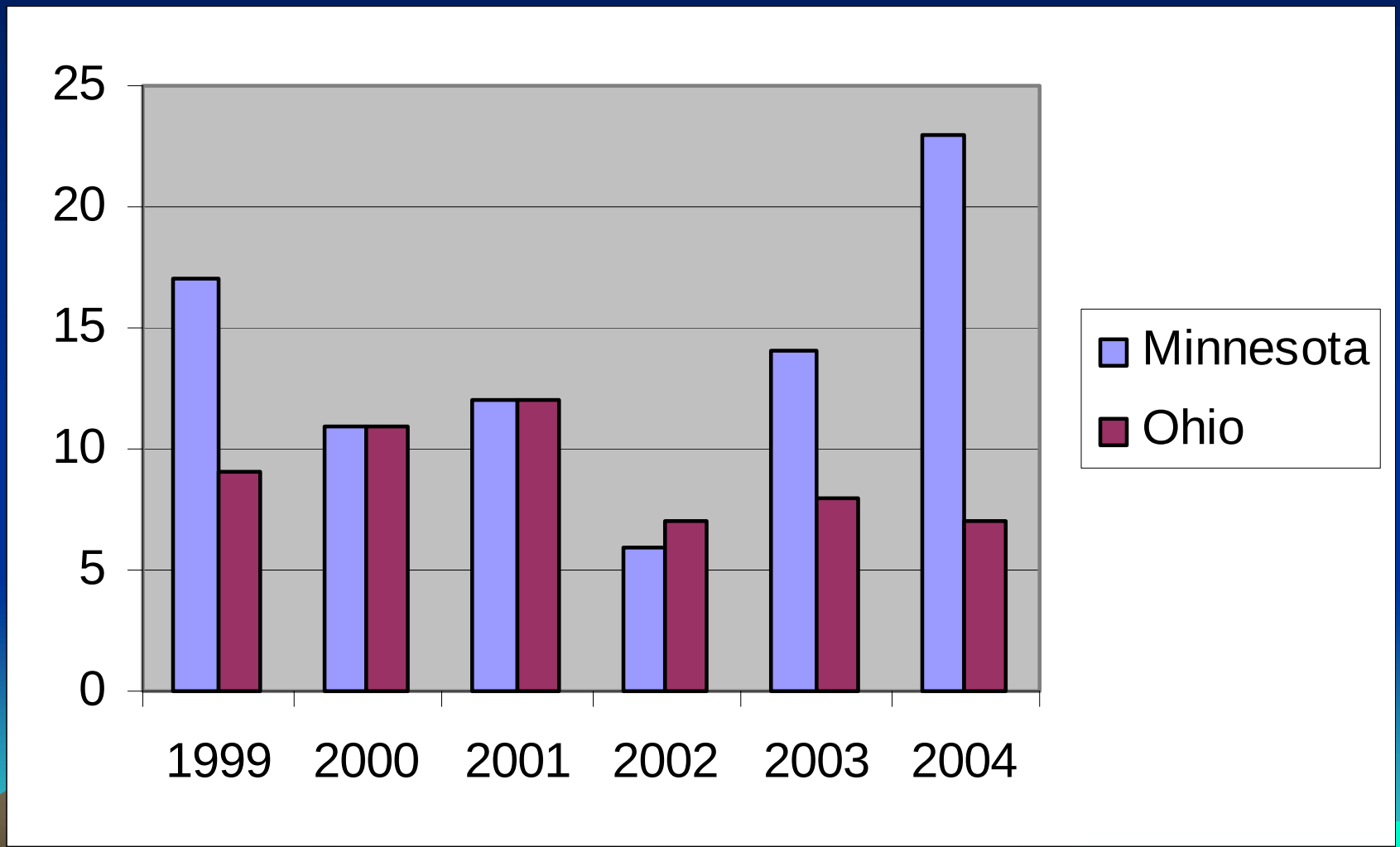
- GHOWs
- Coopers Hawks
- Red-tailed Hawks

Annual Comparisons among 3 Raptor Species



Do Coopers Hawks receive additional exposure from prey?

Admission Rates of Unfledged GHOW before and after WNV



Greater Sage Grouse

GSG: The Setting

- Powder River Basin, Montana, N. Wyoming
- 2003: 44 radiocollared birds at 4 sites tracked
- At one site:
  - 10 birds marked
  - 2 died of “natural causes” (predation, powerline)
  - 6 found dead, intact => WNV
- Overall Late summer survival
  - 22% in WNV area
  - 76% in non-WNV areas
  - 95% decline in female Lek attendance the following spring
  - 95% decline in male Lek attendance the following spring
- Lab studies found GSG to have exquisite sensitivity to virus

GSG: 2004

- 2 cases in Wyoming
- 1 case in Colorado (concern about Gunnison Sage Grouse)
- What's the difference compared to 2003?
- Possible factor: Dry, cool year
- Of 102 hunter-killed birds tested, none were +
- At this point, no definitive evidence of a population-level effect
- But it will forever be an additive source of morbidity and mortality to an already stressed species.

Opportunities for Further Studies

- Quintessential requirements are baseline data and marked birds
  - Blue birds
  - Florida Scrub Jays – Archbold Research Center, Central Florida
  - Continuing Corvid studies
  - Sage Grouse - Montana
  - Sage Grouse – University of Wisconsin Study
  - Raptor Studies in SW Idaho

California GIS-based Model

(Boyce et al, 2004)

- Identify Specific Target Species
  - Small Populations
  - Limited Distribution
  - Known level of susceptibility to WNV
  - Include known amplifier species
- Apply multi-parametered scheme integrated with GIS information for distribution of targets, reservoirs & vectors

California GIS-based Model Inputs (Boyce et al, 2004)

- Susceptibility to index WNV (NY99)
- Level of viremia
- Level & Duration of Antibody
- Vector abundance in area of interest
- Amplifying host abundance
- Marked individuals in each population
- Recovery of dead birds – radiocollars
- Cause - specific mortality determination
- Change in population parameters

URL:
http://www.vetmed.ucdavis.edu/whc/pdfs/wnreportnopix.pdf

Proposed GSG study by Univ. of Wisconsin/USGS - Objectives

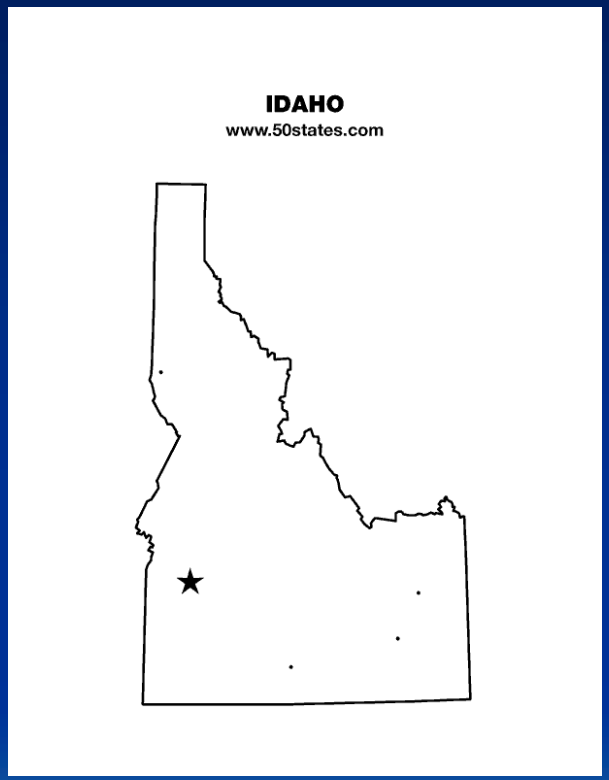
- Site: Western U.S. - unspecified
- Rates of disease transmission
- Susceptibility to infection
- Avian and mammalian reservoirs
- HY susceptibility
- Prevalence of WNV
- Role of physiological stress
- Development of a predictive model

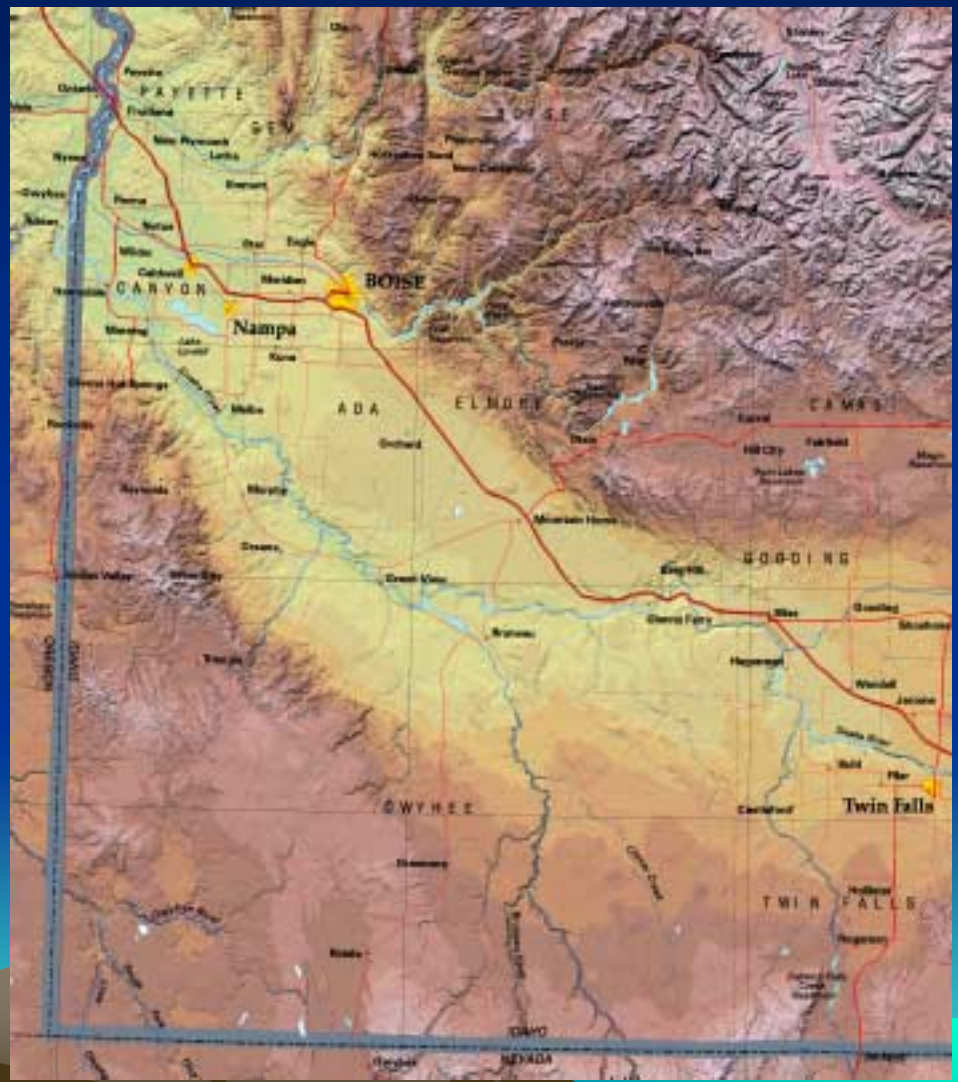
Proposed Raptor Studies in Idaho

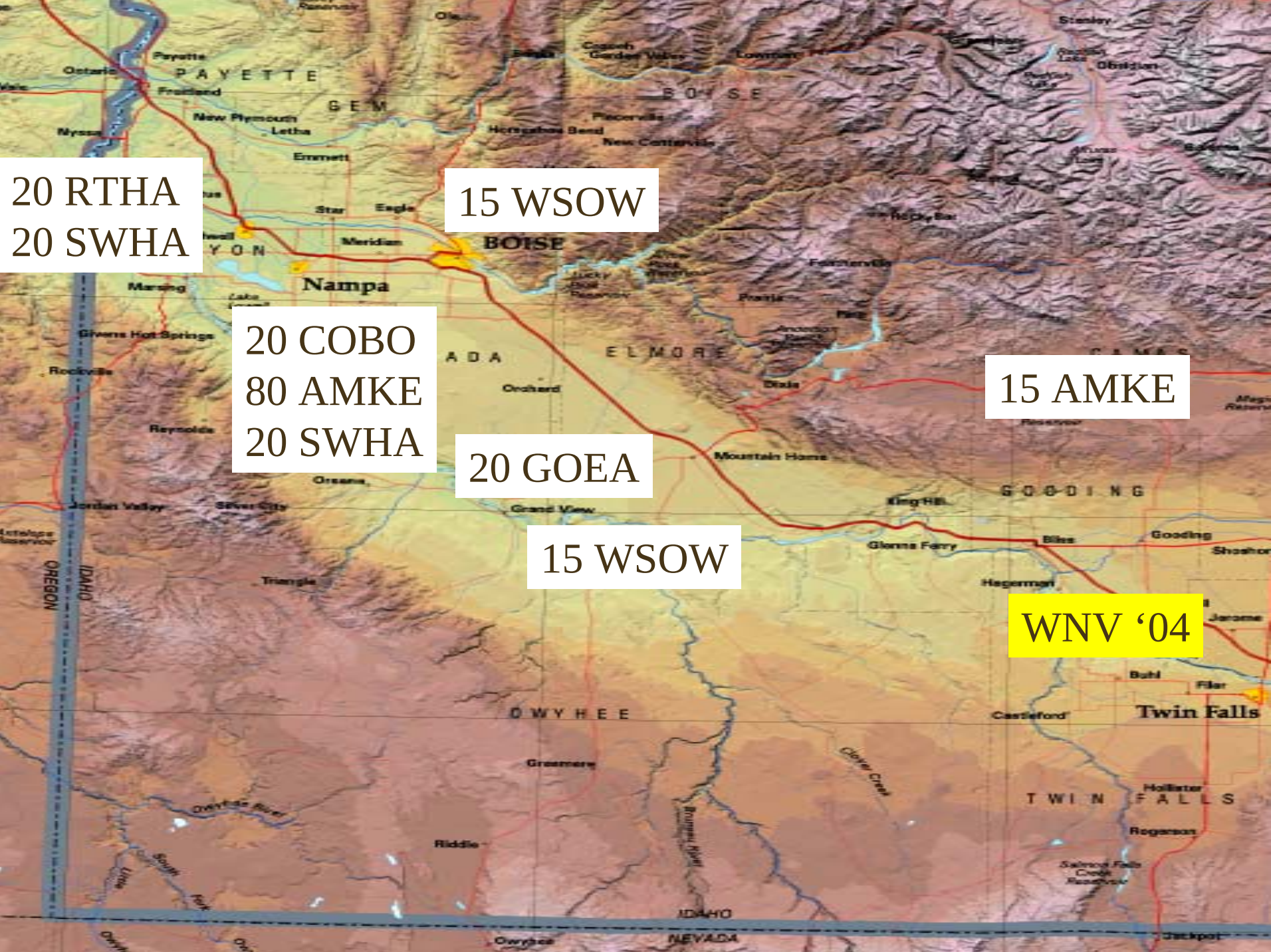
(Fuller, Belthof, Dufty, Kochert, Steenhoff, Mattox, Redig, USGS)

- Nest Surveys (occupancy, productivity)
  - Golden Eagles: helicopter - 64 nests (50 occupied/y)
  - Black-billed Magpies
- Surveys plus blood sampling
  - Kestrels: Nestboxes, 95 pairs/18y, 2 different habitats
  - Screech Owls: Nextboxes 30 pairs/10-15y
  - Barn Owls – 20 pairs/5y
  - Red-tailed Hawks – 20 pairs/5y
  - Swainson's Hawk – 40 pairs/15y
- Radiotracking included
- Five year Timeline

Areas of Interest






20 RTHA
20 SWHA
15 WSOW
20 COBO
80 AMKE
20 SWHA
20 GOEA
15 WSOW
15 AMKE
WNV ‘04
PAYETTE
GEM
BOISE
ADA
ELMORE
GOODING
OWYHEE
TWIN FALLS
Nampa
Twin Falls
OREGON
IDAHO
NEVADA

Kestrels

1986 –2002

95 pairs

- 350 encounters with banded birds
- 2800 Kestrels banded
- From ~ 100 nest boxes

Courtesy Karen Steenhof, USFWS, Boise

Screech Owls

30 pairs monitored for up to 15 years


Melba Site
Canyon County
SW Idaho
Golden Eagles
Photo courtesy of Mike Kochert and USGS, Idaho

Summary of “Known” Impacts

- Large scale population impacts for most species of birds remain unknown and insufficiently studied

- Potential for Local Population Devastation or Extirpation exists for:
  - Crows
  - Greater Sage Grouse
  - Hawaiian Birds
  - Others with small populations or limited distributions

Recommendations for Population Impact Determination and Understanding of the Ecology of WNV

- Apply principles of California Model on a state-by-state or regional basis
- Utilize ongoing long-term abundance studies
- Integrate efforts with USGS, BLM, USFWS, and Human Health interests to promote establishment of long-term population studies for future detection and monitoring

Prospects for a Vaccine

- Agent: DNA subunit vaccine
  - (Chang, Bunning, Komar, Turrell et al, CDC)
- Subjects
  - Crows: 5/9 survived challenge (Turrell, 2003)
  - Condors: (Dr. Chang)
  - Red-tailed Hawks
  - Next Steps

Objective

- Test red-tailed hawks vaccinated with DNA-plasmid vaccine for:
  - Seroconversion
  - Resistance to Challenge

Vaccine Testing Protocol

- 20 antibody negative red-tails
- 15 vaccinated c/ Plasmid; 5 controls
- Vaccinated 2x (c/ 3 week interval); sampled for seroconversion (antibody formation) 2w after second vaccination
- Challenged c/ live virus

Vaccine Subjects

Response to Vaccination and Challenge

- Vaccination:
  - 3/15 birds became seropositive – low titer
- Challenge:
  - 1. Vaccinated birds had lower viremia than non-vaccinates
  - 2. 1 bird was euthanized on day 10 owing to signs of WNV; confirmed by necropsy
  - 3. It was a vaccinated bird (received only partial dose)
  - 4. None of the other birds exhibited any clinical signs
  - 5. All but one challenged birds were seropositive on day 6 post-challenge
  - 6. Seronegative bird rechallenged in 6 weeks; remained seronegative

Next Steps

- Develop an acceptable model for USDA licensing for DNA-plasmid
- Possible Species
  - Emden Geese Goslings
  - Impeyan Pheasants
  - Chukar Patridge
  - Screech owls or kestrels
  - Japanese Quail
- Viremia reduction model
- Tissue reduction model
- Conduct comparative tests of 3 available vaccines

Thank You