Use of sentinel animals for West Nile virus surveillance

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WNV Surveillance Modalities

- Mosquitoes
- **Dead birds (especially crows)**
- Live wild bird sentinels
- Live captive sentinels (e.g. chickens)
- Veterinary surveillance
- Human surveillance

WNV Surveillance Totals, 2000-2001

Reported to CDC thru 3/07/02

	2000	2001
Dead birds	4305	7241
Mosquito pools	515	905
Horses	63	720
Other mammals	6	0
Humans	21	66
Sentinel chickens	13	218
Wild birds	9	3

Why do we need sentinel surveillance data?

- Early detection
- Quantification of transmission
  - Risk assessment
- Prediction of disease (early warning)
- Theory discussed in:
  - Komar N, 2001, Annals N.Y. Acad. Sci. 951:58-73 (available online)

Earliest detection per county (n=359), 2001

Dead birds	295 (82.2%)
Horse cases	39 (10.8%)
Mosquito pools	16 (4.5%)
Sentinel chickens	6 (1.7%)
Human cases	2 (0.6%)
Other	3 (0.8%)

Avian mortality surveillance

- **What is the purpose of this type of surveillance?**
  - **Early detection of virus activity**
  - **Flag regions where quantitative surveillance should be conducted (e.g. mosquito infection rates, avian seroconversion rates)**
  - **Indicator of ongoing transmission**
  - **Possibly useful in predicting human cases**
    - **See Eidson et al 2001 Emerg. Inf. Dis. 7(4):662-664**

Avian mortality surveillance

- What species to target?
  - Over 100 species have been affected since 1999
  - 71% of positive carcasses were crows (2001)
    - Only 27% were crows in Florida
    - No positive crows in 22 of 63 Florida counties with positive birds
  - Mortality rate in crows is >90%
  - Ecology of WNV transmission may differ in new regions

Experimental WNV Mortality -1

Species	n	mortality rate	controls
American Crow	13	92	0
Blue Jay	6	83	0
American Magpie	5	100	1
House Finch	2	100	1
Common Grackle	10	40	2
Fish Crow	11	64	5
House Sparrow	12	25	5
Ring-billed Gull	2	50	1

Source: Unpublished data

Experimental WNV Mortality -2

Species	n	mortality rate	controls
European Starling	6	0	2
Rock Dove	6	0	6
Chicken	18	0	24
Ring-necked Pheasant	3	0	0
Canada Goose	3	0	0
American Robin	3	0	3
Red-winged Blackbird	3	0	0
Mallard	2	0	1
American Coot	1	0	0
Northern Flicker	1	0	0
Mourning Dove	3	0	3
Killdeer	2	0	0
Budgerigar	3	0	3
Monk Parakeet	3	0	3
Japanese Quail	3	0	3
Northern Bobwhite	3	0	3

Source: Unpublished data

Avian mortality surveillance

- How many to test?
  - Depends on transmission rates
  - Local decision
  - New regions should test as many as possible until local transmission dynamics are understood (more data is better than less data)
    - Determine lab capacity for testing
    - Meet capacity early in season
    - Triage specimens if necessary

Avian mortality surveillance

- Logistics …..
  - Who collects reports, and how?
  - Who picks up carcasses, where are they submitted?
    - Carcasses should be kept cold, ideally frozen
  - Triage of carcasses
    - Importance of species identification
    - Fresher the better (24 hr rule)
    - Pathologist's examination not required

Which organs to test?

- **Refs:**
  - **Steele K., 2000, Vet. Path. 37: 208-224.**
  - **Panella N., 2001, Emerg. Inf. Dis. 7(4): 754-5.**
  - **Kramer L. & Bernard K., 2001, Ann. N. Y. Acad. Sci. 951:84-93.**

- **20 crow carcasses collected in New Jersey, 1999**

- **6 organs tested by Vero Plaque Assay and TaqMan RT-PCR: 10 WNV-positive carcasses**

Test	Brain	Heart	Kidney	Spleen	Lung	Liver
Virus Isolation	80%	70%	70%	60%	50%	40%
RNA detection	100%	70%	70%	60%	70%	70%

Source: Panella N., 2001, Emerg. Inf. Dis. 7(4): 754-5.

Streamlined testing

- Corvids shed large quantities of virus
- Comparison of brain vs swabs in corvid carcasses:

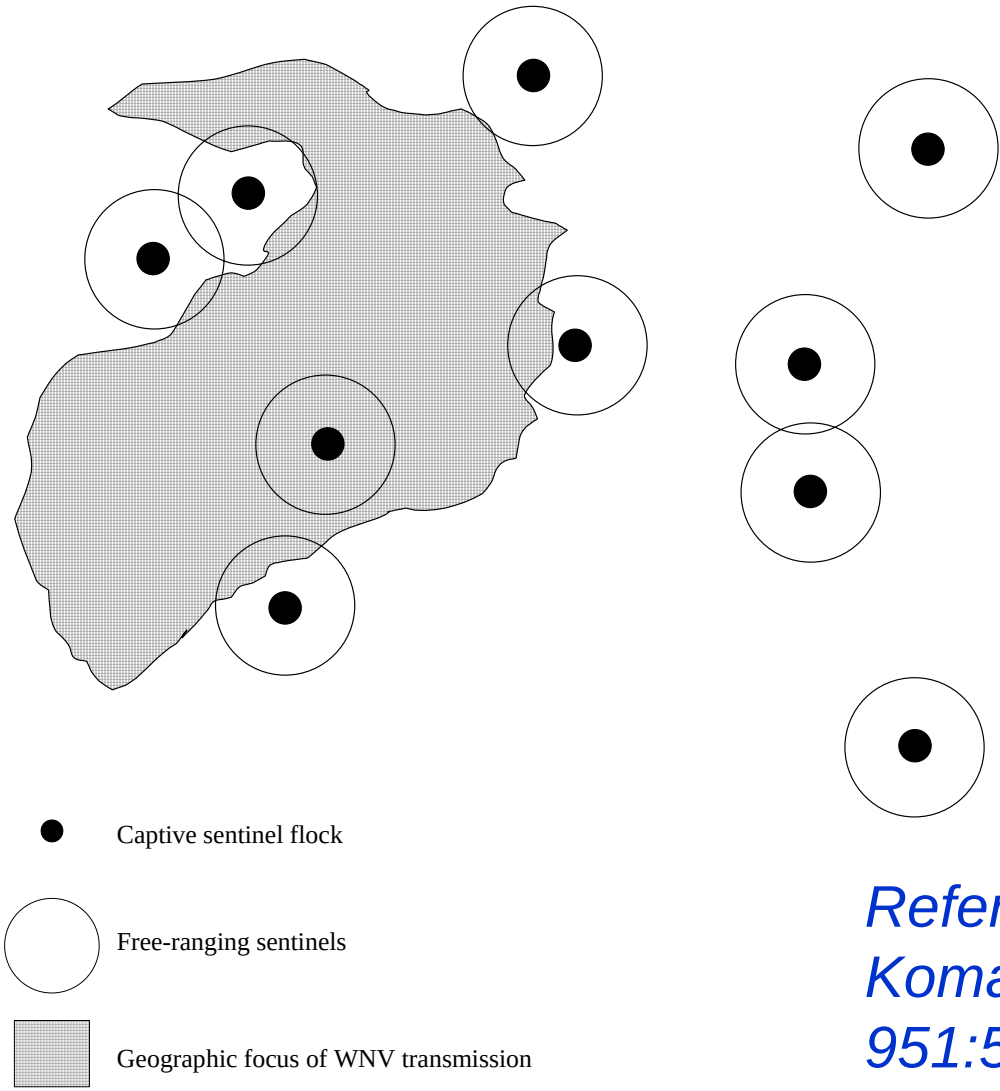
Species (n)	Brain	Oral	Cloacal
American Crow (12)	7.1 [1]	6.6	6.9
Fish Crow (4)	5.8	6.1	6.6
Blue Jay (2)	6.3	5.7	6.7

1. Mean PFU equivalents by TaqMan RT-PCR

Captive Sentinels

- **What is the purpose of this type of surveillance?**
  - **Indicator of ongoing transmission**
  - **Useful in detecting increased transmission (risk)**
  - **Transmission monitoring, rather than early detection**
  - **Most useful in known transmission foci**
  - **Multiple years of data required to determine decision-making thresholds**

Limitations to Sentinel Flocks



Reference:
Komar N. Ann. NYAS 951:58-73; 2001

Captive Sentinels: Interpretation of Test Results

- How many seroconversions needed to indicate increased level of risk?
  - Local decision; years of data needed
- Natural lag between transmission and positive test result
- Possible cross-reaction in screening tests
- Requires confirmatory testing

How is transmission measured?

- Seroconversion rates are skewed when infected birds are not replaced, because denominator of susceptible birds changes.

- Best measure of transmission uses “Host-exposure-days” as denominator (needed for accurate quantification of transmission).

What is the best captive sentinel species?

- Chickens have been used extensively in SLE/WN monitoring programs in Florida in 2001, with >200 seroconversions detected
- Other bird species?
- Domestic mammals?
  - Horses?
  - Dogs?

Candidate sentinel birds that are incompetent for WNV:

Chicken
Ring-necked Pheasant
Bobwhite
Japanese Quail
Rock Dove (Pigeon)

Comparison of surveillance methods in NYC, 2001

Collaboration among:

- **CDC**
- **NYCDOH**
- **NYSDOH**
- **Green Street Scientific LLC**
- **NIH and HSPH**
- **Study conducted at 9 sites with history of WNV transmission in 1999-2000**

Comparison of surveillance methods in NYC, 2001

- Sentinel chickens and pigeons were useful for monitoring transmission in enzootic study sites
- Mosquitoes provided the best early detection
- Avian mortality surveillance was slow in detecting WNV: effect of enzootic transmission?

Summary

- Avian mortality surveillance for early detection, especially in new regions
  - Useful for tracking geographic spread
  - Watch out for results of swab field tests
- Captive sentinels useful for monitoring WNV activity in transmission foci
- Free-ranging sentinel surveillance impractical (although wildlife serosurveys are important!!)