WNV Vertebrate Ecology and Biology-Birds

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Experimental infection of WNV in 25 species of birds

Komar et al., 2003, EID 9(3): 311-323;
www.cdc.gov/ncidod/eid/vol9no3/02-0628.htm

Other studies:
Senne et al. 2000
Swayne et al. 2000
Langevin et al. 2001
Swayne et al. 2001
McLean et al. 2002

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Very Competent Species

Species (n)	Days Infectious*	Mean Peak Viremia	Reservoir Competence Index, c_i
Blue Jay (4)	4.0	11.0	2.6
Common Grackle (6)	3.0	9.4	2.0
House Finch (2)	5.5	8.5	1.8
American Crow (8)	3.2	10.1	1.6
House Sparrow (6)	3.0	8.9	1.6

*Infectious viremia = log 5 or greater per ml serum

Moderately Competent Species

Species (n)	Days Infectious*	Mean Peak Viremia	Reservoir Comp. Index, c_i
Ring-billed Gull (2)	4.5	7.4	1.3
Black-billed Magpie (3)	3.0	8.7	1.1
American Robin (2)	3.0	8.5	1.1
Red-winged Blackbird (3)	3.0	8.1	1.0
Killdeer (2)	3.0	8.1	0.9
Great Horned Owl (1)	4.0	7.6	0.9
American Kestrel (2)	3.0	8.4	0.9
Fish Crow (8)	2.8	6.8	0.7

* Infectious viremia = log 5 or greater per ml serum

Weakly competent species

Species (n)	Days Infectious*	Mean Peak Viremia	Reservoir Comp. Index, c_i
Mallard (2)	3.0	6.7	0.5
European Starling (6)	2.0	6.0	0.2
Mourning Dove (3)	1.7	5.3	0.2
Northern Flicker (1)	1.0	5.4	0.1
Canada Goose (3)	0.3	4.7	0.03

* Infectious viremia = log 5 or greater per ml serum

Non-competent species

Species (n)	Days Infectious*	Mean Peak Viremia	Reservoir Comp. Index, c_i
American Coot (1)	0	4.6	0
Rock Dove (6)	0	4.3	0
Chicken (11)	0	3.4	0
Northern Bobwhite (3)	0	2.8	0
Ring-necked Pheasant (3)	0	2.5	0
Budgerigar (3)	0	2.5	0
Monk Parakeet (3)	0	2.4	0
Japanese Quail (3)	0	2.2	0

* Infectious viremia = log 5 or greater per ml serum

Summary of Competence Studies

- Passerines are most competent
  - jays, crows, sparrows, finches, blackbirds, etc.
- Not all passerines are equally competent
- Not all birds are competent
  - pigeons, chickens incompetent
- Competence does NOT imply Reservoir Status

Reservoir Host Criteria

- Competent
- Naturally Exposed
- Abundant

Natural Exposure: Seroprevalence Studies

- High seroprevalence (typically >30%) in resident birds after epizootic transmission
- Low seroprevalence (typically <1%) in enzootic foci, in non-resident birds, early in transmission season

WNV Seroprevalence in Birds

Queens, September 1999

Species	POS/Total	% POS
Domestic Goose	6/ 7	86
Turkey	2/ 3	67
Chicken	89/141	63
House Sparrow	12/ 20	60
Pigeon	13/ 49	27
Canada Goose	2/ 7	29
Mallard	1/ 16	6

Ref: Komar et al. 2001. Emerg. Inf. Dis. 7(4): 621-625.

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Relative Abundance of Birds, Queens

Species	Relative Abundance	Infection Rate	Relative no. of Infections
House Sparrow	6000	0.60	4186
Pigeon	1000	0.27	314
Mallard	60	0.06	4
Canada Goose	60	0.29	20
Chicken	3	0.63	2
Domestic Goose	1	0.86	1

Ref: Komar et al. 2001. Emerg. Inf. Dis. 7(4): 621-625.

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Reservoir Potential of Birds, Queens

	A	x	B	=	C
Species	Relative no. infections		Competence Index		Reservoir Inoculation Index
House Sparrow	4186		1.6		11,000
Pigeon	314		0		0
Mallard	4		0.5		3
Canada Goose	20		0.03		1
Chicken	2		0		0

Read: "For every one WNV-infectious <u>Culex pipiens</u> infected by a Canada goose, there were 3 infected by mallards and more than 11000 infected by house sparrows"

Birds affected by WNV – 162 spp.

American Crow	Carolina Wren	Gray Catbird	Northern Goshawk	Scissor-tailed Flycatcher
American Goldfinch	Cedar Waxwing	Gray-cheeked Thrush	Northern Harrier	Sharp-shinned Hawk
American Kestrel	Chilean Flamingo	Great Black-backed Gull	Northern Mockingbird	Short-eared Owl
American Robin	Chimney Swift	Great Blue Heron	Northern Parula	Snowy Owl
American White Pelican	Cockatiel	Great Egret	Northern Saw-whet Owl	Song Sparrow
Bald Eagle	Cockatoo	Great Horned Owl	Northern Waterthrush	Steller's Jay
Baltimore Oriole	Common Grackle	Great-tailed Grackle	Osprey	Swainson's Hawk
Barn Owl	Common Ground-Dove	Green Heron	Ovenbird	Swainson's Thrush
Barn Swallow	Common Loon	Guanay Cormorant	Pied-billed Grebe	Swallow-tailed Kite
Barred Owl	Common Nighthawk	Harris' Hawk	Prairie Falcon	Traill's Flycatcher
Belted Kingfisher	Common Raven	Hermit Thrush	Purple Finch	Tufted Titmouse
Black Skimmer	Common Yellowthroat	Herring Gull	Purple Martin	Tundra Swan
Black Vulture	Cooper's Hawk	Hooded Warbler	Red-crowned Parrot	Turkey Vulture
Black-billed Magpie	Dickcissel	House Finch	Red-eyed Vireo	Varied Tit
Black-capped Chickadee	Domestic Chicken	House Sparrow	Red-headed Woodpecker	Veery
Black-crowned Night Heron	Double-crested Cormorant	Impeyan Pheasant	Red-shouldered Hawk	Virginia Rail
Blackpoll Warbler	Downy Woodpecker	Kentucky Warbler	Red-tailed Hawk	Warbling Vireo
Black-throated Blue Warbler	Eastern Bluebird	Killdeer	Red-winged Blackbird	Western Scrub-Jay
Black-whiskered Vireo	Eastern Kingbird	Laughing Gull	Ring-billed Gull	White-breasted Nuthatch
Blue Jay	Eastern Phoebe	Least Bittern	Ring-necked Pheasant	White-crowned Pigeon
Blythe's Tragopan	Eastern Screech-Owl	Loggerhead Shrike	Rock Dove	White-winged Dove
Boat-tailed Grackle	Eastern Towhee	Lorikeet species	Rose-breasted Grosbeak	Wild Turkey
Brewer's Blackbird	Emu	Macaw	Rough-legged Hawk	Winter Wren
Broad-winged Hawk	Eurasian Collared-Dove	Mallard	Ruby-throated Hummingbird	Wood Duck
Bronze-winged Duck	Eurasian Wigeon	Merlin	Ruddy Duck	Wood Thrush
Brown Thrasher	European Goldfinch	Mississippi Kite	Ruddy Turnstone	Yellow Warbler
Brown-headed Cowbird	European Starling	Mourning Dove	Ruffed Grouse	Yellow-bellied Sapsucker
Budgerigar	Evening Grosbeak	Mute Swan	Rusty Blackbird	Yellow-billed Cuckoo
Canada Goose	Field Sparrow	Nashville Warbler	Sandhill Crane	Yellow-crowned Night-Heron
Canada Warbler	Fish Crow	Northern Bobwhite	Savannah Sparrow	Yellow-rumped Warbler
Canvasback	Fox Sparrow	Northern Cardinal	Scarlet Ibis	Zebra Finch
Carolina Chickadee	Golden Eagle			

Avian Mortality: Disease Impact Studies

- Surveillance data lack attack rates, mortality rates

- Preliminary observations were made in 2002 of three marked crow populations: Stillwater, OK; Ithaca NY; Chicago, IL

Experimental WNV Mortality -1

Species	n	mortality rate	controls
American Crow	20	100	8
Black-billed Magpie	5	100	1
Blue Jay	6	83	0
House Finch	3	67	3
Fish Crow	11	64	5
Ring-billed Gull	2	50	1
Common Grackle	10	40	2
House Sparrow	12	25	5

These birds infected by natural means (mosquito, oral, bird-bird)

Komar et al., 2003, EID 9(3): 311-322; www.cdc.gov/ncidod/eid/vol9no3/02-0628.htm

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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
Mourning Dove	3	0	3
Budgerigar	3	0	3
Monk Parakeet	3	0	3
Japanese Quail	3	0	3
Northern Bobwhite	3	0	3

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Alternative Transmission in Birds

WNV Cage Mate Transmission

Species	No. of cages	No. of transmissions
American Crow	4	4
Black-billed Magpie	3	2
Blue Jay	2	2
Ring-billed Gull	1	1
Chicken	18	1
Other species (n=13)	30	0

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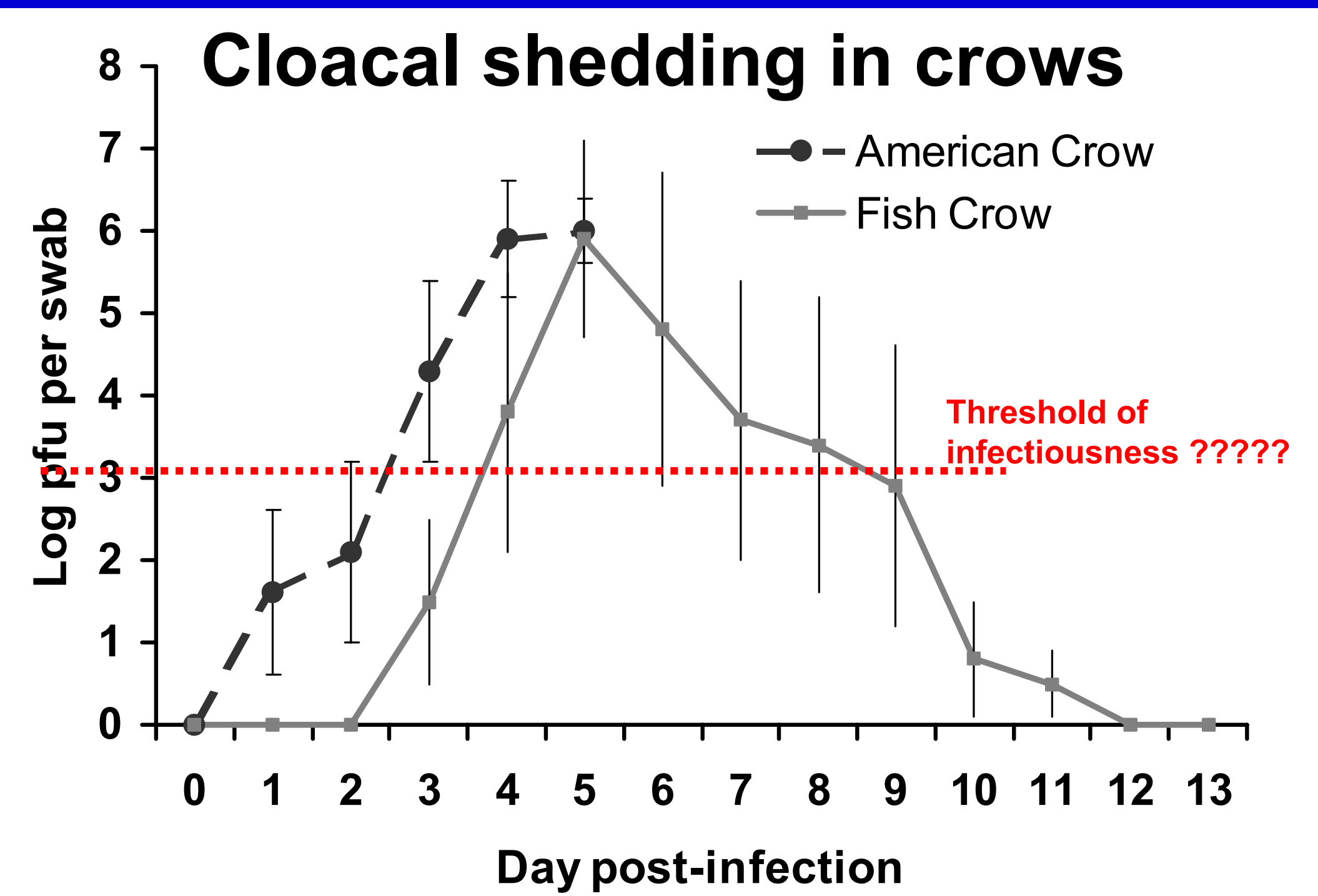
WNV Oral Transmission

Species	n	dose	no. viremic
Common Grackle	4	1000 pfu	4
House Finch	1	mosquito	1
House Sparrow	6	10^7 pfu	6
American Crow	6	sparrow	5
American Crow	3	10^7 pfu	3
Great Horned Owl	1	mice	1

Komar et al., 2003, EID 9(3): 311-322; www.cdc.gov/ncidod/eid/vol9no3/02-0628.htm


Cloacal shedding in crows
American Crow
Fish Crow
Threshold of infectiousness ?????
Log pfu per swab
Day post-infection
0
1
2
3
4
5
6
7
8
9
10
11
12
13

Persistence of WNV in Tissues

Species	Tissue	Viral Load	Days post-viremia
Killdeer 1	Skin	110 pfu/0.5 cm^3	9
Killdeer 2	Spleen	550	10
Killdeer 2	Skin	20,000	10
Mourning Dove	Kidney	100	11
Budgerigar	Heart	130	13
Blue Jay	Eye	360	9
Common Grackle	Skin	380	11
Common Grackle	Eye	150	11
House Sparrow 1	Skin	370	8
House Sparrow 2	Spleen	120	10
House Sparrow 2	Lung	590	10
House Sparrow 3	Brain	300	8

Komar et al., 2003, EID 9(3): 311-322; www.cdc.gov/ncidod/eid/vol9no3/02-0628.htm

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Birds as Dispersal Vehicles

- No hard evidence yet
- Laboratory studies pending
- Field studies unsuccessful to date
- Significance of prolonged viral persistence in organs?

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Ecological Factors Affecting Transmission

Pigeons seroconverted 270% more frequently in the canopy in New York City:

32 vs 12 in 2002

Acknowledgments

West Nile Virus: Primary *Passerine-Culex* Transmission Cycle