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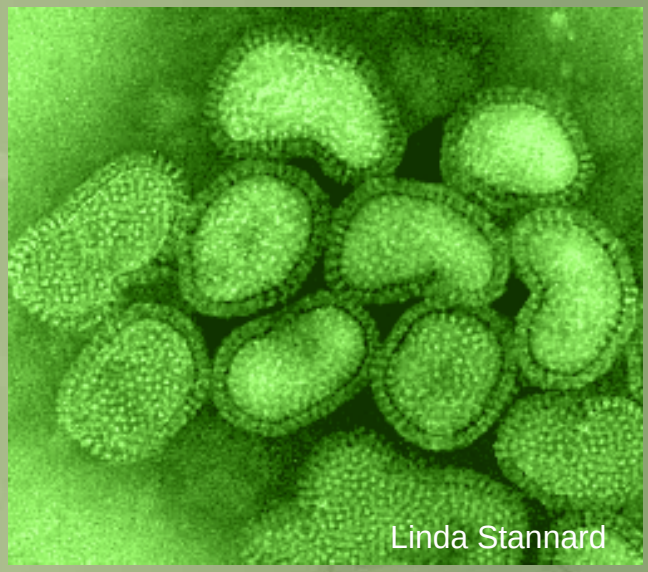
science for a changing world

DOI Avian Influenza surveillance

Hon S. Ip
National Wildlife Health Center

U.S. Department of the Interior
U.S. Geological Survey

2006 Department of Interior Surveillance



- 27, 116 birds tested
- 176 species
- 11 orders and 36 families
  - Anseriformes: 37 species
  - Charadriiformes: 29 species

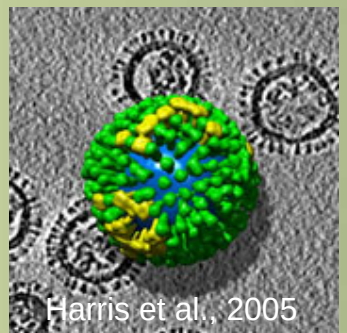
- 741 AI matrix RT-PCR positive
- 2.7% positive

- 392 viruses isolated
- 156 viruses are subtyped

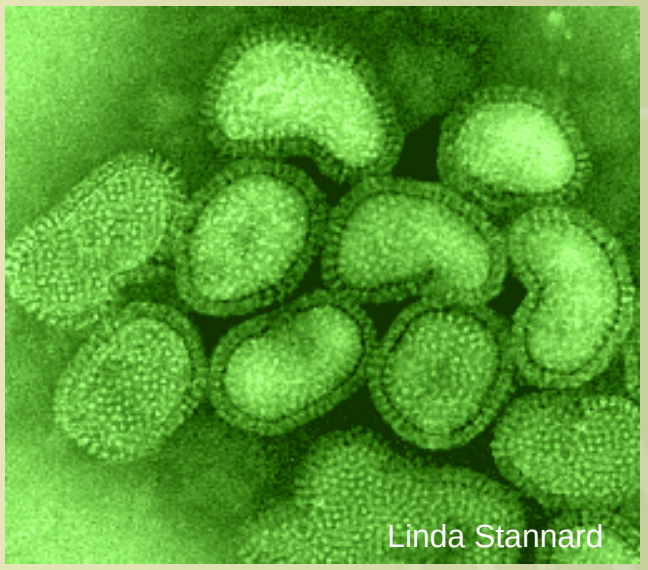

Snowy Plover: Arthur Morris

Source NWHC

USGS


Harris et al., 2005

2007 Department of Interior Surveillance



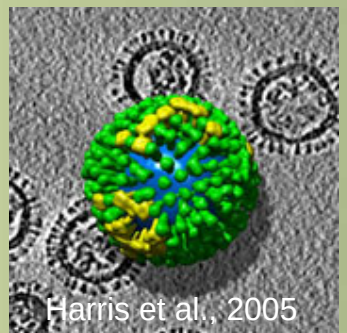
- 16, 732 birds tested (21,054)
- 113 species

- 412 AI matrix RT-PCR positive
  2.5% positive

292 viruses isolated
77 viruses are partially subtyped

Source NWHC

USGS



Laboratory Testing Update

Egg isolation

1803 birds have completed virus isolation testing (10.7%)

292 are HA-positive (16.2%)

3132 VI performed (equiv to 2/3 target numbers)

RT-PCR vs. Egg Isolation

188 birds are both PS and VI positive

185 are PS Positive, but VI Negative

29 are PS Negative, but VI Positive **

USGS

Source: NWHC

Testing Methods Continued

Pooled swabs	15	samples are H5 Pos
	6	also VI H5 Pos
PS VI	10	samples are H5 Pos
	6	also PS H5 Pos
Pooled swabs	4	samples are H7 Pos
	2	H5 Pos are VI H7 Pos
PS VI	5	samples are H7 Pos
	2	also PS H7 Pos

USGS

Source: NWHC

Subtypes Identified So Far

Subtype Combinations Identified

H1N2				
H2N1	H2N3	H2N5	H2N7	
H3N1	H3N2	H3N6	H3N8	
H4N5	H4N6	H4N7		
H5N2	H5N3	H5N9		
H6N1	H6N2	H6N4	H6N5	H6N8
H7N3	H7N6	H7N7	H7N8	H7N9
H8N4				
H9N5				
H10N2	H10N3	H10N7	H10N8	
H11N2	H11N3	H11N9		
H12N2	H12N5	H12N8	H12N9	
H13				
H16N3				

11 suspected co-infections
n=246

Source NWHC

USGS

Subtypes isolated in 2007

Subtype Combinations Identified

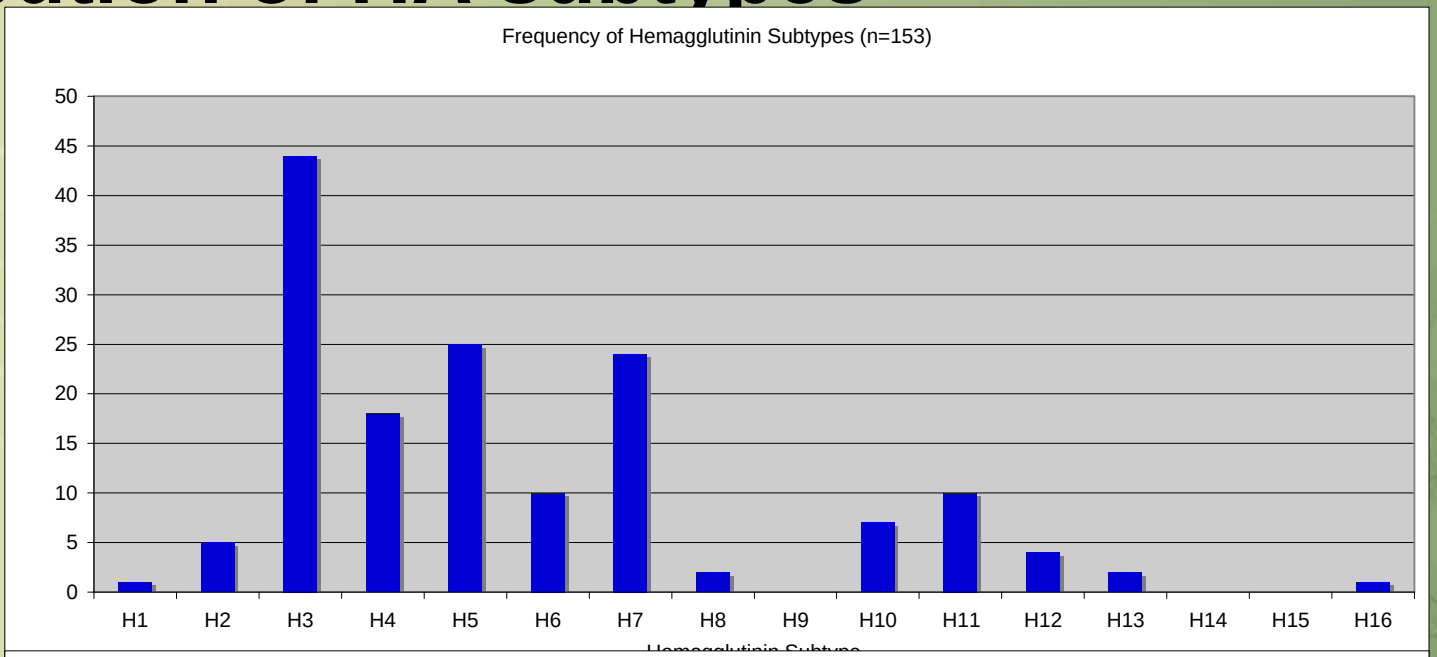
H1N2		
H2N7		
H3N3	H3N6	H3N8
H4N6		
H5N2	H5N3	H5N9
H6N1	H6N5	
H7N3	H7N4	
H8N4		
H10N2	H10N3	H10N7
H11N3	H11N9	

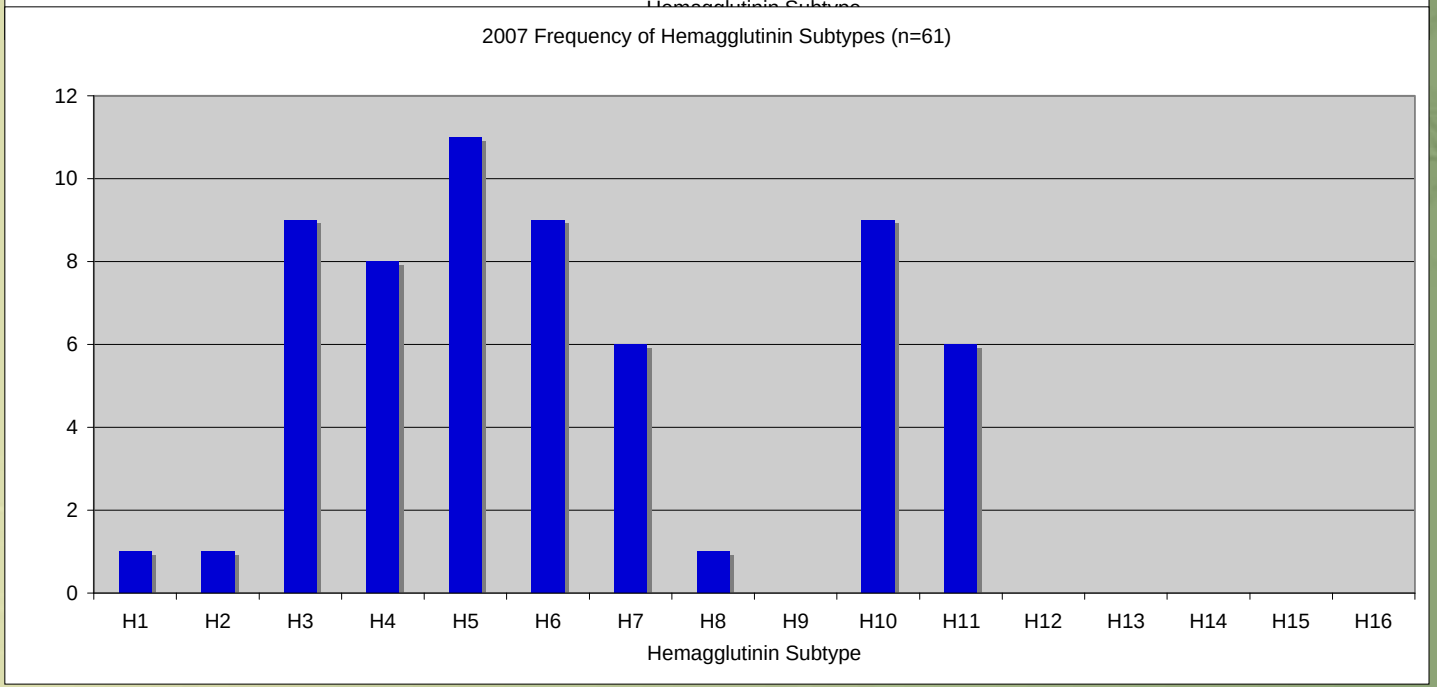
4 suspected co-infections
n=67

Source NWHC

USGS

Distribution of HA subtypes





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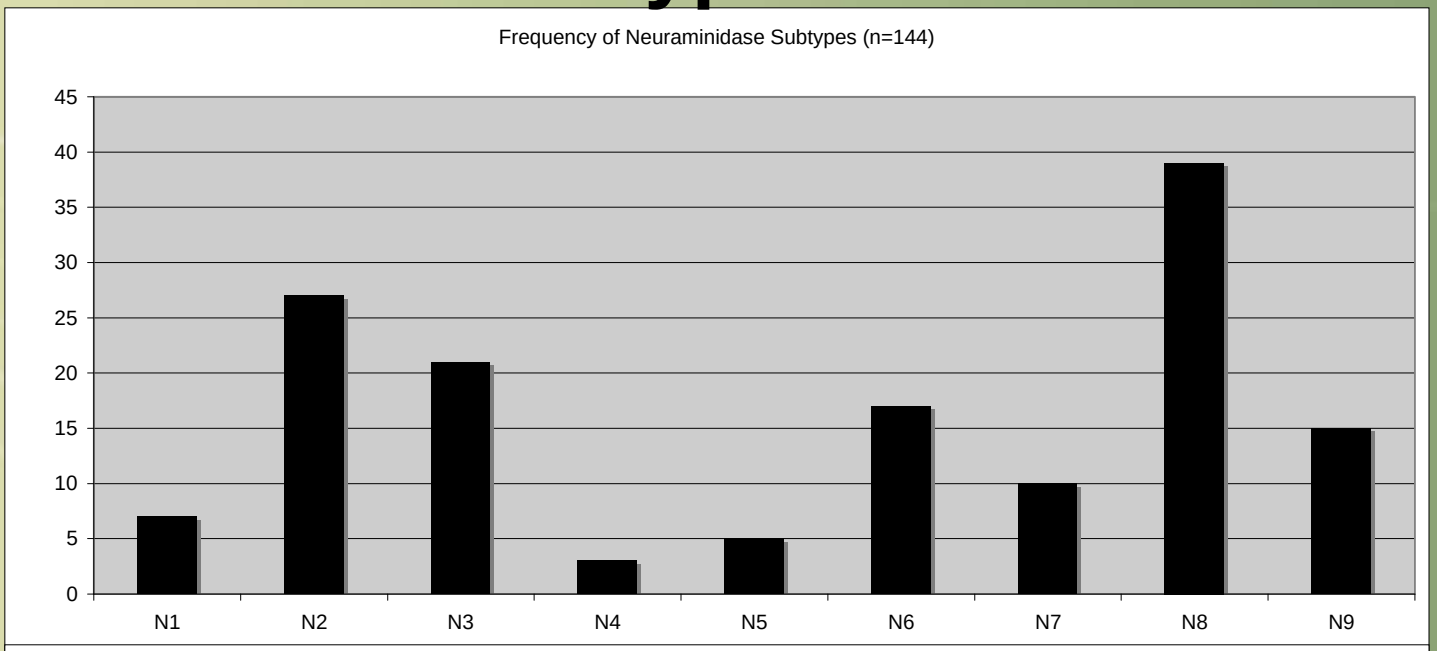
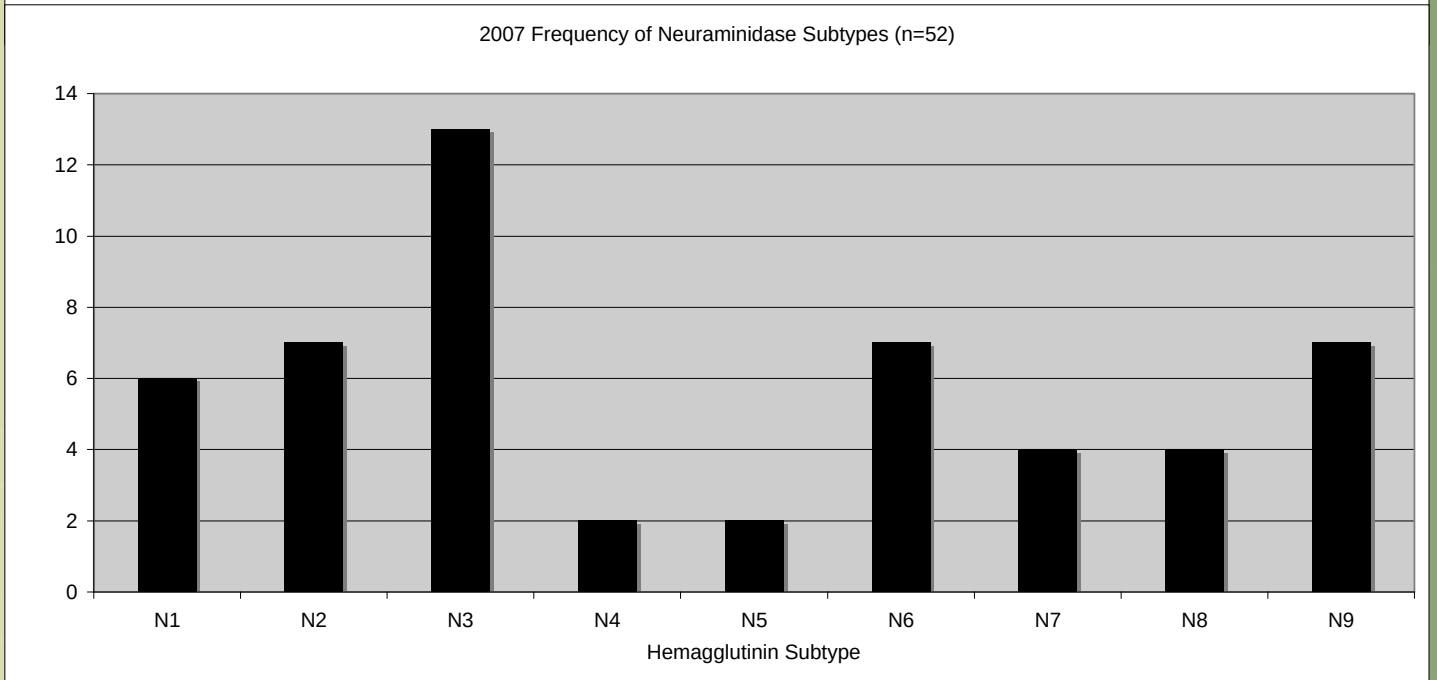
Source: NWHC

Distribution of NA subtypes





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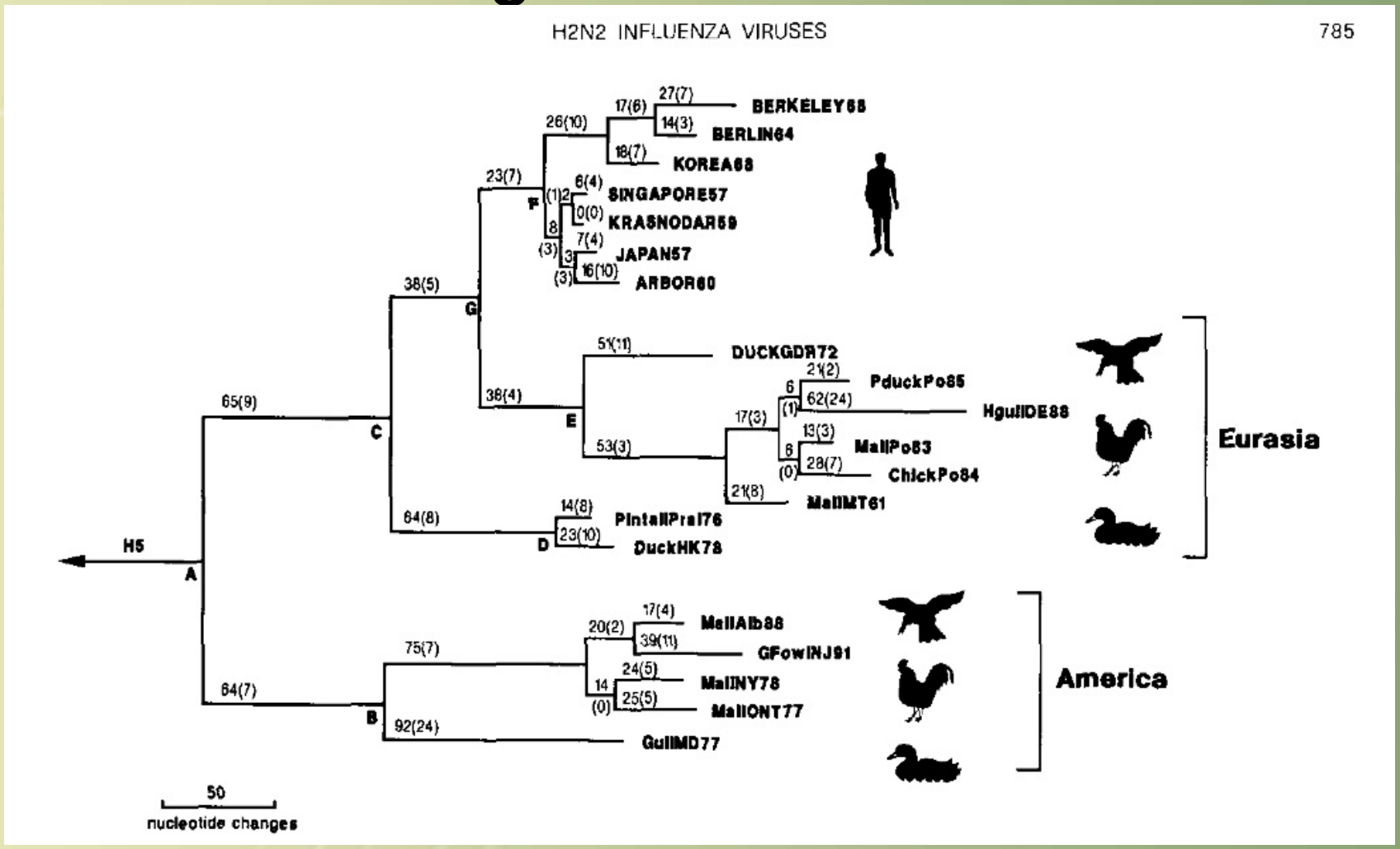
Source: NWHC

Influenza Lineages



H2 viruses. Schafer et al., 1993. Virology.

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Limited Mixing of AIV between Continents

OPEN ACCESS Freely available online

PLoS PATHOGENS

Influenza in Migratory Birds and Evidence of Limited Intercontinental Virus Exchange

Scott Krauss[1], Caroline A. Obert[2], John Franks[1], David Walker[1], Kelly Jones[1], Patrick Seiler[1], Larry Niles[3], S. Paul Pryor[4], John C. Obenauer[2], Clayton W. Naeve[2], Linda Widjaja[5], Richard J. Webby[1], Robert G. Webster[1*]

Table 3. Frequency of Detection of Outsider Events

	PB1	PB2	PA	HA	NP	NA	M	NS	Total Events	Frequency of Outsider Events by Region (Events/Segment)
American events in Eurasian clades	7	5	2	8	0	3	3	4	32	1.05%
Eurasian events in American clades	0	0	3	10	3	8	0	0	24	0.64%
Total outsider events	7	5	5	18	3	11	3	4	56	
Frequency of outsider events (events/segment)	1.25%	0.85%	0.85%	1.77%	0.44%	1.24%	0.25%	0.32%	0.83%	
Total American segments	281	299	280	328	323	367	543	619	3,040	
Total Eurasian segments	279	287	305	686	362	516	644	648	3,727	
Total segments analyzed	560	586	585	1,014	685	883	1,187	1,269	6,767	

Between 0.64-1.05% of the genes show exchange

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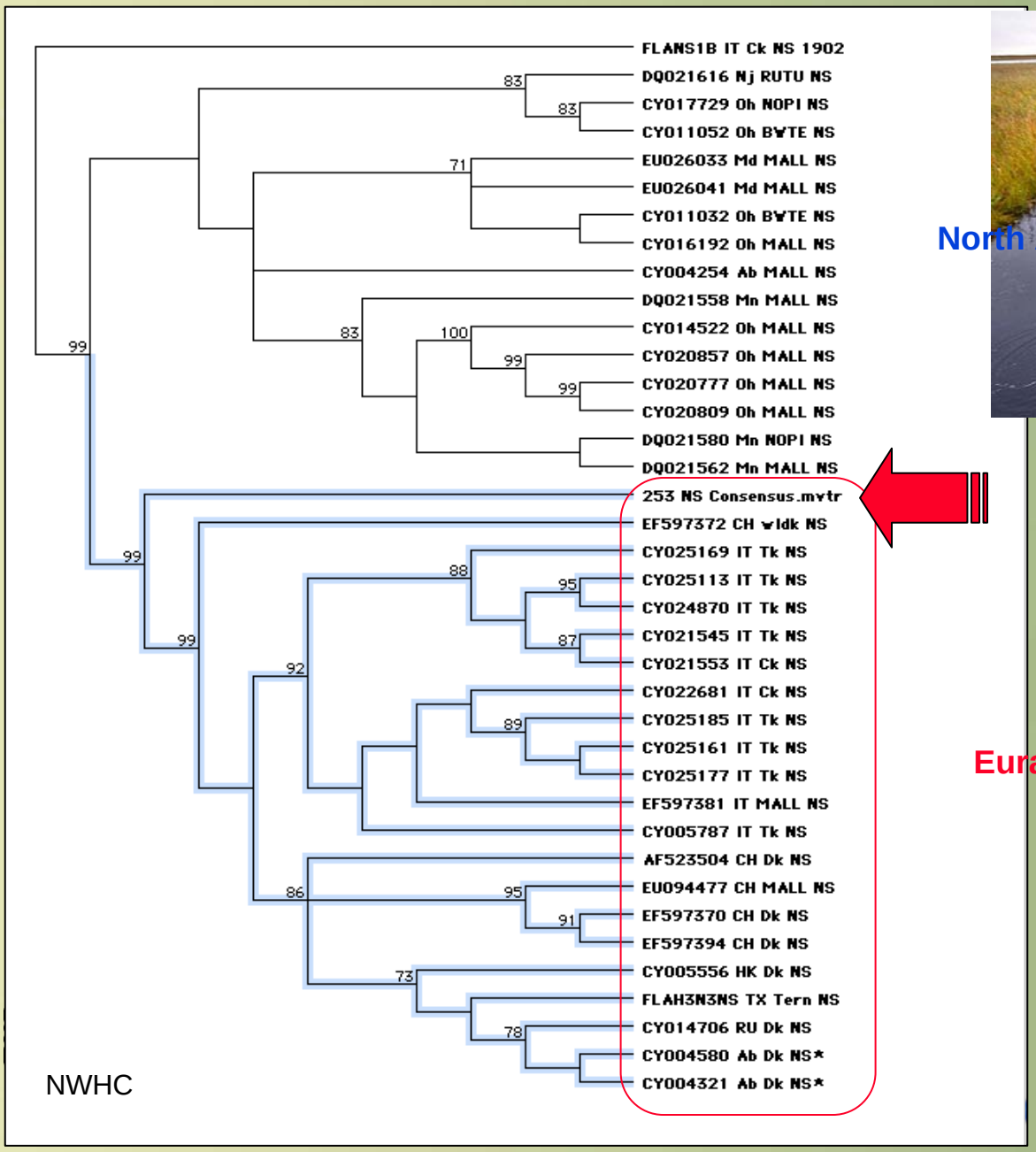
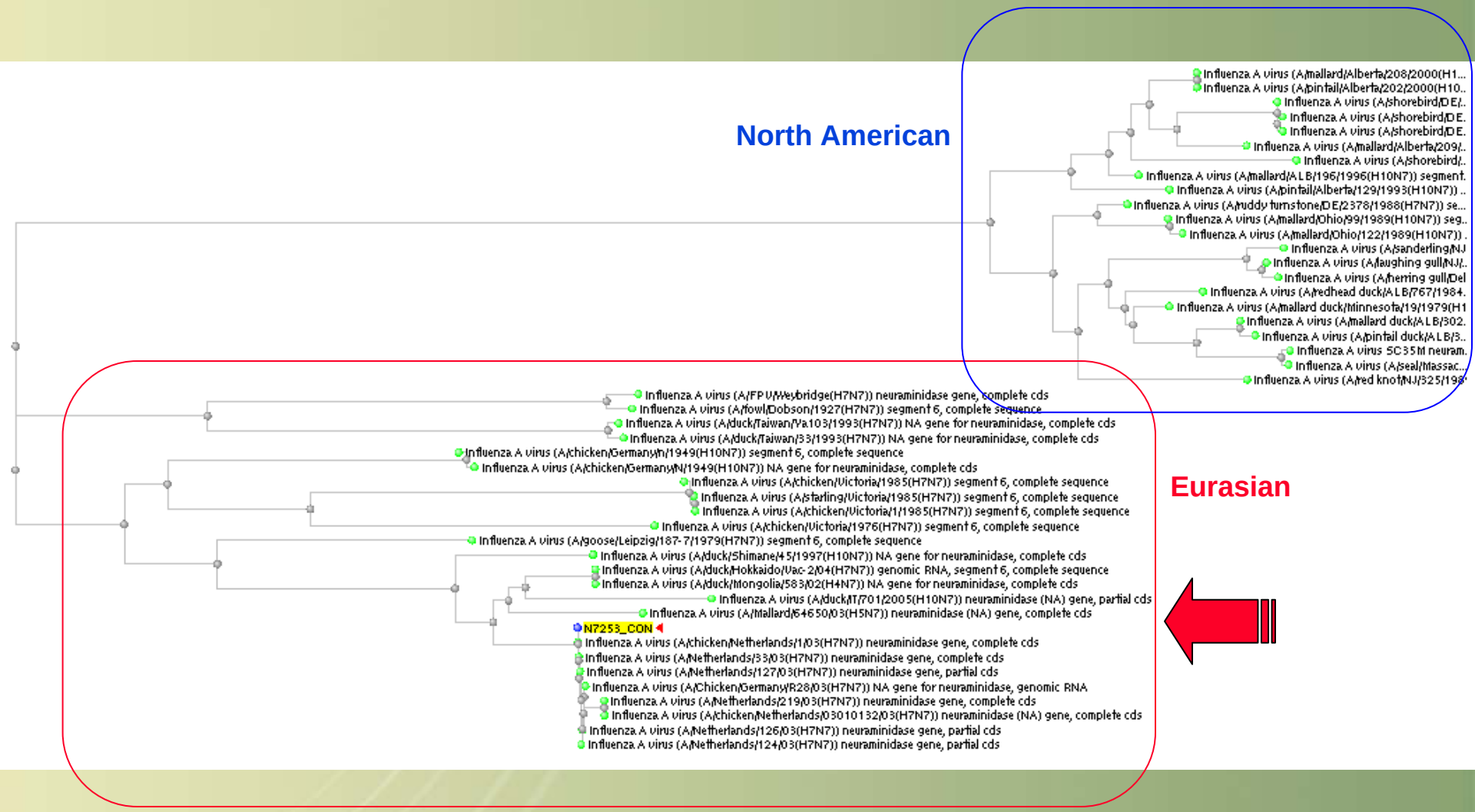
Evidence of Eurasian Lineage in Alaskan Virus



North American

Eurasian

Evidence of Eurasian Lineage in Virus 253



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Neuraminidase gene from 253

Proportion of Eurasian Lineage Genes (2006)

	Alaska		Lower 48	
	Viruses	RNA Segments	Viruses	RNA Segments
# Eurasian	17	76	5	14
# Total	90	496	62	338
Percentage	18.9%	15.3%	8.1%	4.1%

Twice as many viruses isolated in Alaska in 2006 contains RNA segments pf Eurasian lineage that those in the lower 48 states.

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Source: NWHC

Different Distribution of EA genes in Genome

Alaska

	HA	NA	MA	NS1	PB1	PB2	PA	NP
# Eur	16	9	3	4	3	1	9	14
Total	67	60	49	51	44	44	44	47
% Eur	23.9%	15.0%	6.1%	7.8%	6.8%	2.3%	20.5%	29.8%

Lower 48

	HA	NA	MA	NS1	PB1	PB2	PA	NP
# Eur	3	3	0	0	0	0	1	2
Total	39	37	34	36	32	34	32	32
% Eur	7.7%	8.1%	0.0%	0.0%	0.0%	0.0%	3.1%	6.3%

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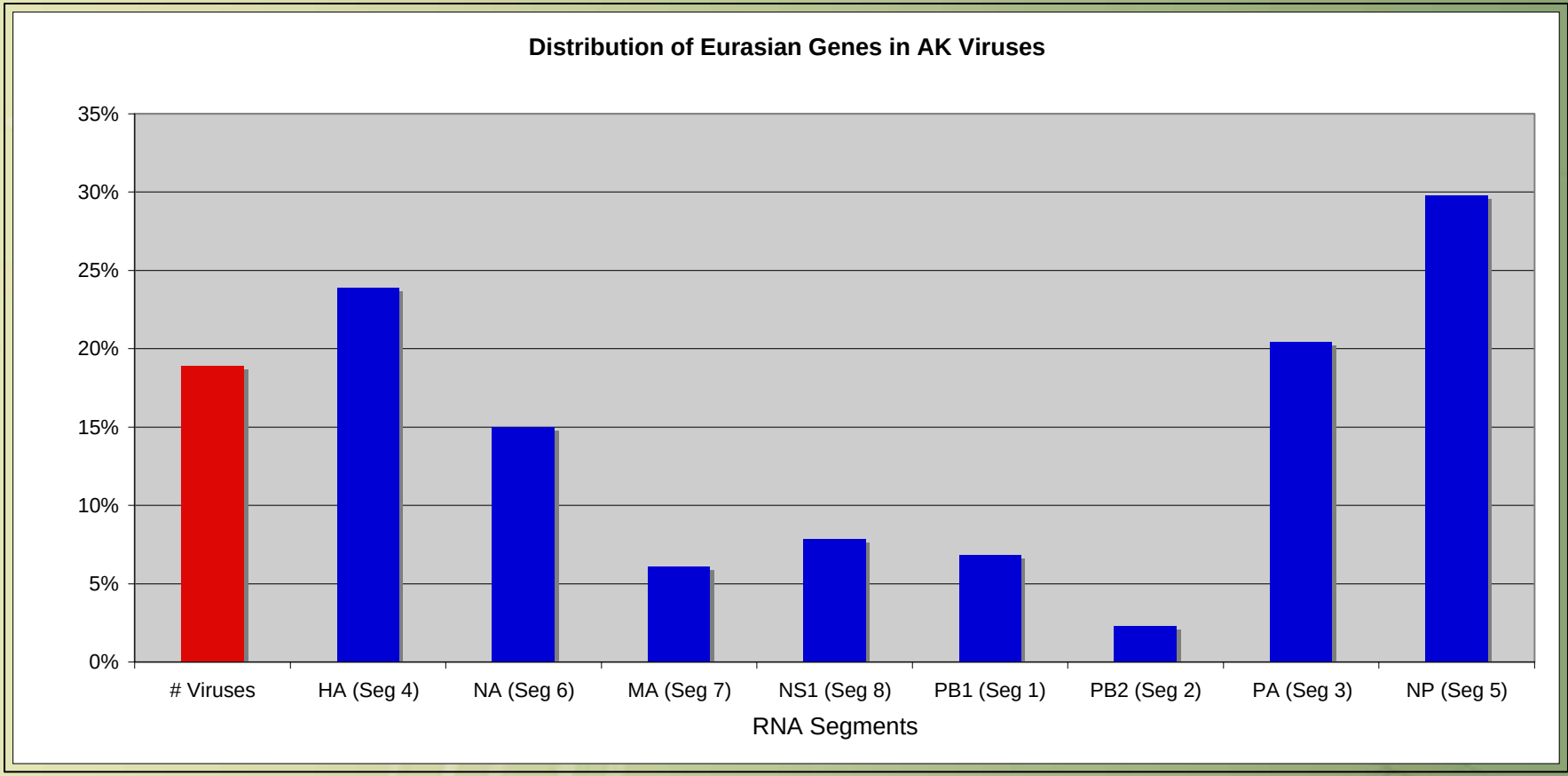
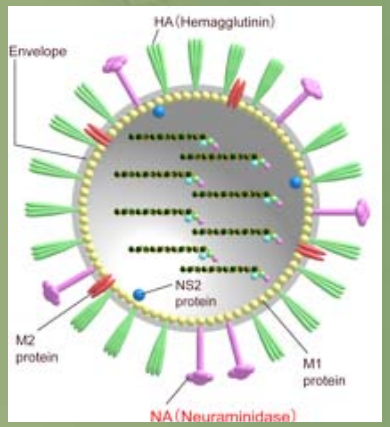
Source: NWHC

Distribution of Eurasian RNAs



The distribution is uneven across the 8 RNA segments
Lower in some internal genes
Lowest in PB1



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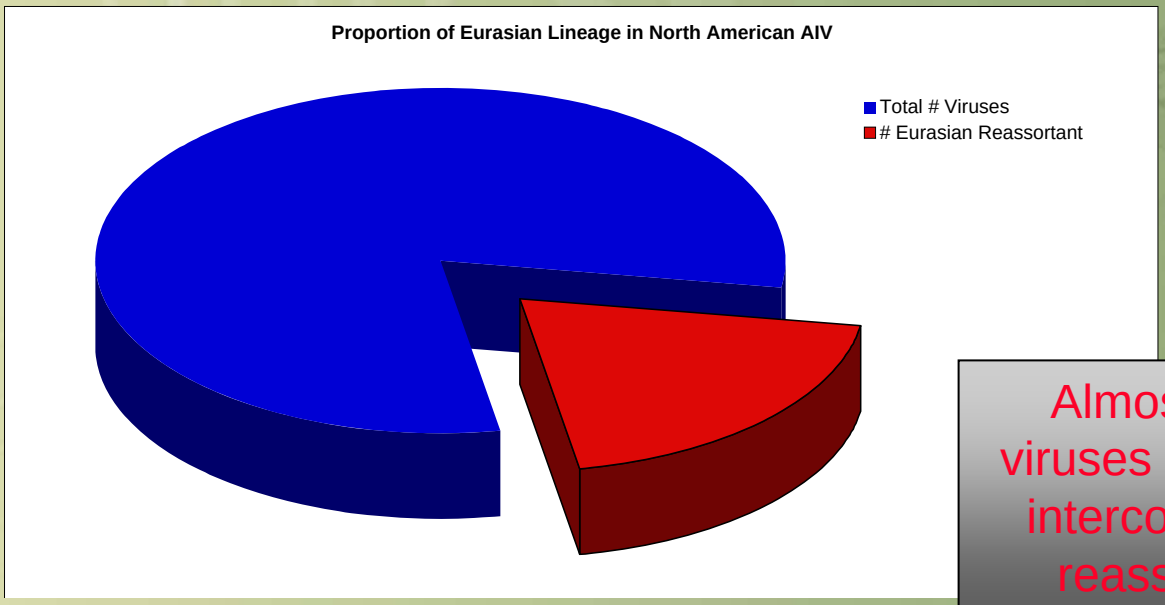
Source: NWHC

Intercontinental Connections

- 903 RNA segments have been sequenced
- 69 have Eurasian viruses as closest relative

- 171 viruses have been at least partially characterized
- 38 viruses have genes from the Eurasian lineage

22 % of the viruses examined to date are reassortants containing genes of viruses from Europe and Asia



Source NWHC

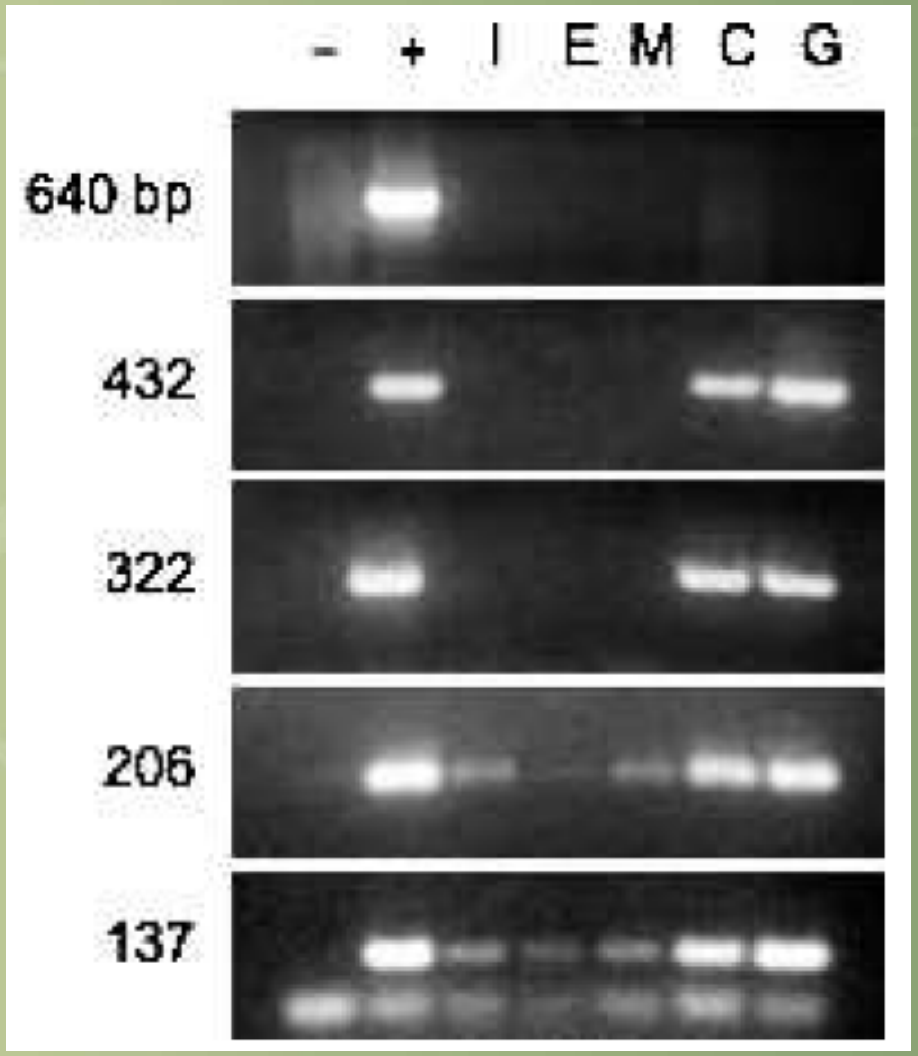
USGS

Almost 1 in 4 viruses tested are intercontinental reassortants

Influenza RNA Preservation

Isopropanol, ethanol and methanol are not as effective in the preservation of influenza RNA at RT than a commercial product (Ambion) or with guanidium thiocyanate.

Evers et al., 2007. Avian Dis 51:965–968.



Evers et al., 2007.

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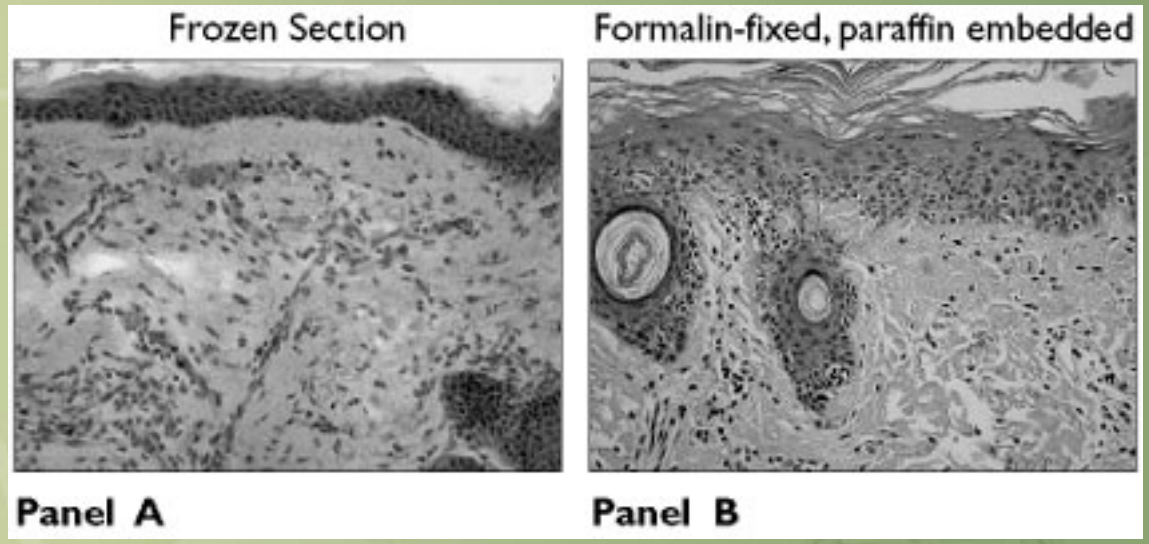
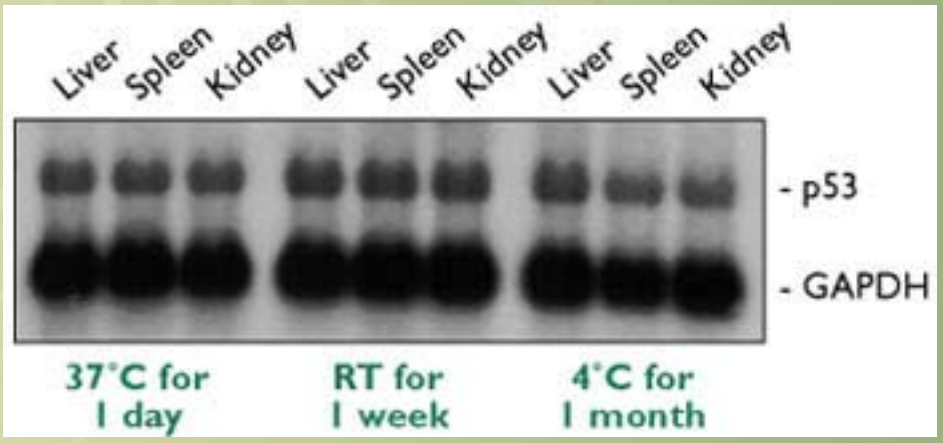
Ambion RNALater



Used to preserve tissue architecture and RNA from field sites with no refrigeration



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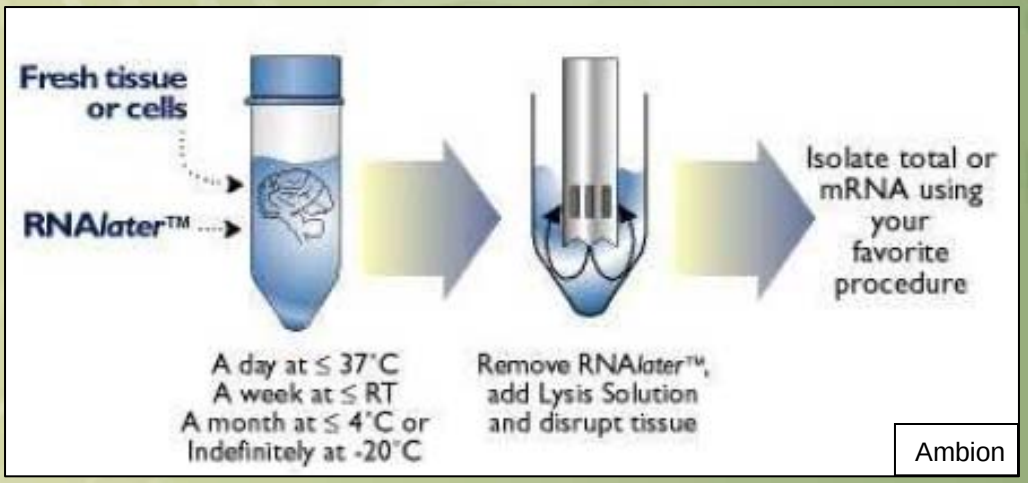
Source: Ambion

RNALater

Treatment	Media	Temperature	MA RT-PCR	Virus Isolation
Feces + H5N2	VTM	-80 C	14.63	Yes
Feces + H5N2	VTM	4 C	21.71	Yes
Feces + H5N2	RNALater	RT	33.11	No
Feces	RNALater	RT	0	No



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Source: NWHC

USGS Environmental AI Sampling

- Preliminary project with Lisa Stewart

Source: USGS Georgia Water Science Center

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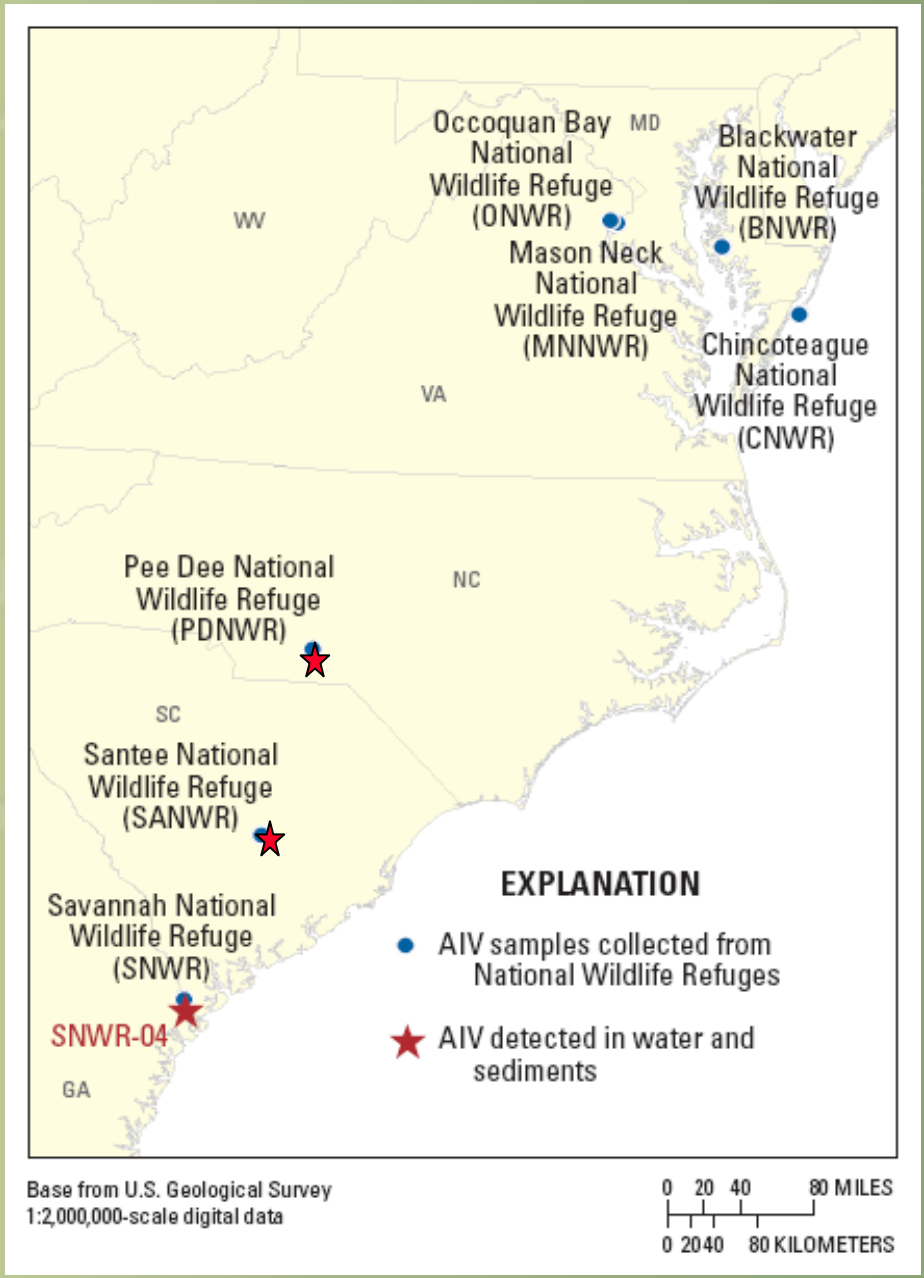
Locations of Sampling Sites

- Seven locations in five states examined
- Three have resulted in positive AI isolation
- H3N1 and 2 H3N8 viruses identified



Source: USGS Georgia Water Science Center

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Features of Water Quality

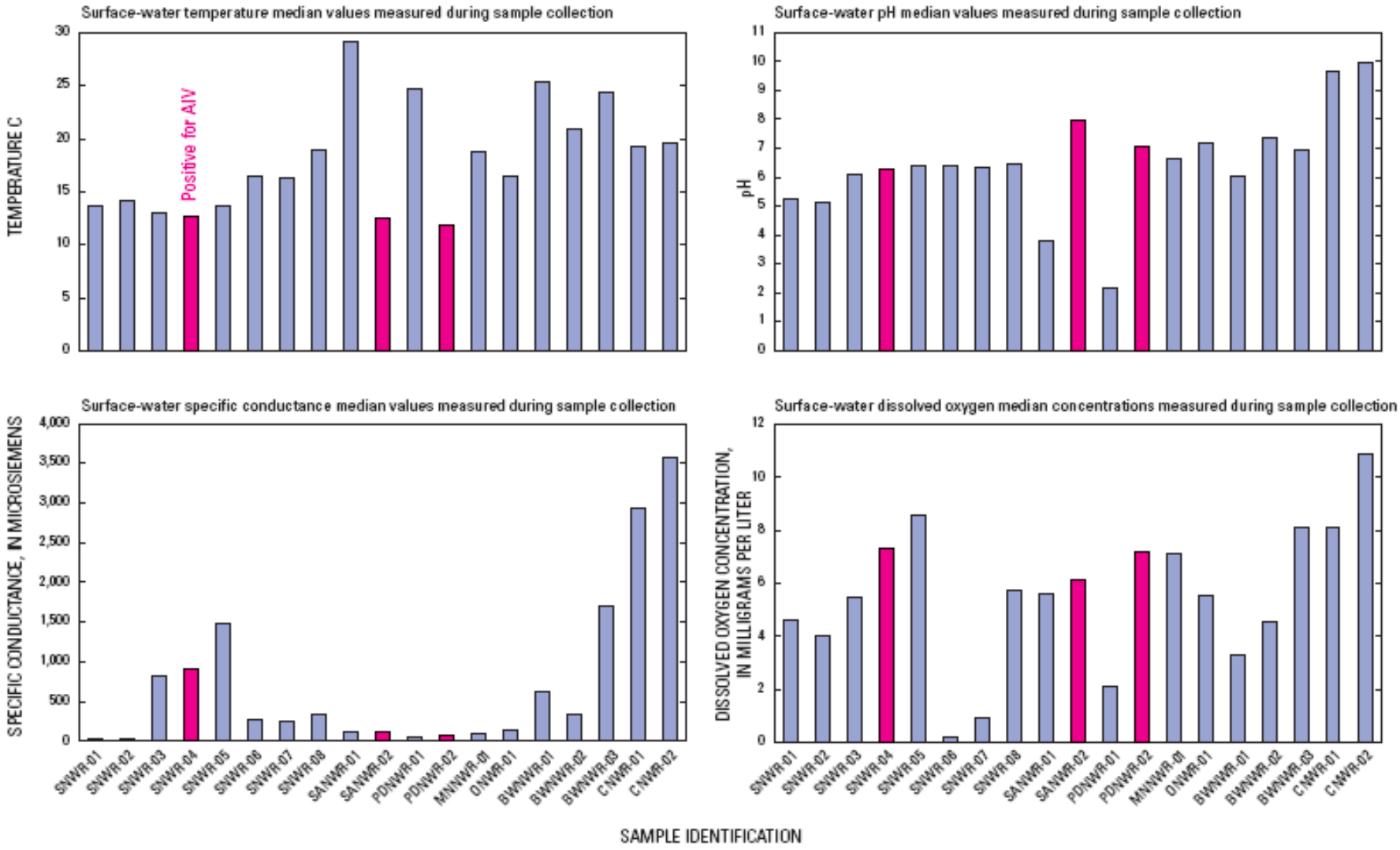

Figure 3. Bar graph showing median values for temperature, pH, specific conductance, and dissolved oxygen for benthic zone samples collected for avian influenza viruses, Feburary and May 2006, and January 2007.

Source: USGS Georgia Water Science Center

Acknowledgements

Aaron Wells Adam Ahonen **Adam Ray** Adrian Riegen **Alexandria Hauser** Alexis Will Allison Sayer Amy Leist **Amy Miyamoto** Andrew Brissette **Anson Koehler** Anthony Boyscout Archer Larned Audrey Taylor Ayme Johnson Ben Haase Beverly Schmitt Bill Larned Bill Schaff Blake Trask **Bob Dusek Bob Gill** Bob Leedy Brad Andres Brad Scotton Brad Winn Brian Harrington Brundaban Panigrahy Caleb Ashling Chi Yeung Choi Chris Dau **Chris Franson** Chuck Steffen Chuck Redd Chung-yu Chiang Cory Gregory **Craig Ely** Dan Ruthrauff Daniel Coster Daniel Fontaine Daniel Rizzolo Dave Krueper **David Irons** David Melville Deb Nigro **Deb Rocque** Deb Rocque Dennis Marks Dennis Senne Devin Taylor **Dirk Derksen** Donna Dewhurst Ed Mallek **Evan Sorley** Evonne Phillips Fabrice Lebouard Fred Broerman Greg Norwood Heather Gates Heather Wilson Hilger Lemke James Lawoon Jan van de Kam **Janice C. Pedersen** Jen Selvidge Jennifer DeGroot Jennifer Spake Jennifer Steffen **Jennifer Tuscher** Jesse Conklin **Jessica Montez** Jim Johnson Joe Liebezeit **John Pearce** John Pepe John Terenzi John Wells Josh Boadway Julian Dowdall **Julian Fischer** Julie Reinsch Julie St. Louis Karen Bollinger Karen Brenneman Karen Laing Katherine Pavlis **Katy Griffin** Kelly Ramster Ken Wright Kent Wohl **Kentissha Franklin** Kevin Pietrzak **Kim Kooiman** Kristen Sowl Kristin DeGroot Larry Larrivee Laura Ganis Laura Kepler Lee Tibbitts Liliana Coelho Naves **Lucky Karwal** Maks Dementyev **Margaret Petersen** Mary Lea Killian Mat Sorum Matt Sexson Matt Wilson Megan Jones **Melanie Mossing Mellisa Houfe** Metta McGarvey Michael Wege Michael Petrula Mike Spindler Naomi Bargmann Nate Olson Nathan Coutsoubos Nathan Senner Nichole Hines Nils Warnock Nora Rojek Paul Anderson **Paul Flint** Pavel Tomkovich **Peter Ladell Rachel Reddington** Randy Cone **Renee Long Rick Lanctot** Rob MacDonald Robert Dusek Robert Rankin Robin Corcoran Robin Hunnewell Rod King **Russ Oates** Ryan Bradley **Samantha Scott** Sandra Talbot Sarah Jamieson Sarah McCloskey Scott Dieni Shawn Hawks **Stephanie Rieger** Stephen Brown Steve Kovach **Steve Matsuoka** Steve Zach Susan Savage Susan Savage Terry Kowalczyk Tess Ely **Thierry Work Thomas Fondell** Tim Bowman **Tina Egstad** Tina Moran **Tom Rothe** Ty Donnelly Umair Iqbal Will Meeks Yvette Gillies

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An “Arctic Effect”- Low AI Prevalence in AK

EMERGING INFECTIOUS DISEASES

Research

Volume 13, Number 4–April 2007

Movements of Birds and Avian Influenza from Asia into Alaska

Kevin Winker,* ✉ Kevin G. McCracken,*† Daniel D. Gibson,* Christin L. Pruett,*† Rose Meier,* Falk Huettmann,† Michael Wege,‡ Irina V. Kulikova,§ Yuri N. Zhuravlev,§ Michael L. Perdue,¶ Erica Spackman,# David L. Suarez,# and David E. Swayne#

- 1998-2004
- 5 AI viruses identified from 8,254 samples (0.06%)
- Only 1 of 3,703 northern pintails infected (0.03%)

“An “Arctic effect” on viral ecology, caused perhaps by low ecosystem productivity and low host densities relative to available water.”

USGS

Source: Winker et al., 2007. Emerg Inf Dis.

DOI Results - Northern Pintail (*Anas acuta*)


Greg Asley

- 1426 animals collected in 2006
- 87 Positive by RT-PCR test
- 6.1% of NOPI are positive for avian influenza virus by RT-PCR

(9.5% Amer Green-winged teal (*Anas crecca*), n=539)
(9.2% mallard (*Anas platyrhynchos*), n=273)


TR Michaels


Bailey Aros

Source NWHC

USGS

AI detected in a majority of targeted species

Species	Name	MA Pos	Percent Pos
ALTE	Aleutian Tern, *Onychoprion aleuticus*	1	0.3%
AMWI	American Wigeon, *Anas americana*	15	6.1%
BARG	Bar-tailed Godwit, *Limosa lapponica*	3	1.4%
BLBR	Black Brant, *Branta bernicla*	9	0.4%
CACG	Cackling Goose, *Branta hutchinsii*	22	2.0%
CAGO	Canada Goose, *Branta canadensis*	9	3.4%
COEI	Common Eider, *Somateria mollissima*	1	0.3%
COMU	Common Murre, *Uria aalge*	1	1.3%
DUNL	Dunlin, *Calidris alpine*	5	0.4%
EMGO	Emperor Goose, *Chen canagica*	11	1.6%
GLGU	Glaucous Gull, *Larus hyperboreus*	5	3.6%
GWFG	Greater White-fronted Goose, *Anser albifrons*	40	3.7%
GWTE	Green-winged teal, *Anas crecca*	91	5.0%
KIEI	King Eider, *Somateria spectabilis*	6	0.9%
LSGO	Lesser Snow Goose, *Chen caerulescens*	10	0.8%
LTDU	Long-tailed Duck, *Clangula hyemalis*	11	1.0%
MALL	Mallard, *Anas platyrhynchos*	134	9.2%
MASA	Marsh Sandpiper, *Limosa fedoa*	1	25.0%
NOPI	Northern Pintail, *Anas acuta*	225	6.3%
NSHO	Northern Shoveler, *Anas clypeata*	78	18.8%
PAGP	Pacific Golden-Plover, *Pluvialis fulva*	1	0.1%
SPEI	Spectacled Eider, *Somateria fischeri*	2	0.6%
STEI	Steller's Eider, *Polysticta stelleri*	6	0.8%
TBMU	Thick-billed Murre, *Uria lomvia*	7	3.0%
TUSW	Tundra Swan, *Cygnus columbianus*	7	1.2%
WESA	Western Sandpiper, *Calidris mauri*	1	0.1%

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Source NWHC

Priority Species - Now


Aleutian Tern: eNature


PESA: BirdsIreland


Common Eider: AnimalPictures

USGS

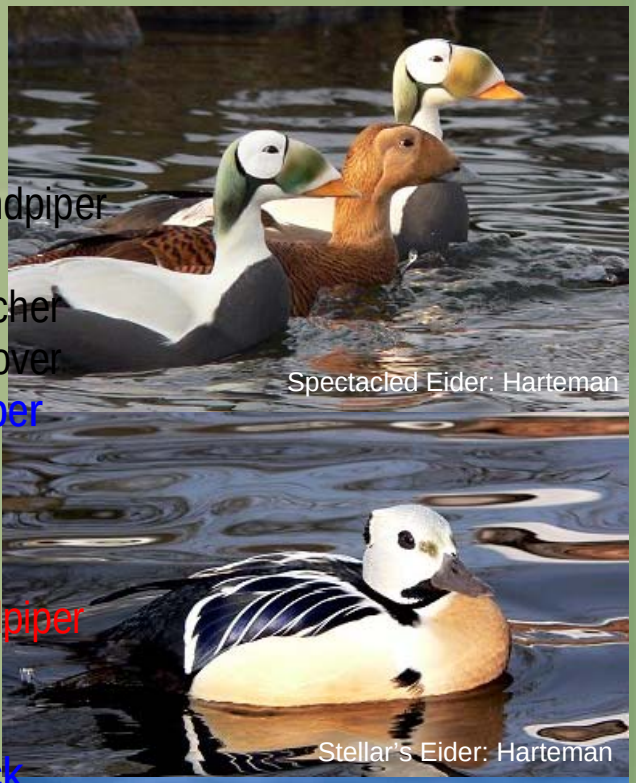
Gulls and Terns
Aleutian Tern
Glaucous Gull

Landbirds
Arctic Warbler
Eastern Yellow Wagtail
Gray-cheeked Thrush
Lesser Sandhill Crane

Shorebirds
Bar-tailed Godwit
Buff-breasted Sandpiper
Dunlin
Long-billed Dowitcher
Pacific Golden-Plover
Pectoral Sandpiper
Red Knot
Ruddy Turnstone
Rock Sandpiper
Sharp-tailed Sandpiper

Waterfowl

Aleutian Cackling Geese
Black Brant
Emperor Goose
King Eider
Lesser Snow Goose
Long-tailed Duck
Northern Pintail
Pacific Common Eider
Spectacled Eider
Steller's Eider
Tundra Swan


Spectacled Eider: Harteman

Stellar's Eider: Harteman


King Eider: Avesphoto

Title

Text

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Subtypes isolated in 2005

Subtype Combinations Identified

H3N1	H3N6	H3N8
H3N	H4N6	
H5N2		
H9N5		

n=26

Source NWHC

USGS

Subtypes isolated in 2006

Subtype Combinations Identified

H1N2				
H2N1	H2N3	H2N5		
H3N2	H3N6	H3N8		
H4N5	H4N6	H4N7		
H5N2	H5N3	H5N9		
H6N1	H6N2	H6N4	H6N8	
H7N3	H7N6	H7N7	H7N8	H7N9
H8N4				
H10N2	H10N3	H10N7	H10N8	
H11N2	H11N9			
H12N2	H12N5	H12N8	H12N9	
H13				
H16N3				

7 suspected co-infections
n=150

Source NWHC

USGS

Previous literature on Lineage Mixing

H2N2. Duck. Hokkaido. Liu et al., 2004. PA.
H2N3. Duck. Hokkaido. Liu et al., 2004. PB2.
H6N2. Guliiemot Sweden. Wallensten et al., 2005.

USGS

Source

Title

Text

Source