LIFE CONOPS: Development & demonstration of management plans against -the climate change enhanced- invasive mosquitoes in S. Europe

West Nile Virus surveillance in Northern Italy

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LIFE CONOPS (LIFE12 ENV/GR/000466)

Summary

- ✓ Key points on West Nile: disease, virus, epidemiology
- ✓ Italian national plan on WNV Surveillance
- ✓ One Health System operated in Northern Italy
- ✓ Discussion and conclusion

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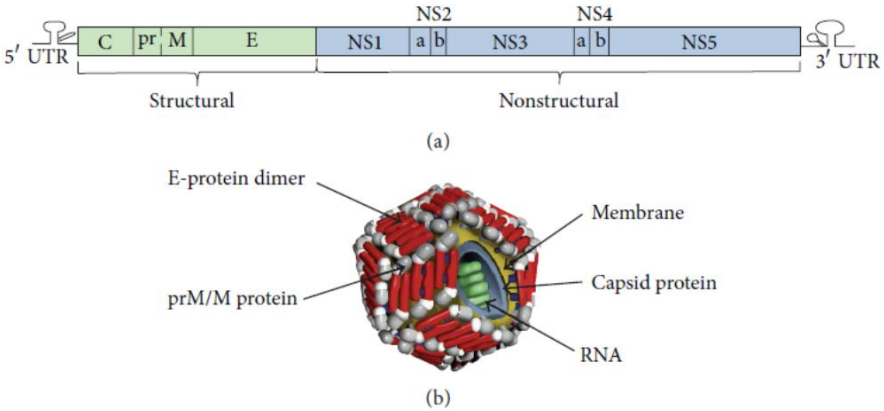
West Nile disease

- ✓ First time detected in Uganda in 1937 and later spread to Europe, Asia, Africa and Middle East. In 1999 detected in U.S.A. In Europe first outbreak in France (Camargue, 1962) and now present in many countries in the eastern part of the continent
- ✓ Most people (8 out of 10) infected with West Nile virus do not develop any symptoms; febrile illness (fever) occurs in some people (about 1 in 5 people who are infected) and serious symptoms affecting the central nervous system in a few people (about 1 in 150 of infected)
- ✓ West Nile virus is most commonly transmitted to humans by mosquitoes and; many species are competent in transmission in field or lab
- ✓ Additional routes of human infection have also been documented. It is important to note that these methods of transmission represent a very small proportion of cases: Blood transfusions; Organ transplants; Exposure in a laboratory setting; From mother to baby during pregnancy, delivery, or breastfeeding

West Nile virus

- ✓ Genus Flavivirus, family Flaviviridae; it is a member of Japanese Encephalites serocomplex
- ✓ Spherical capside (≈50 nm) with single stranded RNA
- ✓ 5 lineages with different pathogenicity linked to the vector-host relation; lineage 1 and 2 are the most frequent

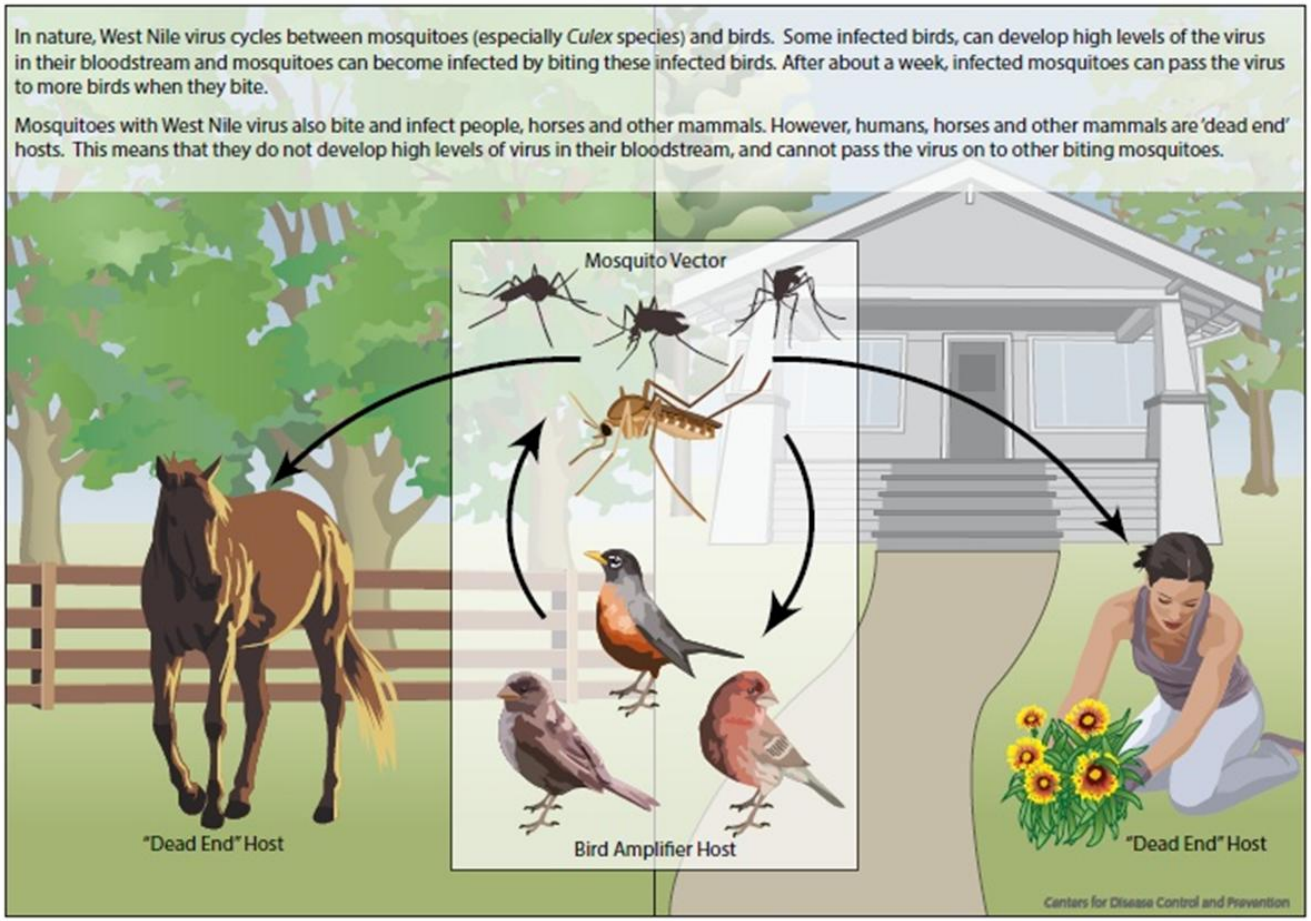


Caren Chancey, Andriyan Grinev, Evgeniya Volkova, and Maria Rios, "The Global Ecology and Epidemiology of West Nile Virus," BioMed Research International, vol. 2015, Article ID 376230, 20 pages, 2015. doi:10.1155/2015/376230

Main vectors of WNV in the world

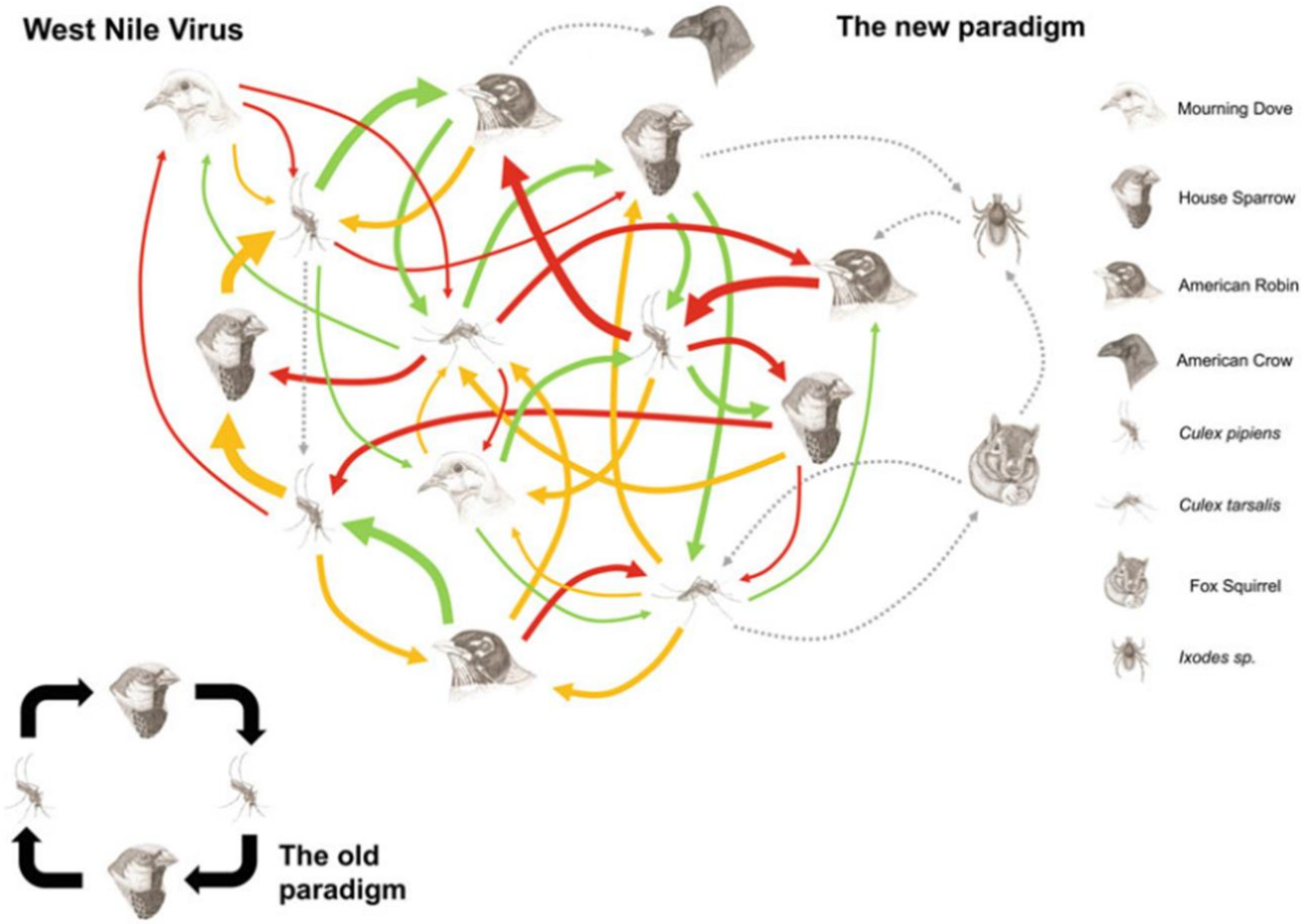
- ✓ US: Cx.pipiens, Cx.quinquefasciatus, Cx.tarsalis, Cx.nigripalpus, Cx.salinarius
- ✓ EU: Cx.pipiens molestus, Cx.modestus, Cx.pipiens pipiens
- ✓ MIDDLE EAST: Cx.univittatus, Cx.pipiens
- ✓ AFRICA: Cx.theileri, Cx.univittatus, Cx.antennatus
- ✓ ASIA: Cx.vishnui, Cx.quinquefasciatus, Cx.tritaeniorhynchus

West Nile Virus Transmission Cycle



West Nile virus (WNV) circulates between mosquito and wild birds, but can infect humans and equids as dead end host

West Nile Virus Cycle



from Contigiani et al 2016

- ✓ Very complex cycle: WNV was isolated in 51 arthropods, including ticks in the old world (Hubalek 1999), and detected in a wide range of wild birds, and in mammals and in reptiles

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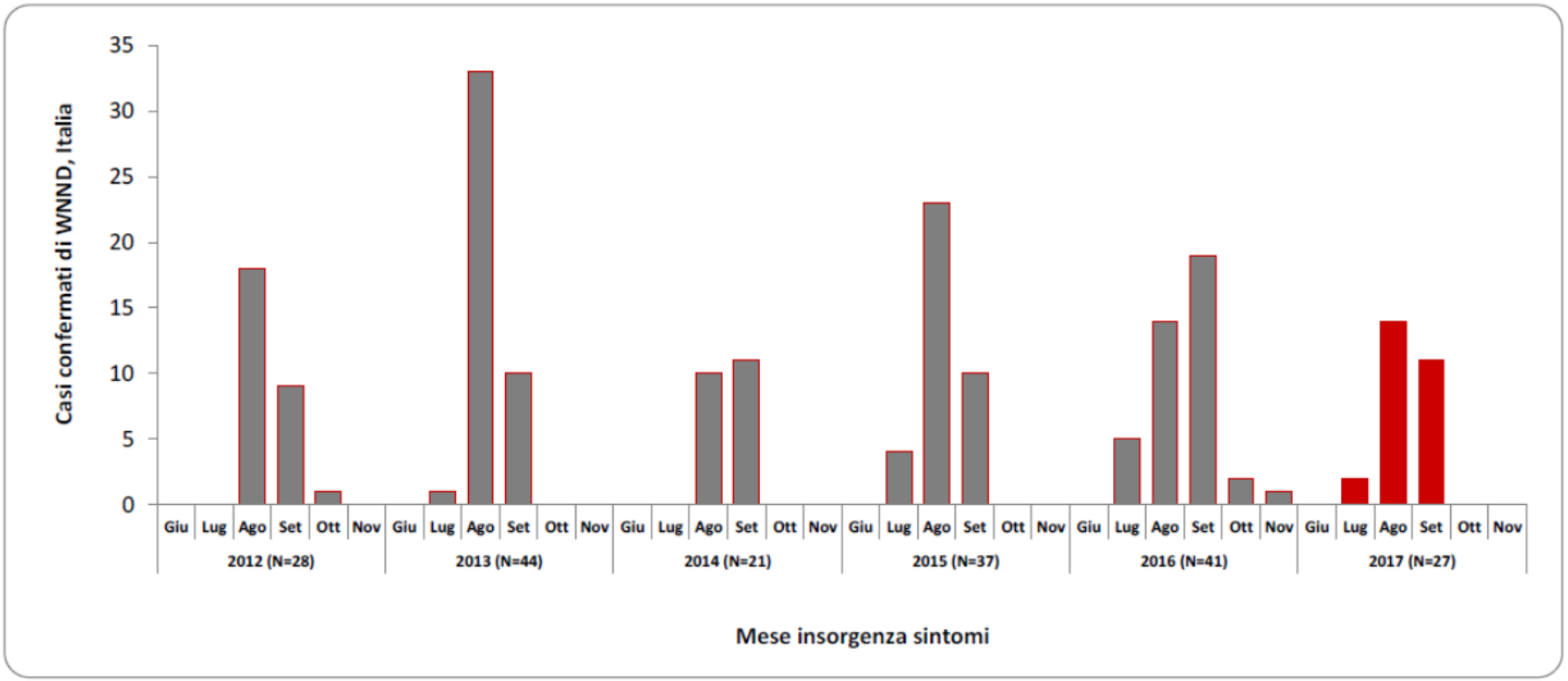
West Nile Neuroinvasive Disease in Italy, 2012-2017

- ✓ Trend of confirmed cases of WNND in Italy by month of symptoms onset



In figura sono riportati anche i casi importati: 2 nel 2013, 1 nel 2015 e 3 nel 2016

Italian national plan on West Nile

0016990-31/05/2017-DGPRE-DGPRE

Ministero della Salute

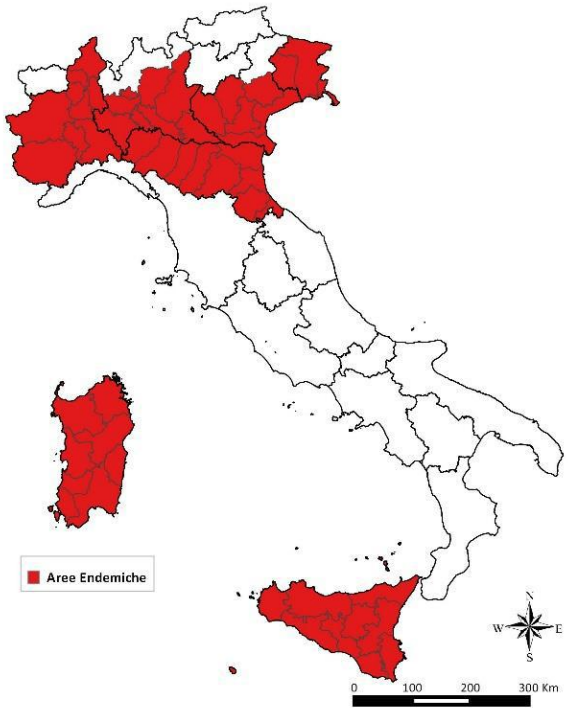
DIREZIONE GENERALE DELLA PREVENZIONE SANITARIA
Ufficio V – Prevenzione delle malattie trasmissibili e profilassi internazionale

DIREZIONE GENERALE DELLA SANITÀ ANIMALE E DEI FARMACI VETERINARI
Ufficio III – Sanità animale e gest. oper. Centro Naz. di lotta ed emergenza contro le malattie animali e unità centrale di crisi

A:
ASSESSORATI ALLA SANITÀ REGIONI
STATUTO ORDINARIO E SPECIALE
LORO SEDI

ASSESSORATI ALLA SANITÀ PROVINCE
AUTONOME TRENTO E BOLZANO
LORO SEDI

Italian national plan on West Nile



✓ In red Italian areas where the disease is endemic

- ✓ Ever active surveillance of human WNND and WND in equids
- ✓ In endemic areas it is mandatory: surveillance of birds (sinanthropic fauna or sentinel chicken) and mosquitoes;
- ✓ In the other parts of the country: serosurveillance on randomly selected horses to detect Ig M (recent infection)

Human surveillance of WNND

Where: In all the country

When: From June1 to October 31

How: Active surveillance aimed to detect WNND autochtonous cases; symptoms: fever (>38,5° C) and neurologycal symptoms

In the rest of the year: surveillance of imported cases of WNND

Surveillance of WND in equids

Where: In all the country

When: From January 1 to December 31

How: Active surveillance aimed to detect clinical WND

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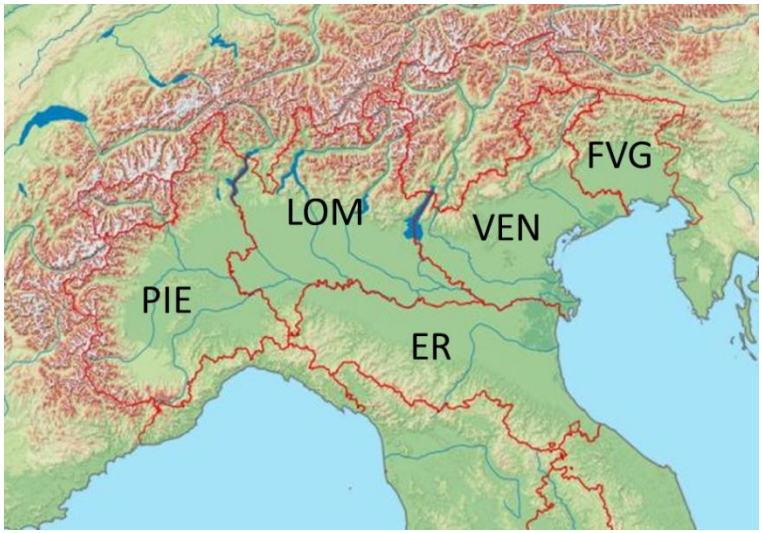
West Nile Virus surveillance: One Health System



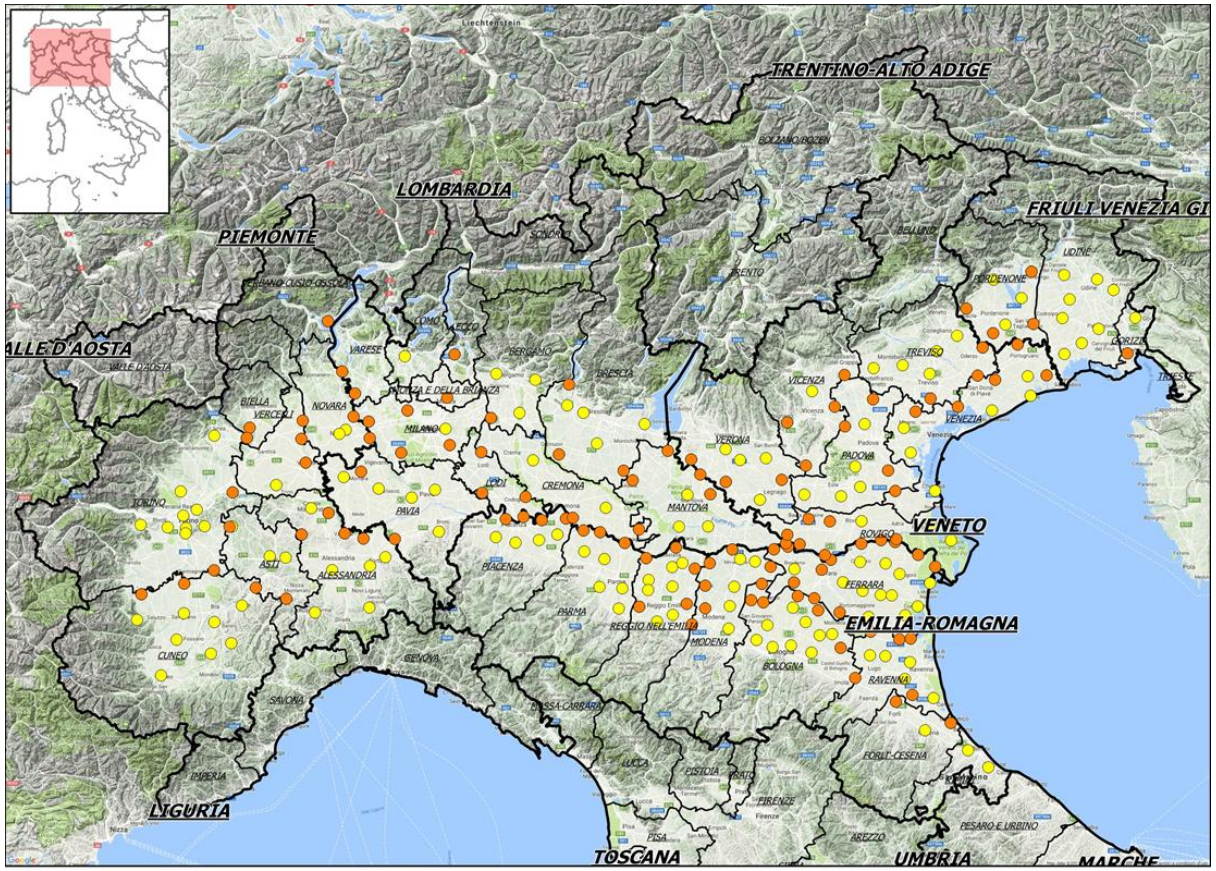
- ✓ Since 2008, besides the activities supported by the Ministry of Health at national level, more comprehensive surveillance programs, including mosquito monitoring, are carried out in some Italian regions
- ✓ Since 2015 this strengthened surveillance is uniform and active in Emilia-Romagna (ER), Veneto (VEN), Friuli Venezia-Giulia (FVG), Lombardy (LOM), Piedmont (PIE) regions
- ✓ It involves medical doctors, entomologists, veterinaries: One Health system

Mosquito surveillance

- ✓ Collection of mosquitoes (attractive traps CO_2 baited) overnight, every two week

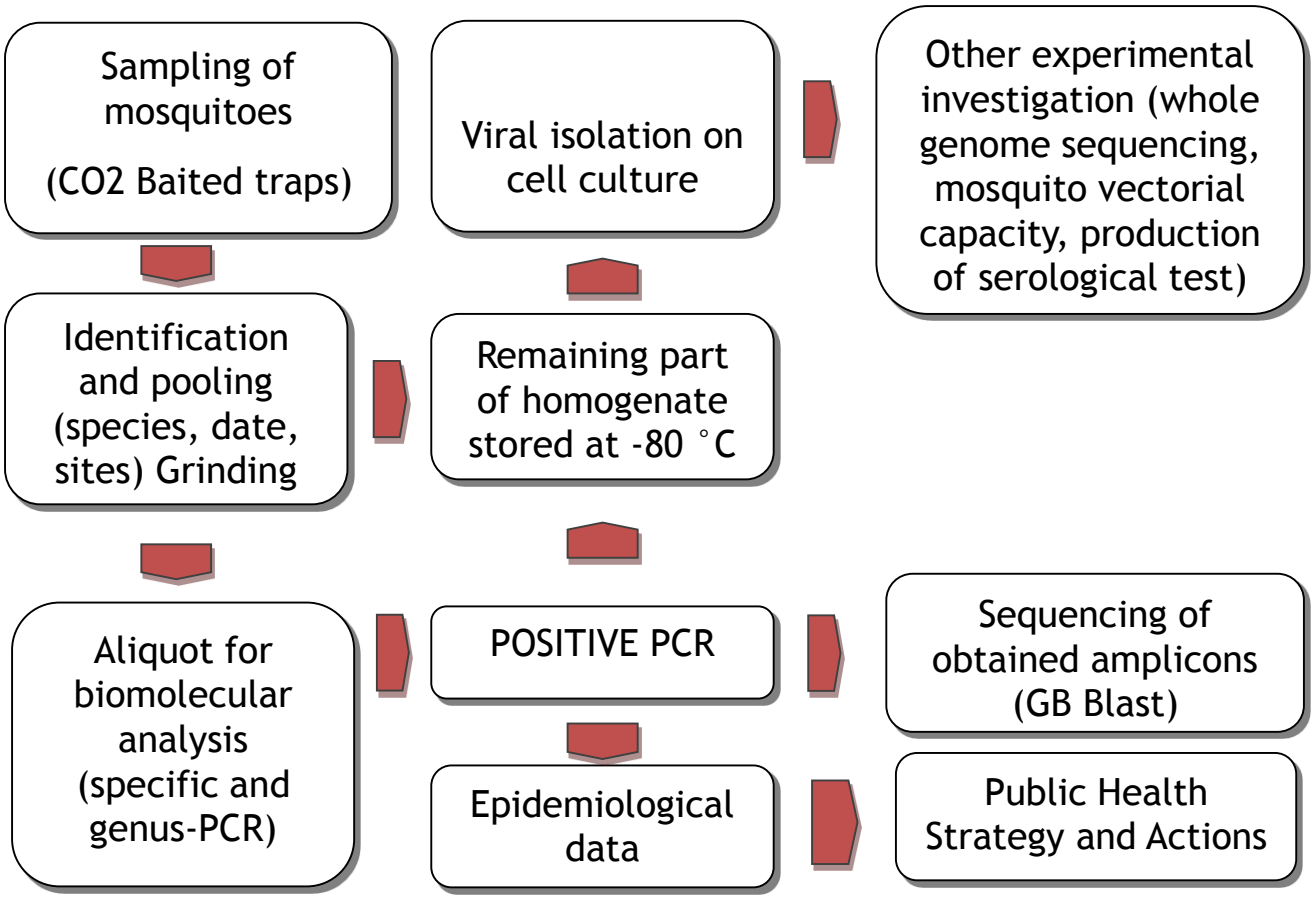
- ✓ Identified and pooled according to species, place and date of sampling (with a maximum of 200 specimens per pool)

Sites for mosquito sampling



- ✓ About 250 traps
- ✓ Located in a grid with variable length (from 11*11 Km_2 to 20*20 $Km_{2)}$

Mosquito surveillance



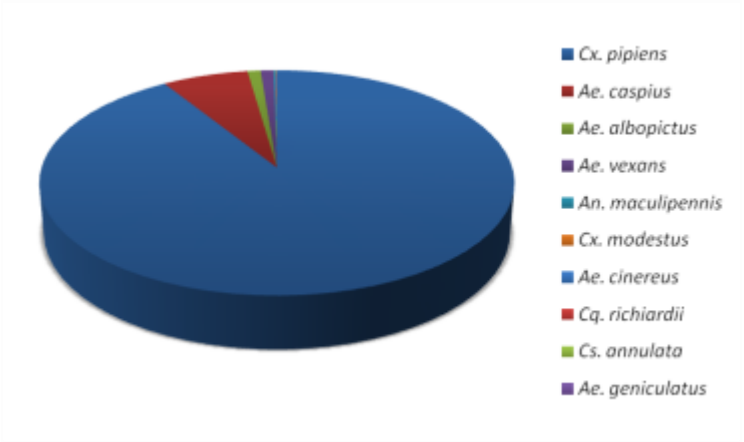
- ✓ Pools are ground and an aliquot submitted to specific PCRs (genus or family)
- ✓ The remaining part is stored for the viral isolation

	Total		
	Sampled	Tested	Pools
Ae. cinereus/geminus	111	95	6
Ae. rusticus	2	0	0
Ae.(Och.)berlandi	1	1	1
Ae.(Och.)cantans	182	74	26
Ae.(Och.)caspius	65.458	42.163	1.256
Ae.(Och.)detritus	700	117	19
Ae.(Och.)flavescens	1	0	0
Ae.(Och.)sticticus	4	3	1
Ae.(St.)albopictus	8.769	3.796	583
Ae.geniculatus	345	249	25
Ae.koreicus	26	6	5
Ae.vexans	17.589	12.324	300
Aedes spp.	14	7	3
An.claviger/petragnani	16	10	8
An.maculipennis s.l.	8.818	3.382	237
An.plumbeus	111	47	22
Cq.richiardii	398	247	39
Cs. annulata	316	206	83
Cs. subchorea	2	2	2
Culiseta sp	2	2	2
Cx.hortensis	1	1	1
Cx.modestus	3.285	2.361	117
Cx.pipiens	1.119.774	943.010	12.563
Cx.territans	42	39	5
Total	**1.225.967**	**1.008.142**	**15.304**

Sampled/Tested mosquitoes in the 5 Regions in 2013-2014

Sampled mosquitoes in Emilia-Romagna in 2016

- ✓ In 2016 a about 250,000 mosquitoes, belonging to 15 species, were sampled (species over 0.1% were Cx.pipiens, Ae.caspius, Ae.albopictus, Ae.vexans, An.maculipennis s.l.)
- ✓ More than 200,000 specimens of Cx.pipiens (and Cx.modestus) were tested (82.6% of sampled mosquitoes)



	Total	%
Cx. pipiens	225,034	90.8
Ae. caspius	16,481	6.7
Ae. albopictus	2,511	1.0
Ae. vexans	2,485	1.0
An. maculipennis	401	0.2
Cx. modestus	78	<0.1
Ae. cinereus	38	<0.1
Cq. richiardii	34	<0.1
Cs. annulata	27	<0.1
Ae. geniculatus	25	<0.1
An. plumbeus	9	<0.1
Ae. detritus	9	<0.1
Ae. berlandi	1	<0.1
Cx. mimeticus	1	<0.1
Cs. longiareolata	1	<0.1
	247,135	

Bird surveillance

- ✓ Active surveillance on sinathropic species (target of control plans), particularly corvids:
  - ✓ European Magpie (Pica pica)
  - ✓ Hooded Crow (Corvus cornix)
  - ✓ Eurasian Jay (Garrulus glandarius)
- ✓ Passive surveillance: birds found dead in the field or dead in Wildlife Rehabilitation Centres

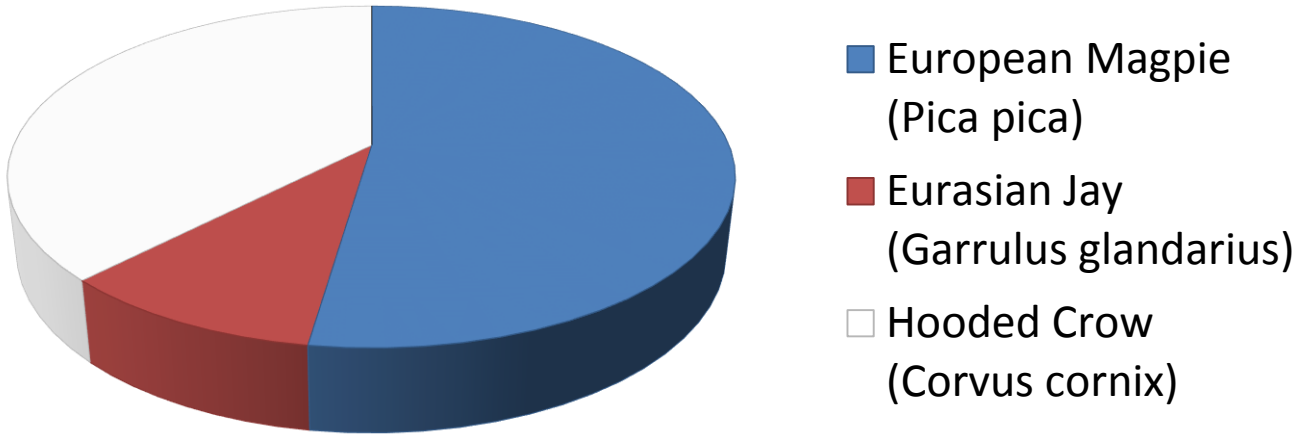
Magpie

Hooded Crow

Jay

Active birds surveillance in the 5 Regions in 2013-2014

	2013		2014	
	tested	WNV+	tested	WNV+
European Magpie (*Pica pica*)	1725	115	1772	26
Eurasian Jay (*Garrulus glandarius*)	232	1	440	1
Hooded Crow (*Corvus cornix*)	1113	31	1401	24
Common Raven (*Corvus corax*)	-	-	2	0



One Health WNV Surveillance Results

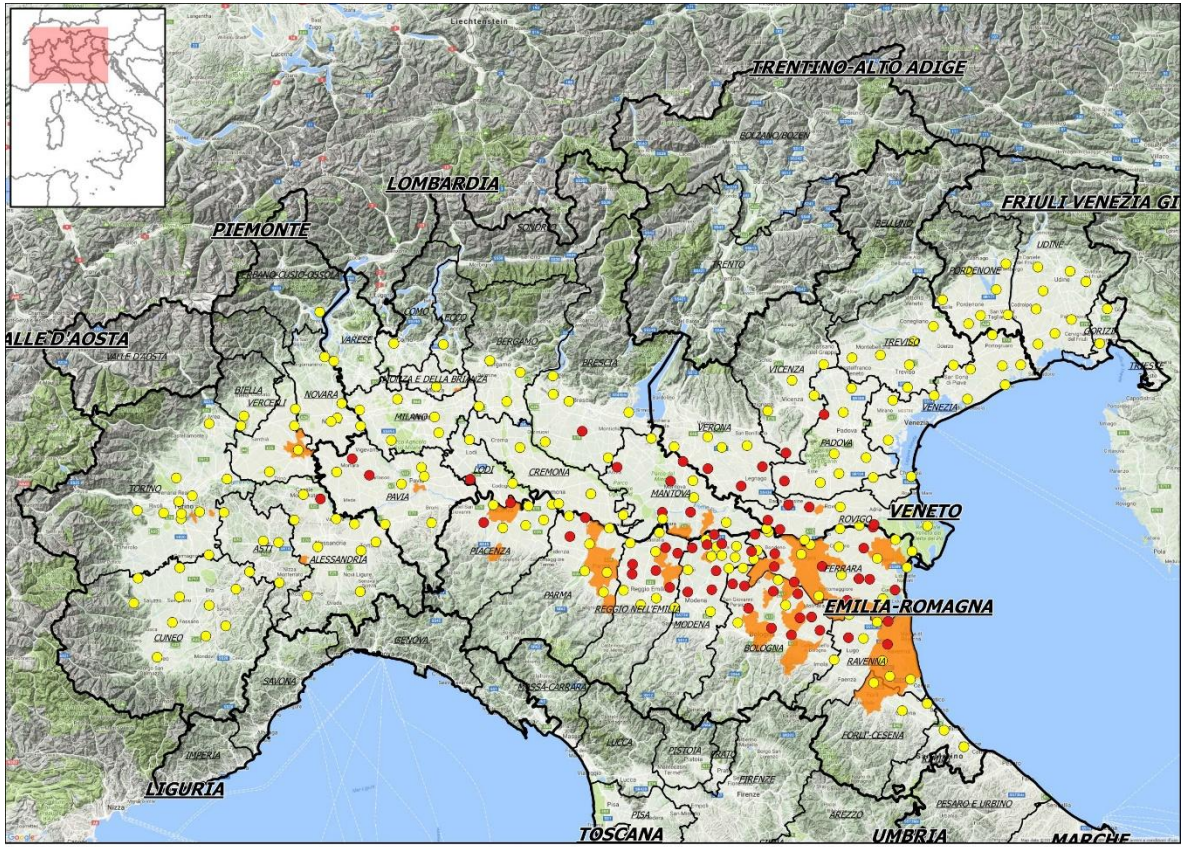
Total Number of PCR+ in 2016 in the 5 Italian regions

Birds: **83** specimen
Mosquitoes: **153** pools
Horses: **9** with neurological symptoms
Human cases:

- ✓ Blood Donors: **31**
- ✓ WNND: **39**
- ✓ WNF: **16**

One Health WNV Surveillance Results

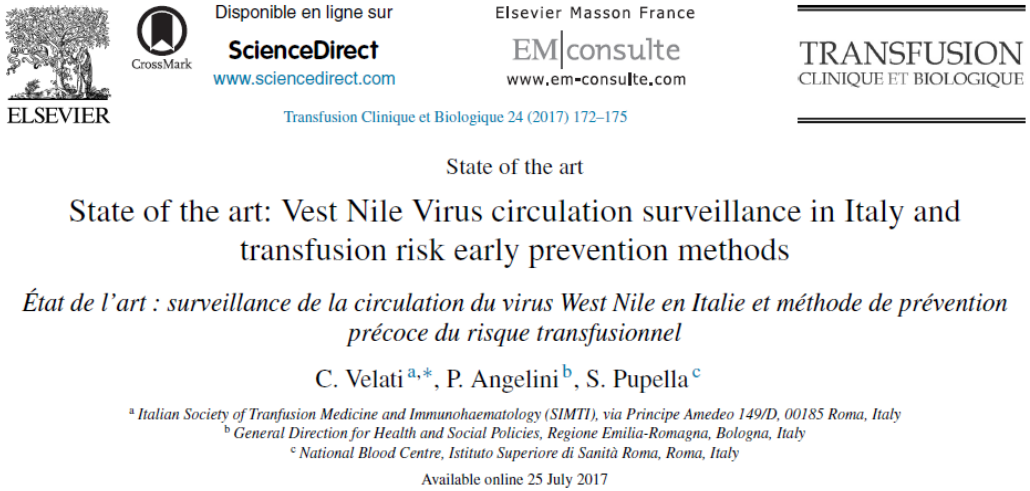
Distribution of viral detection in birds and mosquitoes in 2016 in the 5 Italian regions



One Health WNV Surveillance

Transfusion risk early prevention methods

- ✓ The common protocol for exchanging data (One Health system) has the goal
  - ✓ to anticipate the introduction of WNV-NAT screening in blood donors
  - ✓ to limit testing only in geographic areas where the virus circulation is actual



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TRANSFUSION CLINIQUE ET BIOLOGIQUE
Transfusion Clinique et Biologique 24 (2017) 172–175

State of the art

State of the art: Vest Nile Virus circulation surveillance in Italy and transfusion risk early prevention methods

État de l'art : surveillance de la circulation du virus West Nile en Italie et méthode de prévention précoce du risque transfusionnel

C. Velati [a,*], P. Angelini [b], S. Pupella [c]

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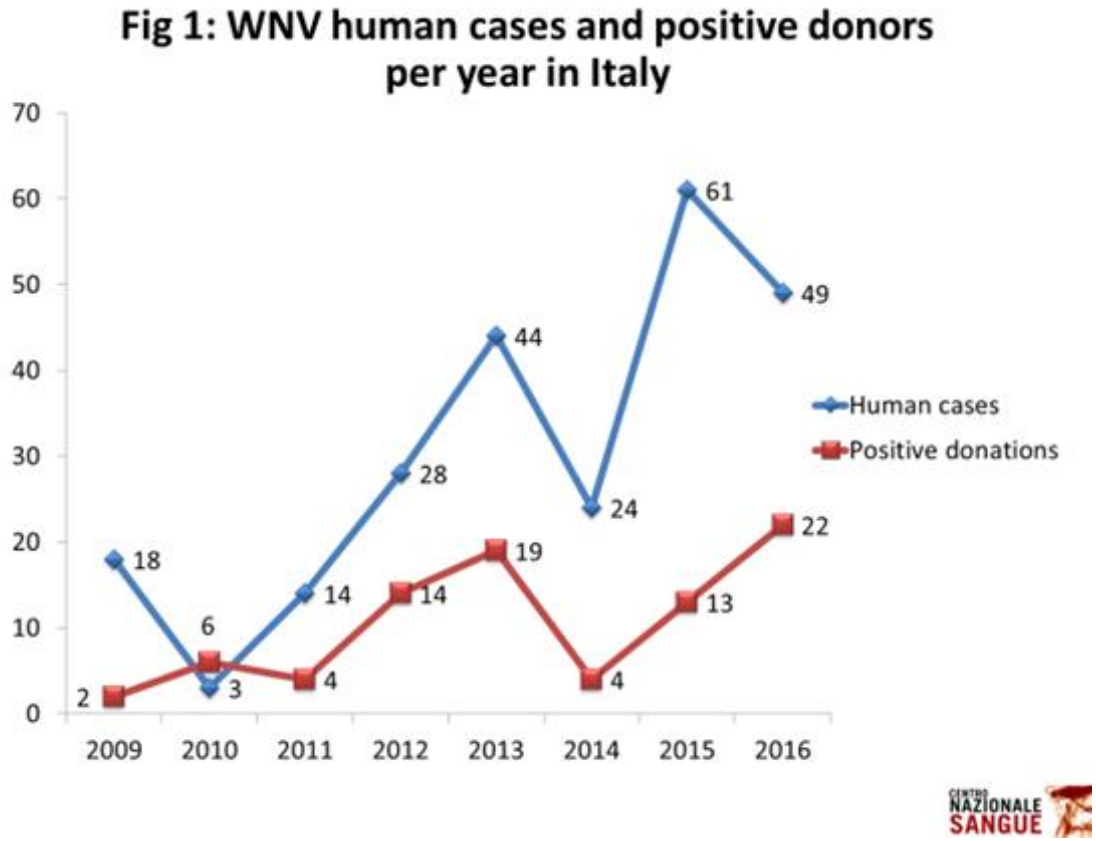
Available online 25 July 2017

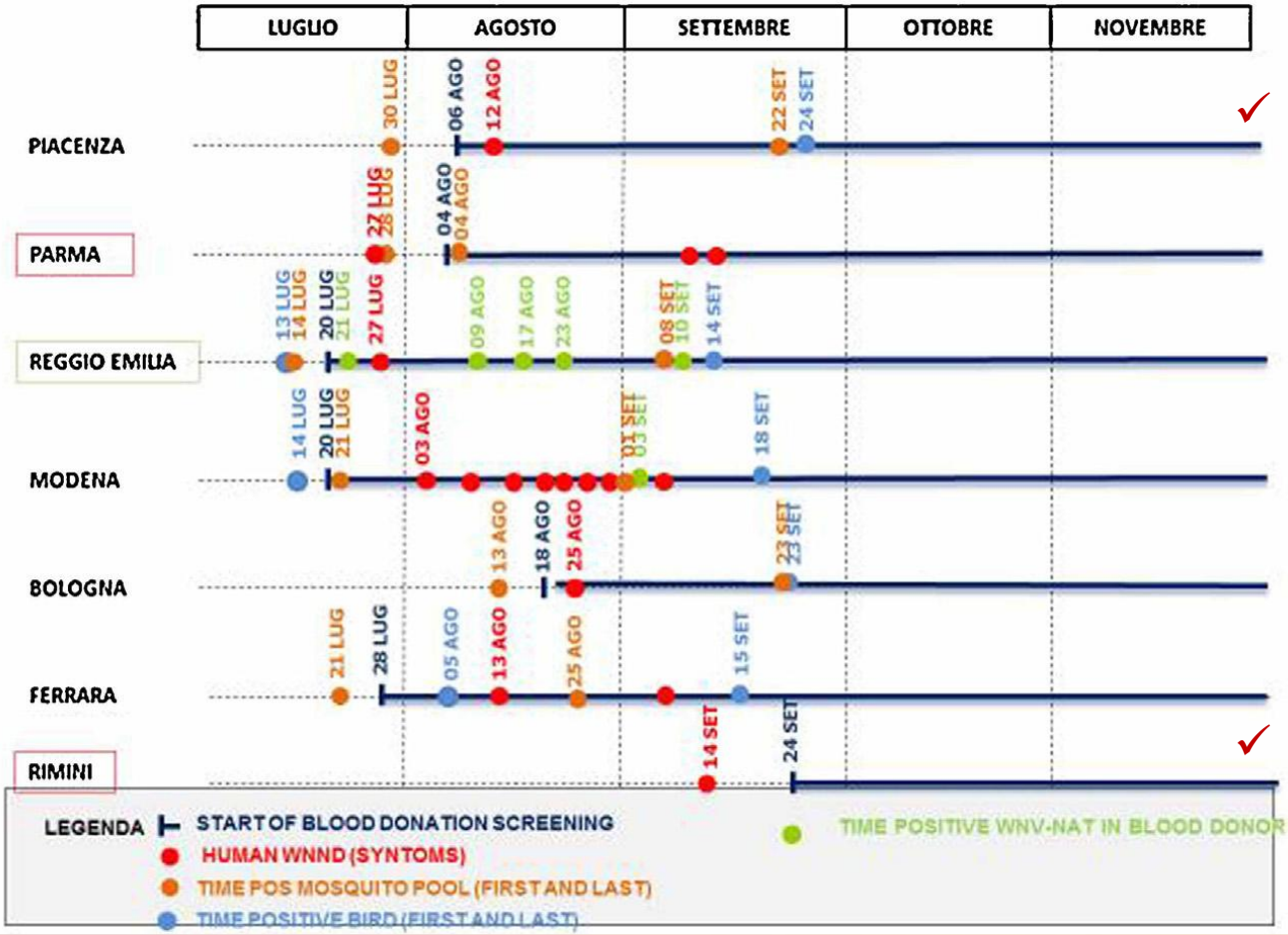
One Health WNV Surveillance

Transfusion risk early prevention methods



One Health WNV Surveillance Results

Timing of viral circulation in Emilia-Romagna 2016



- ✓ timing of:
  - ✓ WNV RNA positivity in birds and mosquito pools,
  - ✓ Onset symptoms of WNND in humans,
  - ✓ start of blood donor NAT screening
- ✓ blood donor NAT positivity.

One Health WNV Surveillance

Transfusion risk early prevention methods

1. Blood donor selection and haemovigilance:
   a) Strengthening pre-donation questionnaire and donor examination on (even mild) flu-like symptoms.
   b) Strengthening post-donation information on (even mild) flu-like symptoms.
   c) Implementation of ad hoc haemovigilance procedures.
2. Trigger criteria for the implementation of WNV NAT testing (Jun - Oct/Nov):
   a) Notification of WNV circulation through entomological and birds surveillance in the Regions with One Health System;
   b) Notification of WNV human case and/or WND equid case;
   c) In case of a) and/or b): WNV NAT testing shall be timely introduced in the interested provincial areas and continued until the end of the surveillance season.
3. Blood donor deferral or testing
   a) all donors having been for at least one night in the Italian provinces where WNV NAT testing is introduced as a consequence of the trigger criteria a) and/or b) or caming from countries with WNV circulation shall be deferred for 28 days.
   b) Alternatively, in order to avoid critical blood shortages, donors can be admitted to donate provided their donations are tested by ID WNV NAT.

One Health WNV Surveillance

Cost-benefits analysis

1.

Table 6. Overall costs of the One Health and uni-sectoral scenarios, Emilia-Romagna, Italy, 2009–2015.

	One Health scenario cost (Euro)	Uni-sectoral scenario cost (Euro)
Surveillance activities		
Human surveillance	71,188	71,188
Entomological surveillance	646,505	0
Wild birds surveillance	245,320	0
Horse surveillance	2340	0
Sharing of information	156,800	0
Triggered interventions		
Blood testing	3,276,352	4,488,238
Communication campaigns	105,000	105,000
Vector control interventions	411,480	411,480
	4,914,985	**5,075,906**

Citation: Paternoster G, Babo Martins S, Mattivi A, Cagarelli R, Angelini P, Bellini R, et al. (2017) Economics of One Health: Costs and benefits of integrated West Nile virus surveillance in Emilia-Romagna. PLoS ONE 12(11): e0188156. https://doi.org/10.1371/journal.pone.0188156

One Health WNV Surveillance

Cost Benefits analysis

1.

Table 8. Benefits of the One Health scenario quantified as averted costs of potential human cases of West Nile virus neuroinvasive disease (WNND) associated to infected blood component transfusion. Best-case, intermediate, and worst-case scenario according to the probability of WNND transfusion associated transmission. Emilia-Romagna, Italy, 2009–2015.

	Best-case scenario	Intermediate scenario	Worst-case scenario
Short term cost of hospitalization avoided (Euro)	0	30,792	277,128
Compensation for transfusion-associated disease avoided (Euro)	0	300,000	2,700,000
Total benefit of the One Health scenario (Euro)	**0**	**330,792**	**2,977,128**

WNND: West Nile virus neuroinvasive disease

Benefits of the One Health scenario are estimated as potential transfusion associated West Nile virus neuroinvasive disease (WNND) cases avoided. Three scenarios are considered based on the assumed probability of developing WNND after receiving an infected blood transfusion. This probability was assumed to be 0%, 10%, and 100% in the best-case, intermediate, and worst-case scenario, resulting in 0, 2, and 18 potential WNND cases avoided, respectively.

Citation: Paternoster G, Babo Martins S, Mattivi A, Cagarelli R, Angelini P, Bellini R, et al. (2017) Economics of One Health: Costs and benefits of integrated West Nile virus surveillance in Emilia-Romagna. PLoS ONE 12(11): e0188156. https://doi.org/10.1371/journal.pone.0188156

Added values of the One Health surveillance

- ✓ Detection of other viruses by genus PCR and sequencing (Tahyna virus, Batai virus)
- ✓ Isolation of new viruses
- ✓ Definition of culicidic fauna of the surveyed area (es. *Anopheles maculipennis* complex, different sibling species with different vectorial competence for Malaria)
- ✓ Better knowledge of
  - ✓ the influence of weather parameters on the circulation of the detected viruses
  - ✓ possible reservoir and amplification role of tested birds

Conclusions

- ✓ One health system
  - ✓ May detect viral circulation early in the season thanks to mosquitoes and bird surveillance
  - ✓ Is sustainable also in the regions whish has begun recently to implement it
  - ✓ In middle-long period is economically convenient
  - ✓ Assures higher safety: in Emilia-Romagna 6 viremic donors have been detected thanks to the One Health system

Thank you for your attention
and thanks to Life Conops and all the group

For further information ask me:

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