West Nile Virus surveillance based on nervous syndromes in horses

Authorship: Céline Faverjon [1], Flavie Vial [2], Mats Gunnar Anderson [3], Agnès Leblond [4]

[1]INRA UR346 Animal Epidemiology, Vetagrosup, F-69280 Marcy l'Etoile, France ; celine.faverjon@vetagro-sup.fr, [2] Veterinary Public Health Institute, DCR-VPH, Vetsuisse Fakultät, CH-3003 Bern, Switzerland, flavie.vial@vetsuisse.unibe.ch, [3]Department of Chemistry, Environment and Feed Hygiene. The National Veterinary Institute, SE- 751 89 Uppsala, Sweden, gunnar.anderson@sva.se; [4] INRA UR346 Animal Epidemiology et Département Hippique, VetAgroSup, F-69280, Marcy L'Etoile– France; agnes.leblond@vetagro-sup.fr

INTRODUCTION

West Nile Virus (WNV) is an emerging vector-borne disease transmitted by *Culex* mosquitoes, main hosts are birds but the virus also affects more than 30 non-avian species, including horses and humans, with serious consequences on public health and on the equine industry.

The last French outbreak occurred in 2006 but, recently, more outbreaks have been recorded in Southern and Eastern Europe

⇒ **Risk of a new WNV emergence in France**

⇒ **Need efficient early detection systems !**

Nervous syndromes in horses can be an early warning signal of WNV emergence but the possibility to routinely use reported cases for WNV surveillance is still unknown.

The RESPE, the passive French network for the surveillance of equine diseases, collects data from veterinary practitioners on nervous syndromes in horses and could serve as a basis for WNV syndromic surveillance.

The time series (TS) provided by the RESPE exhibits several aberrations resulting from outbreaks of Equine Herpes Virus -1 (EHV-1). Removing such historical prior to developing a baseline model for the TS should improve the surveillance system's ability to detect simulated WNV outbreaks.

OBJECTIVE: to determine the capacity of nervous syndromes in horses to be used to early detect WNV outbreaks in France.

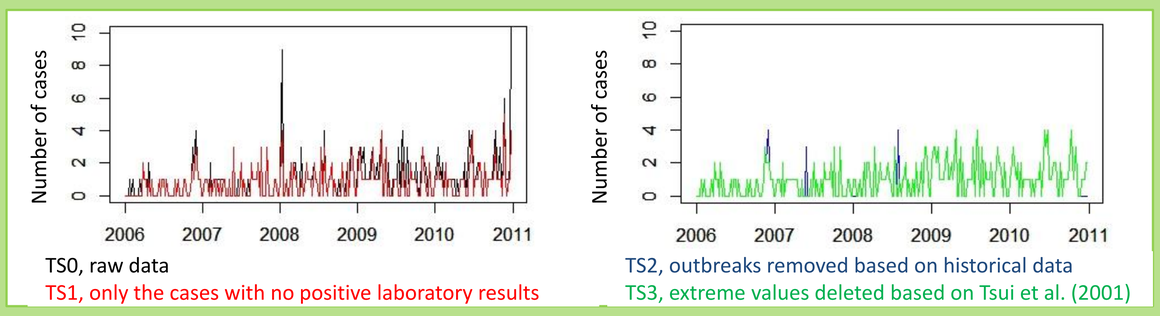
MATERIAL & METHODS

Data

- Weekly number of nervous syndromes in horses between 2006 and 2013
- All horses tested for EHV-1 and WNV

3 Pre-processing methods to remove the aberrations (TS, TS2, TS3)

Weeks considered as "aberrations" replaced by the average value of the 4 previous weeks.



2 Forecasting methods

Generalize linear model & Holt-Winters generalized exponential smoothing (HW)

Model fit

- Training data: 2006 to 2010; Test data: 2011 to 2013.
- Criteria used : AIC, Pacf, Acf, Root Mean Square Error (RMSE), Mean Absolute Error (MAE)

Simulated WNV outbreaks

- Based on historical data
- 3 simulated outbreaks randomly inserted between 2011 and 2013 (at least 15 weeks between each outbreak)
- Process repeated 100 times

Quantitative performance assessment

- 300 years containing a total of 300 outbreaks used
- Sensitivity (SE) & Specificity (SP)
- ROC curves & Area Under the Curve (AUC)

RESULTS

Selection of Generalized linear models (glm)

For the Poisson as well as the NB regression, the best fit was obtained for all TS with the simple model:

Number_of_cases ~ sin(2*pi*week/53) + cos(2*pi*week/53) + year

NB and Poisson regressions performed equally well for all TS, with the exception of TS0 (raw data) for which the NB model provided a better fit (AIC 732 vs. 741)

Comparison HW and glm selected

		Autocorrelations present in Acf / Pacf	AIC	RMSE	MAE
TS0	glm (NB)	No / No	732	1,26	0,87
	HW	No / Yes	1521	1,07	0,73
TS1	glm (poisson)	No / No	624	1,29	0,89
	HW	Yes / Yes	1356	0,78	0,58
TS2	glm (poisson)	Yes / Yes	689	1	0,80
	HW	Yes / Yes	2569	0,82	0,63
TS3	glm (poisson)	Yes / Yes	668	0,94	0,76
	HW	Yes / Yes	1360	1,20	0,71

Table1: Smoothing performances (RMSE and MAE are better when smaller)

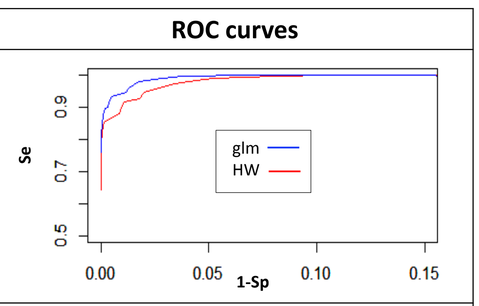
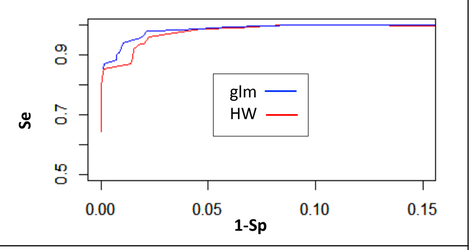
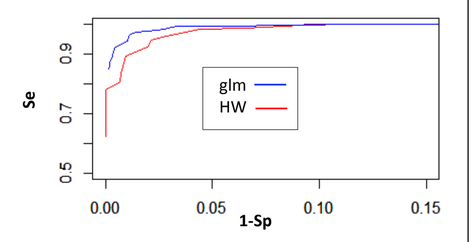
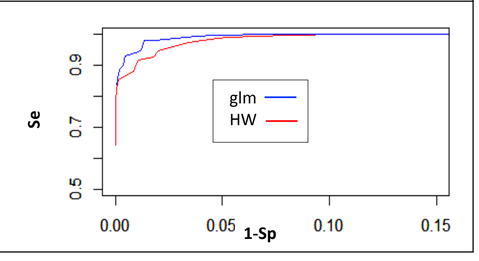
	AUC	ROC curves
TS0	0,736 0,745	
TS1	0,736 0,743	
TS2	0,734 0,743	
TS3	0,736 0,745	

Table2: Detection performances

DISCUSSION & CONCLUSION

- The glm outperformed HW for all TS in terms of smoothing and detection performances.
- The best fit was obtained when only cases with no positive laboratory results (TS1) were retained and modeled using a Poisson regression
- The impact of the pre-processing methods on the performance seems weak (AUC ~ constant over TS). Further work should be done to test this impact on different situations and time series.
- The data collected by RESPE on nervous syndromes in horses could be used for routine syndromic surveillance for WNV in France.

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