On-Farm Mortality for Early Detection of Emerging Diseases

state of play of a ongoing project

on

"Epidemiological tools for the evaluation and management of risks related to the spread of infectious diseases in cattle farms"

- National animal databases in all Member States of the EU
- National Cattle databases record amongst others
  - Individual holding identification codes, geographical location, type of holding
  - Individual animal identification codes, date of birth/entry and date of exit/death, sex, breed
- Events notified to the databases within 7 days after event

Other sources for mortalities could be found e.g. in rendering plants

Objective

Could on-farm mortality data available in National Cattle Databases help

- to model expected mortalities and
- to establish an early warning system for emerging diseases?

Data source

- Records from Italian Cattle Database for 2008
- More detailed in-field data from the autonomous provinces of Trento and Bolzano for 2008

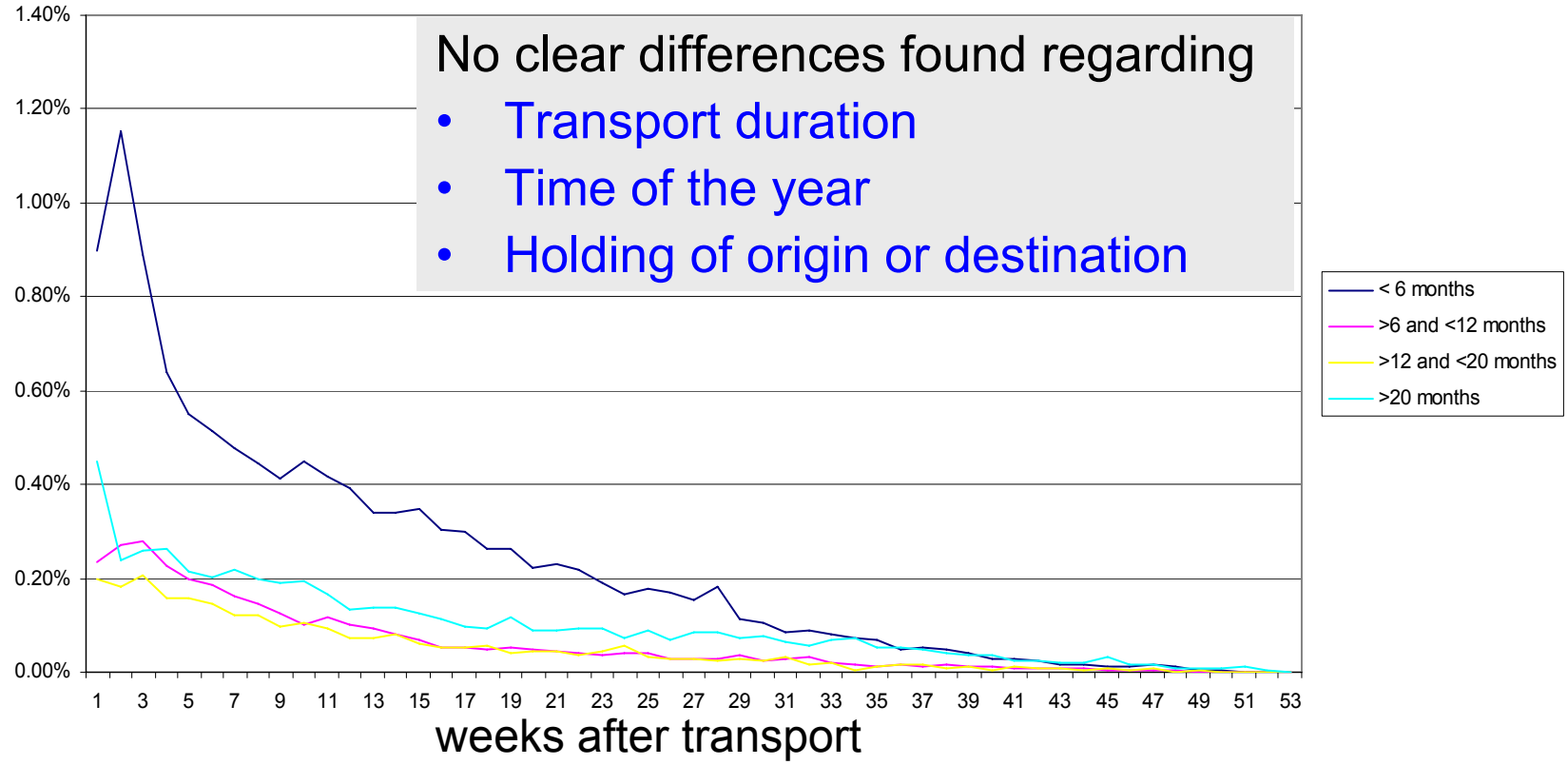
Approach

1. Mortalities after transport
2. Comparing observed on-farm mortalities of a subset of the population with the surrounding population
3. Comparing observed on-farm mortalities for a subset of the population against the expected values

Mortality and Transport

0.50% monthly mortality rate for transported animals vs. 0.28% monthly mortality rate at national level

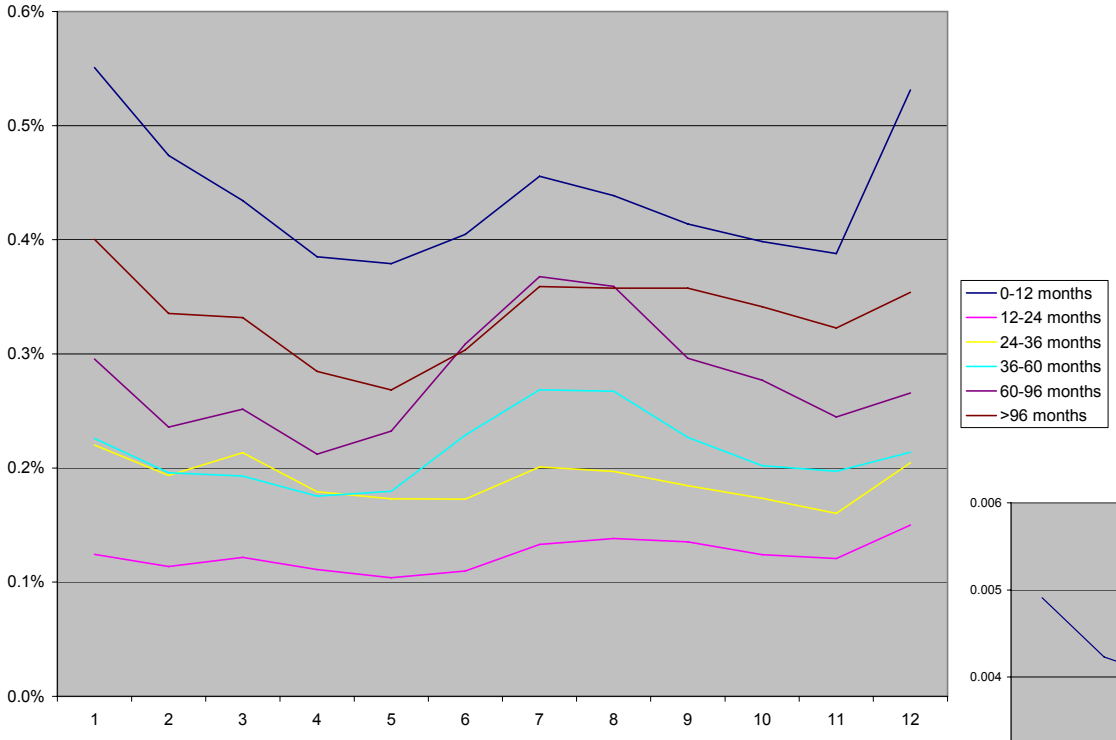
Mortality rate of cattle after transport in Italy in 2008 (by age groups)



No clear differences found regarding

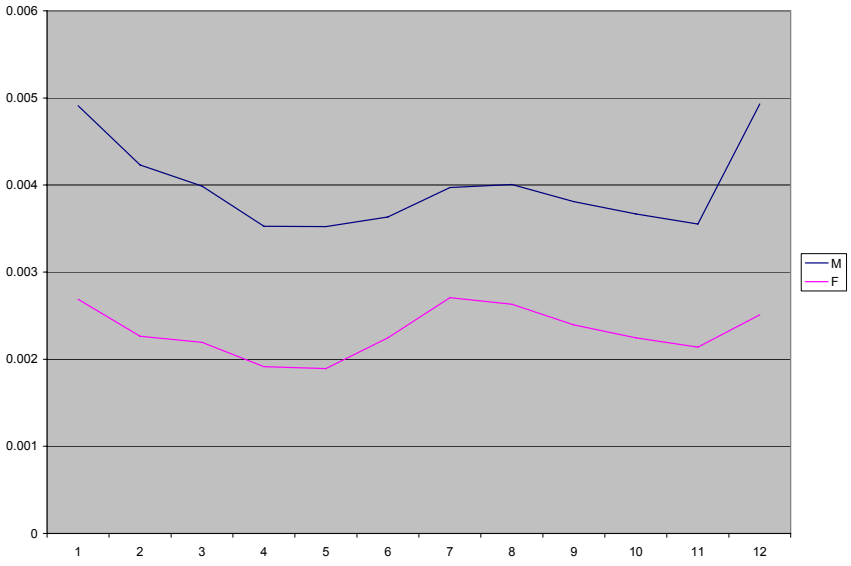
- Transport duration
- Time of the year
- Holding of origin or destination

Monthly mortality rates by age and sex in Italy in 2008



Differences in

- **Age**
- **Sex**
- **Time**

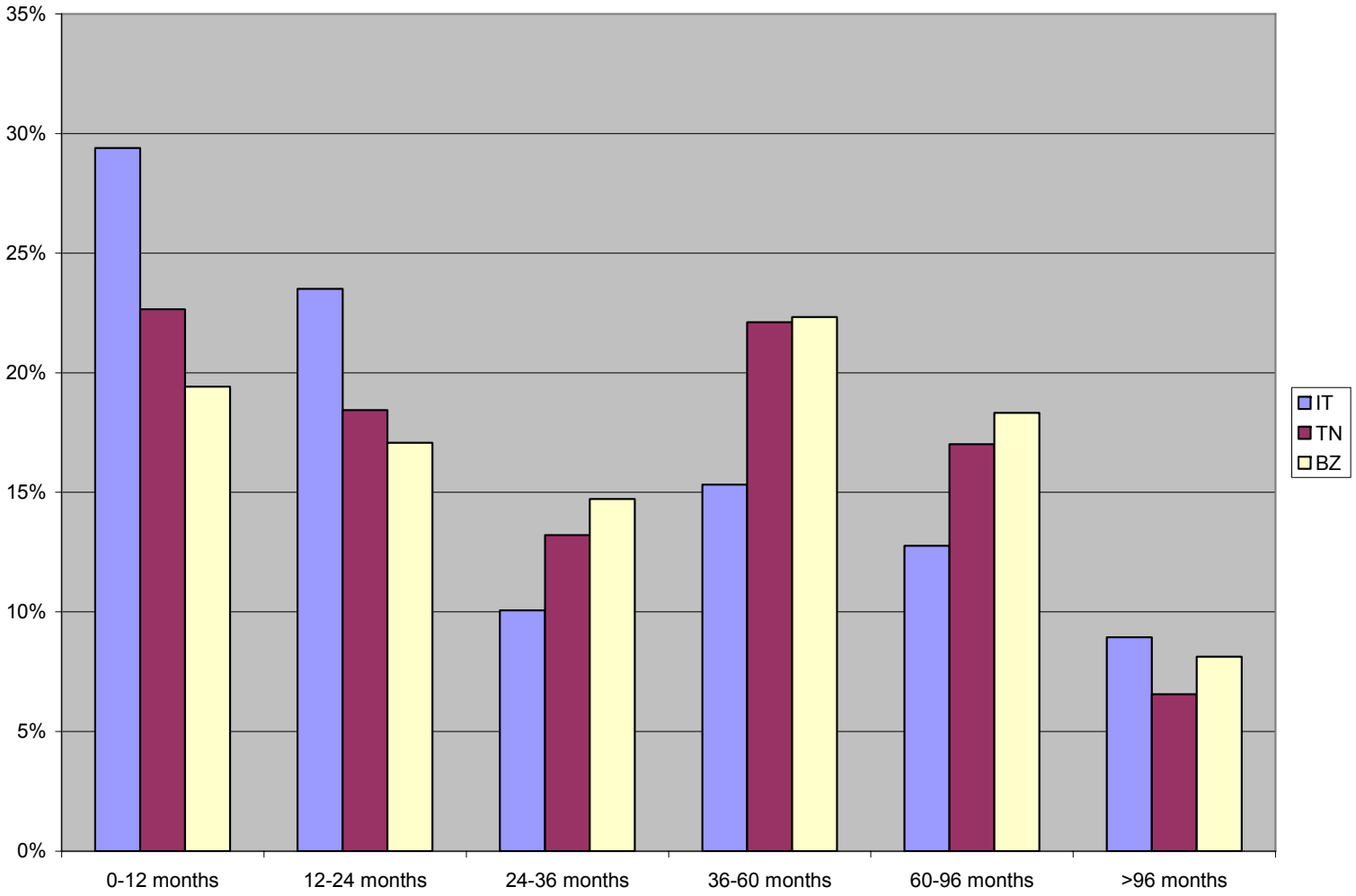


Comparison of a subset with the surrounding

Average monthly mortality rates on farm 2008

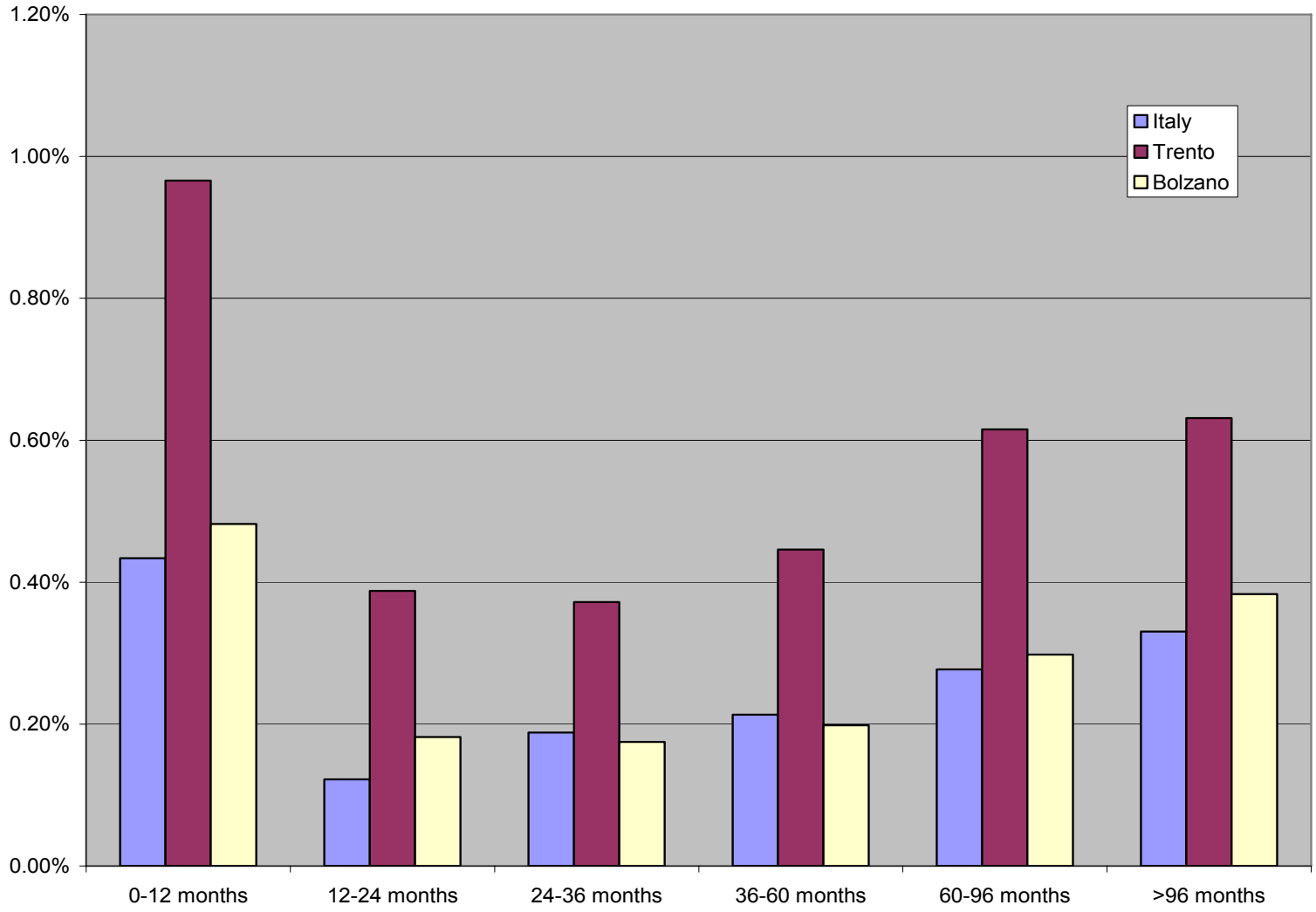
Italy	BZ	TN
0.28%	0.27%	0.58%

Population by age group



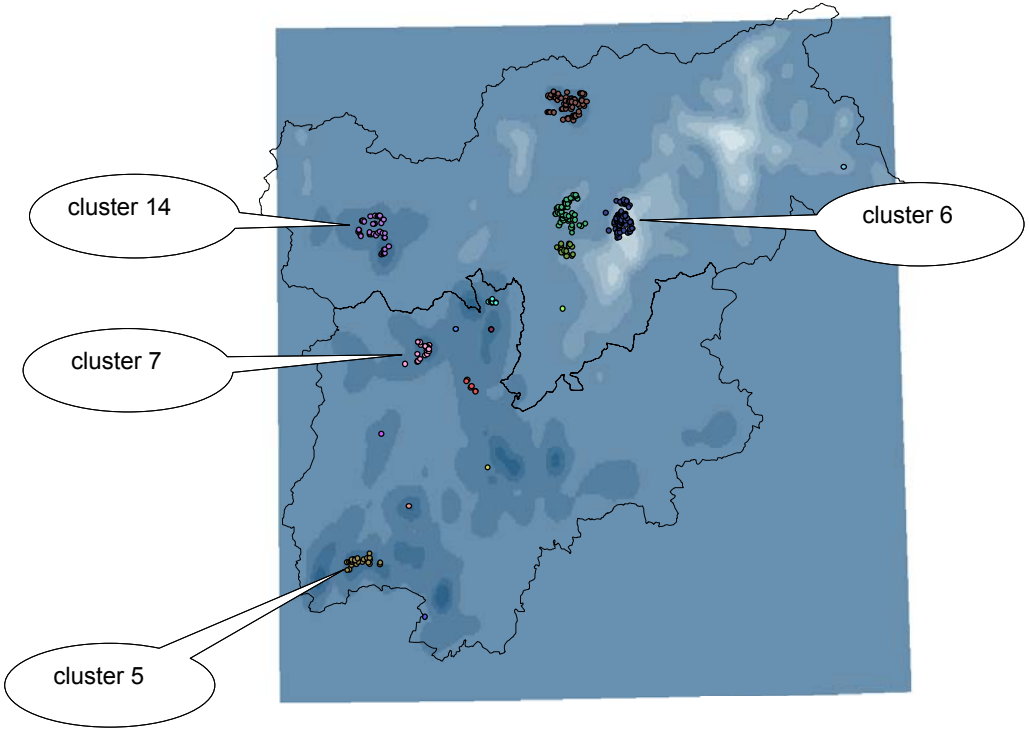
Cattle in 2008 (distribution by age groups in %t)

Annual mortality rate by age groups



Annual mortality rate in cattle in 2008 (in % by age groups)

Spatial and spatio-temporal Clusters



Examples of clusters of higher mortality compared to the mortality rate outside the clusters (SaTScan and Getis-Ord statistics)

cluster	province	radius	from	to	locations	loglikelihood	montecarlorank	expected	observed/expected
14	BZ	4.89	30/10/08	17/12/08	40	20.492626	0.001	6.62	4.38
5	TN	4.29	01/01/08	20/02/08	27	29.204818	0.001	6.41	5.31
6	BZ	4.88	20/11/08	31/12/08	79	25.132958	0.001	11.07	3.79
7	TN	4.65	28/08/08	15/10/08	28	24.416687	0.001	11.33	3.71

Case analyses

Notification of on-farm mortality includes:

- Animals which died on a farm holding (e.g. caused by an accident or a disease);
- Animals killed on a farm holding (e.g. euthanized downer cows or due to low value, end of productive live, accident, disease);
- Animals slaughtered on a farm holding for own consumption.

Death notification to the Italian Cattle Database does not distinguish between the three categories

Causes of mortality

Causes in 2008

- in two spatio-temporal clusters with high mortality rates in the province of Trento (clusters 5 and 7)
- of the 4783 on-farm mortalities in the province of Bolzano

grouped in 9 categories (data from ASL and central rendering plant):

- accidents (on-farm, alps, pasture)
- complications related to birth (e.g. downer cows)
- skeletal-muscular disorders other than related to birth
- neonatal death
- respiratory diseases
- gastro-intestinal diseases
- on-farm slaughter of own consumption
- other specified causes of death
- cause of on-farm death not specified

Descriptive analysis causes of death in the provinces of TN

Distribution of mortalities in categories for two clusters with high mortality in 2008 in the province of Trento

category	cluster 5	cluster 7	
Accidents	10%	10%	
Birth related	6%	9%	
Skel-musc	5%	7%	
Neo-natal	0%	25%	1 holding notified dead calves < 7 days
Respiratory	5%	4%	
Gastro-intestinal	15%	26%	
Own-consumption	49%	7%	1 commune applies rules differently
Other-sp	7%	6%	
Other-nsp	4%	6%	
	(108) 100%	**(173) 100%**	

Descriptive analysis causes of death in the province of BZ

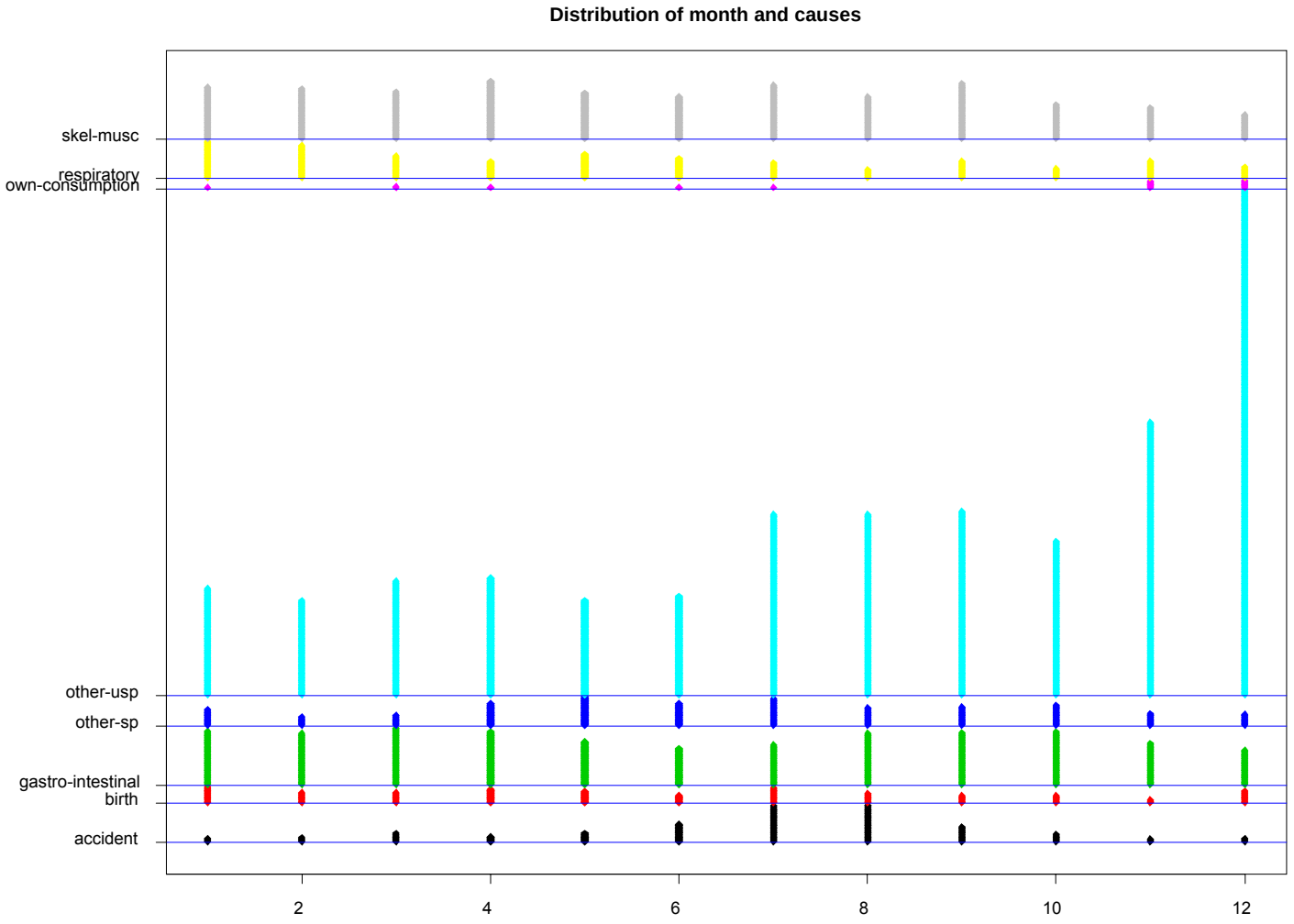
Distribution of mortalities in categories for the province of Bolzano

of all 4783 cases notified in 2008

category	
Accidents	4%
Birth related	3%
Skel-musc	14%
Neo-natal	0%
Respiratory	6%
Gastro	14%
Own-consumption	1%
Other-sp	6%
Other-nsp	53%
	(4783) 100%

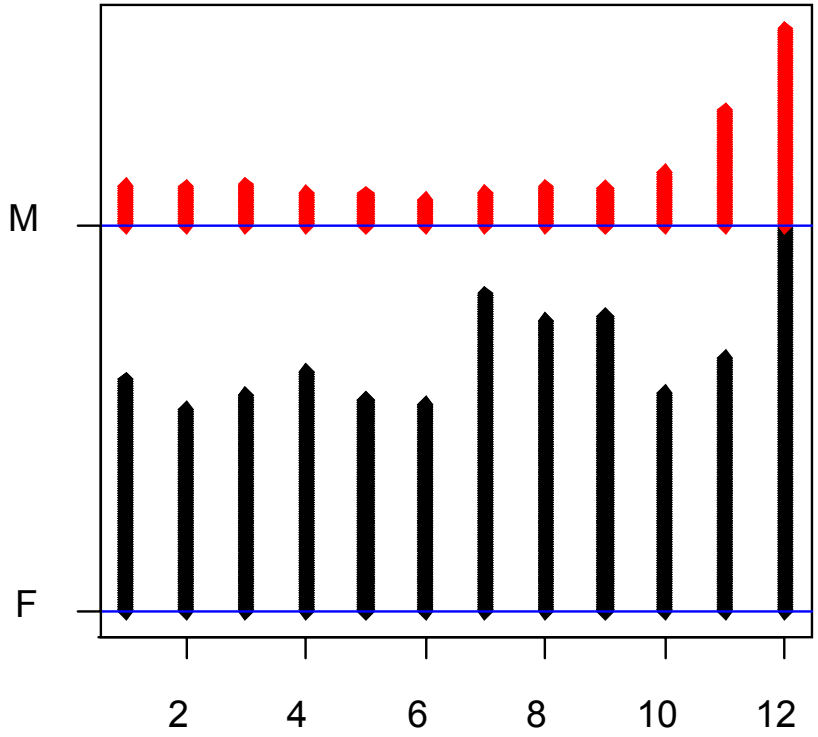
Descriptive analysis causes of death in the province of BZ

Distribution of cases by month in 2008

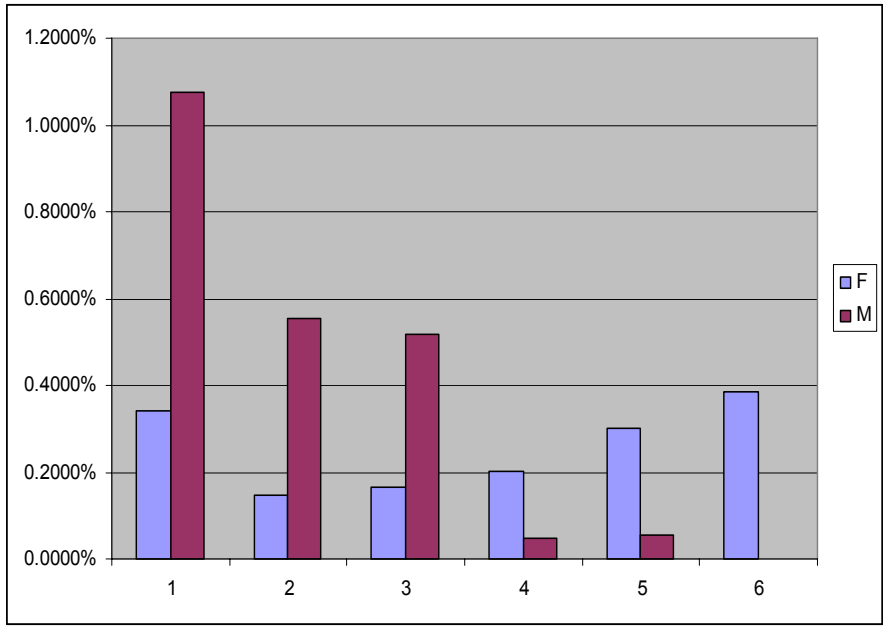


Descriptive analysis causes of death in the province of BZ

Distribution of cases by sex and month



Distribution of mortality rates by sex and age group



Case analyses

Results of comparing clusters and regions with the surrounding population

- areas where on-farm slaughtering is more common (distance to slaughterhouses, differences in issuing authorization between municipalities),
- insurance schemas which render it more economic to kill an animal on farm than to send it for slaughter,
- differences in the notification practice, e.g. some farms notify systematically dead born or newborn dead claves also when not already identified (first 7 days),
- value of newborn calves is so low that little effort is made to keep them alive, especially for pure milk breeds.

=>Differences of mortality rates of clusters with the mortality rates outside a cluster are rather to explain by differences in farm management of some individual holdings compared to other holdings of a region

Comparisons within a subset

Comparing differences within a subset (e.g. holding, spatial, spatio-temporal clusters or regions) against its expected value

Modeling on-farm mortality

Why a model for on-farm mortality?

- systems for anomalous event detection and spatio-temporal clustering could benefit from an on-farm mortality model establishing a baseline

e.g.

- baseline for CUSUM
- spatio-temporal scan using an Expectation-based poisson (Neill et al. 2005) in alternative to the Population-based Poisson (Kuldorff, 1997

Modeling expected mortalities

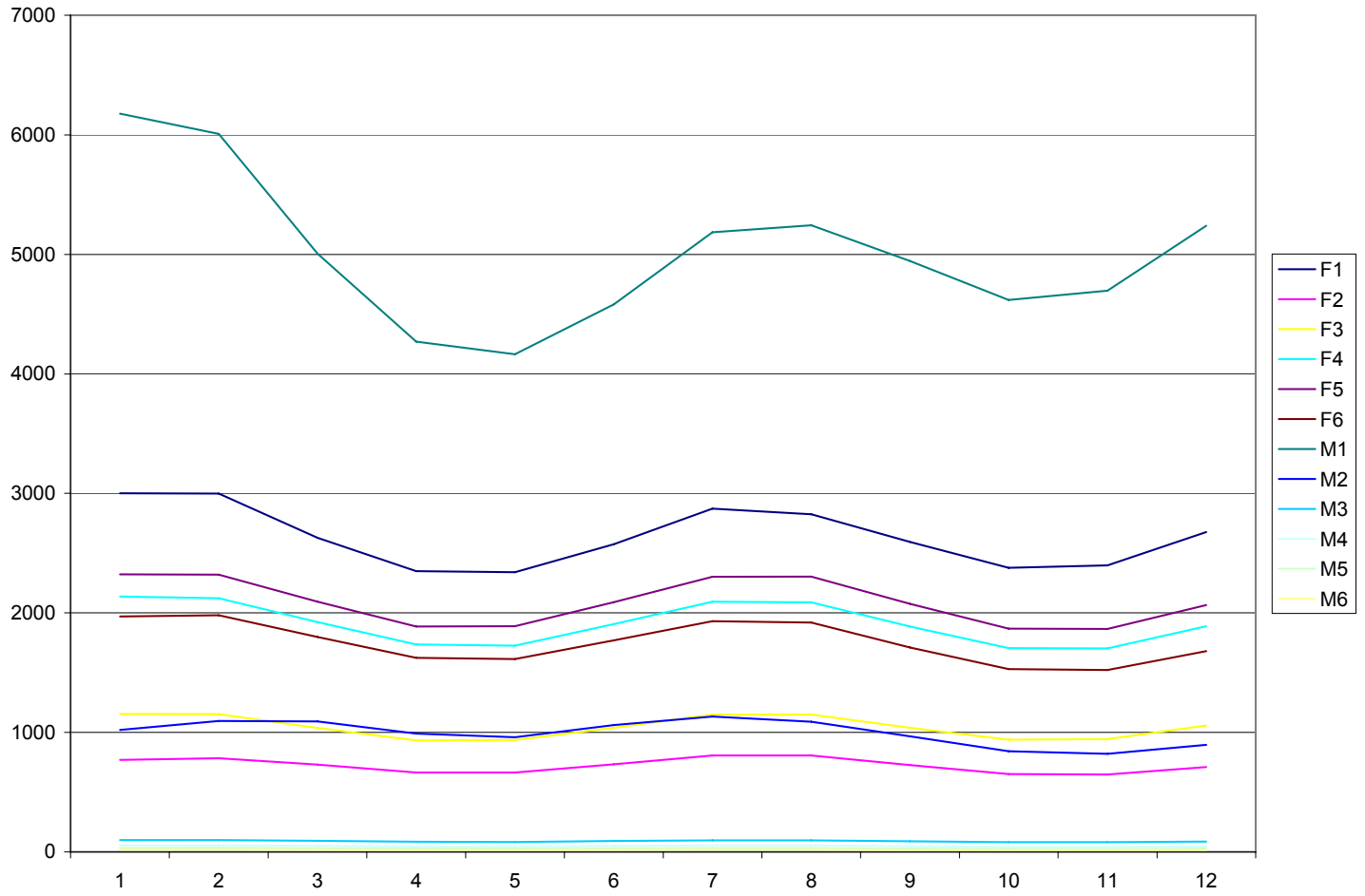
Time series of single holding are too sparse in most cases for giving meaningful CUSUMs

Generalized Linear Model using negative binomial distribution to adjust for over-dispersion with sex/age covariates and seasonal trend

$$\log(E) = \alpha + \beta_{m1} Z_{m1} + \ldots \beta_{m6} Z_{m6} + \beta_{f1} Z_{f1} + \ldots \beta_{f6} Z_{f6} + \beta_s \sin(\frac{4\pi t}{12}) + \log(P)$$

E expected deaths in the sex/age category
t month
P population in the sex/age category for month t
β estimated parameter for sex/age category
Z dummy variable (1 for the sex/age category considered, 0 otherwise)

Model predictions



Next steps

- Verify model by comparing expected with real mortalities for different regions / clusters and different years
- Improving model by including data over several years in the model
- Finding cut-offs between expected and real mortality from when on a warning should be triggered

G. Fiore
F. Natale
J. Hofherr

TP 361
Via E. Fermi 2749
21027 Ispra (VA) Italy