Distribution and factors affecting wild boar (Sus scrofa) damage in a lowland area in northern Italy

Fabrizio Cappa, Marco Lombardini and Alberto Meriggi
Introduction

from Barrios-García and Ballari, 2012
Introduction

Growing impact on agricultural activities
Aims of the research

• To provide a general description of wild boar damage to croplands in an Italian lowland area;

• To describe the spatio-temporal distribution of the events;

• To identify which factors determine the risk of damage, through the formulation of a risk prediction model.
Study area

Lomellina
(Lombardy, Northern Italy)

Total Surface: 127,192 Ha

Altitude: 95 m a.s.l.

91%   Cultivated areas
4%    Urban areas
4%    Natural vegetation
Materials and methods

Data collection

Acquisition of data from the Wildlife Service of the Province of Pavia

- Date
- Farmers name and address
- Damaged crops
- Damaging species
- Refund amount (€)
Materials and methods

Data collection

Direct interviews with local farmers

- Farm location
- Geographic coordinates of damaged fields
- Damage or presence signs
- Damage type (trampling, feeding, rooting, etc.)
- Position in the field (central, border)
- Crop type
- Damage extension (% of coverage)
Materials and methods

Statistical analyses

• Evaluation of spatial distribution of damage events: *Kernel Analysis* 50%

• Evaluation of monthly distribution of damage: *Chi-Square test* (Goodness-of-Fit)

• Comparison between damaged and available crops: *Chi-Square test* (Goodness-of-Fit)
Materials and methods

Statistical analyses - Risk prediction model

Binary logistic regression analysis ("use vs. availability" approach), (Cumming, 2000; Boyce et al., 2002)

12 predictors: distance from water, distance from woodlands, distance from continuous hedges and rows, distance from discontinuous hedges and rows, distance from urban settlements, human population density, distance from primary roads, distance from secondary roads, distance from railways, area, perimeter and fractal dimension of damaged fields.

Collinearity among variables: Variance Inflation Factor (VIF)

Model selection: AICc (Akaike, 1973)

\( w_i \): Akaike weight

\( w \): relative importance of predictors

Best model: the one containing all the variables with a \( w \geq 0.50 \) (Barbieri and Berger, 2004)

Evaluation of model performance: area under the ROC curve (AUC)
# Results

General description of wild boar damage

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
<th>Total Refund (€)</th>
<th>Mean Per Event (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Events</td>
<td>93</td>
<td>€ 61,293.00</td>
<td>€ 659.10</td>
</tr>
<tr>
<td>Total Refund (Maize)</td>
<td></td>
<td>€ 58,511.00</td>
<td>€ 759.90</td>
</tr>
<tr>
<td>Mean Per Event (Maize)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Refund (Rice)</td>
<td></td>
<td>€ 2,382.00</td>
<td>€ 198.50</td>
</tr>
<tr>
<td>Mean Per Event (Rice)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Refund (Wheat)</td>
<td></td>
<td>€ -</td>
<td>-</td>
</tr>
<tr>
<td>Mean Per Event (Wheat)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Refund (Sorghum)</td>
<td></td>
<td>€ -</td>
<td>-</td>
</tr>
<tr>
<td>Mean Per Event (Sorghum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Refund (Soybean)</td>
<td></td>
<td>€ 400.00</td>
<td>€ 200.00</td>
</tr>
<tr>
<td>Mean Per Event (Soybean)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Damaged crops**

- Maize: 83%
- Rice: 13%
- Wheat: 1%
- Sorghum: 2%
- Soybean: 1%
Results

Spatial distribution of damage

2013: 26% HD PV 1, 13% HD PV 2, 61% HD PV 6

2014: 27% HD PV 1, 40% HD PV 2, 33% HD PV 6

2015: 15% HD PV 1, 8% HD PV 2, 77% HD PV 6
Results

Spatial distribution of damage – Kernel analysis

KA 50% overall: 183.3 km²
KA 50% SPA: 23.7 km²

Pavia province
HD PV6 – SPA
KA 50% overall
KA 50% SPA

KA 50% overall: 183.3 km²
KA 50% SPA: 23.7 km²
Results

Chi-square test:
2013 - Chi-square = 93.93; d.f. = 11, P < 0.001.
2014 - Chi-square = 38.50; d.f. = 11, P < 0.001.
2015 - Chi-square = 26.00; d.f. = 11, P = 0.006.
Results

Comparison between used and available crops

Chi-square test:
Availability vs damage area - Chi-square = 739.35 ; d.f. = 2, P < 0.001.
Availability vs damage frequency- Chi-square = 325.86; d.f. = 2, P < 0.001.
Results

Risk prediction model - **AUC = 0.96  P < 0.0001**

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Akaike Weight (W)</th>
<th>Coefficient</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from main roads</td>
<td>1.00</td>
<td>0.002</td>
<td>0.022</td>
</tr>
<tr>
<td>Population density</td>
<td>0.99</td>
<td>-0.036</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Distance from forest patches</td>
<td>0.98</td>
<td>-0.010</td>
<td>0.017</td>
</tr>
<tr>
<td>Distance from continuous hedgerows</td>
<td>0.91</td>
<td>0.003</td>
<td>0.007</td>
</tr>
<tr>
<td>Distance from urban areas</td>
<td>0.79</td>
<td>0.002</td>
<td>0.008</td>
</tr>
<tr>
<td>Fractal dimension of fields</td>
<td>0.59</td>
<td>-18.23</td>
<td>0.067</td>
</tr>
<tr>
<td>Distance from railways</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance from discontinuous hedgerows</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance from rivers</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of fields</td>
<td>0.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance from secondary roads</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion

General description of damage

- Damage focused on maize
- Event peak at sowing and ripening
- Spatio-temporal displacement of damage
- Concentration of events in the HD PV6 (Special Protection Area “Risaie della Lomellina”)
Discussion
Risk prediction model

- Fields close to forests are commonly exploited by the wild boar throughout its overall range (Calenge et al., 2004; Cai et al. 2008; Thurfjell et al. 2009; Bleier et al., 2017).
- The probability of damage decreases as the anthropogenic disturbance increases (Saito et al., 2012 e Lombardini et al., 2016).
- Unexpected positive effect of the distance from continuous hedgerows.
- Field characteristics do not have a significant effect on the occurrence of damage.
Management strategies

• Capture with cages
• Selective culling (adult females and subadults)
• Non-lethal methods
Thanks for the attention