Case-control studies for risk-assessment in ecology and agriculture

Matthias Suter & Andreas Lüscher
Background

Complex research questions?

• Case studies: Ambiguous statistical foundation
• Experiments: Treatments? Range? Duration?

Investigation on site combined with optimised statistical design

Case-Control Studies

Agresti 2002 Wiley
Case-control studies

Well known in human health research

- Cases: persons with disease are being compared with controls: persons without that disease

- age
- gender
- nutrition
- social background
- smoker
- ...

Peto et al. 2000 Brit Med J
Case-control studies

- Analyse the relative risk for the occurrence of cancer with smoker compared to non-smoker

<table>
<thead>
<tr>
<th>Trait</th>
<th>Relative risk for cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smoker (comparison)</td>
<td>3</td>
</tr>
<tr>
<td>Smoker</td>
<td></td>
</tr>
</tbody>
</table>

- age
- gender
- nutrition
- social background
- smoker
- ...

Peto et al. 2000 Brit Med J

- cancer

- no cancer
Applikation in agriculture

• What is the relative risk for the occurrence of poisonous *Senecio* species in managed grassland?
Good to know about *Senecio* sp.

- Increase of *Senecio* species in agricultural grassland in recent years
- *Senecio jacobaea*, *S. aquaticus*, *S. erucifolius*
- *Senecio* sp. contain pyrrolizidine-alkaloids that are toxic for animals and humans

- Produce up to 50‘000 seeds per individual and year (*S. jacobaea*)
- Achenes with pappus: wind dispersion
- High germination percentages (up to 80%)

*Bosshard et al. 2003 AFo*
Approach

- On-farm
- Case: parcel (management unit) with *S. jacobaea*
- Control: parcel without *S. jacobaea*
- Paired case-control design
- Similar environmental conditions, management may have differed (or not)
- Measurements: vegetation (5 x 5 m²), site conditions, management, disturbance
- 62 parcels investigated
# Factors for risk analysis

## Tested variables

<table>
<thead>
<tr>
<th>Environment</th>
<th>Unit or class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclination</td>
<td>%</td>
</tr>
<tr>
<td>Exposition</td>
<td>N, E, S, W, none</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>ppm P</td>
</tr>
<tr>
<td>K</td>
<td>ppm K</td>
</tr>
<tr>
<td>Mg</td>
<td>ppm Mg</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
</tr>
<tr>
<td>Texture (4 variables)</td>
<td>%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management and vegetation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant available N applied</td>
<td>kg ha⁻¹ yr⁻¹</td>
</tr>
<tr>
<td>Type of management</td>
<td>Mowing, Rotational grazing, Continuous grazing</td>
</tr>
<tr>
<td>Changes in management intensity</td>
<td>No change, Increase, Decrease</td>
</tr>
<tr>
<td>Disturbance</td>
<td>No, Yes</td>
</tr>
<tr>
<td>Openness of sward (bare ground)</td>
<td>Low (≤ 25%), High (&gt; 25%)</td>
</tr>
</tbody>
</table>
High-risk areas for *S. jacobaea*

**Analysed with generalised linear models (GLM)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Relative risk</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept (comparison)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N applied (100 kg ha(^{-1}) yr(^{-1}))</td>
<td>0.2</td>
<td>0.008</td>
</tr>
<tr>
<td>Openness high (&gt; 25%)</td>
<td>40.3</td>
<td>0.005</td>
</tr>
<tr>
<td>Continuous grazing vs. mowing</td>
<td>11.6</td>
<td>0.017</td>
</tr>
<tr>
<td>Rotational grazing vs. mowing</td>
<td>1.0</td>
<td>0.953</td>
</tr>
</tbody>
</table>

Intercept: mown grassland, N applied 50 kg ha\(^{-1}\) yr\(^{-1}\), low openness (≤ 25%)

Low nutrient, continuously grazed pastures with open patches

Suter et al. 2007 Weed Res
Evaluation case-control

Benefits

• Reliable statements in relatively short time
• Test of challenging treatments such as grazing systems
• Test of influences with very broad range or composed of several components
• Effects can be assigned to factors that acted over long time
• Close to practice, on-farm $\Rightarrow$ relevant for application
Evaluation case-control

Limits

• Only existent factors can be investigated
• Correlated factors cannot be separated

Experiments can test extended factors, ranges, and correlations, once first evidence is gained

Applications

• Success in sowing (e.g. field margin strips)
• Wild boar attacks in crop fields
• Economy of farms
Conclusions

Case-control studies

- Offer a great opportunity for dealing with complex questions
- Great potential in surveys and on-farm research – close to application
- Can be applied to a wide range of research topics
Thanks to

John Connolly
Willy Kessler
Agricultural Advisory Service
Swiss Federal Office for Agriculture FOAG
Strategies

for the control of the species

- Prevent sward damage
- Replace set stocking by rotational grazing
- Adjust grazing rates, avoid overgrazing
- Maintenance parcels ⇒ cut weeds
- Prevent seed formation in meadows and local environment
- Act early, when the species arrives ...

Suter et al. 2007 Weed Res
... before it's too late