

# Butterflies and nitrogen: The Netherlands experience

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- **Chris van Swaay** (de Vlinderstichting)
- **Arjen van Hinsberg** (PBL)
- **European Environment Agency**  
Contract: EEA/BSS/07/010
- Nitrogen deposition (nCLE) and butterfly biodiversity are two of the 26 SEBI 2010 indicators; we were asked to see if they could be validated against each other.

**Butterflies and nitrogen**

- **Hypothesis** (H1) was that nitrogen deposition expressed as nitrogen Critical Load Exceedence (nCLE) affects butterfly population biodiversity quality.
- **nCLE** is modelled on the interaction of remotely sensed nitrogen deposition levels and the background vegetation and geology (deposition is measured as mol/ha/yr). The amount by which the deposited nitrogen exceeds the modelled natural ability (vegetation and geology) to incorporate the nitrogen without affect on biodiversity is the **exceedence**.

## Butterflies and nitrogen

- **Resources:**

- 1. 17 years of standardised butterfly surveys for a range of habitats in the Netherlands (de Vlinderstichting)
- 2. nCLE data for each site for each year (PBL)
- 3. Fungib biodiversity assessment programme (**e**cosulis) which creates a range of biodiversity indices

**Butterflies and nitrogen**

- Problem 1:
- **1. Butterfly data changes rapidly from year to year due to weather impacts (often delayed by one or more years)**
- Solution:
- **Aggregate data into 6;6 and 5 year sets of data(1990-2006)**
  
- Problem 2:
- **Little experimental data on which to base butterfly species response to nitrogen deposition**
- Solution:
- **Create a scoring for hypothetical nitrogen influence based on Ellenberg scores (Species Nitrogen Value Index; SNVI) and expert experience.**

## **Butterflies and nitrogen**

- **The Data:**

- The data was for four habitat types and therefore we had 12 sets of data (four habitats by three time periods) as can be seen in the next slide.

**Butterflies and nitrogen**

- Results of biodiversity quality analysis:

Habitat and period/factor	SNVI	Species Richness	Simpson	SCVI	Population	Biomass	CLE	n=
<b>Agriculture 1</b>	<b>5.65</b>	<b>15.35</b>	<b>4.72</b>	<b>2.67</b>	<b>714</b>	<b>10147</b>	<b>1405</b>	<b>8</b>
<b>Agriculture 2</b>	<b>5.67</b>	<b>16.17</b>	<b>5.19</b>	<b>2.69</b>	<b>871</b>	<b>17338</b>	<b>1138</b>	<b>14</b>
<b>Agriculture 3</b>	<b>6.08</b>	<b>14.56</b>	<b>4.83</b>	<b>2.61</b>	<b>539</b>	<b>11548</b>	<b>145</b>	<b>21</b>
<b>Grassland 1</b>	<b>5.8</b>	<b>15.86</b>	<b>4.71</b>	<b>2.83</b>	<b>720</b>	<b>14698</b>	<b>1765</b>	<b>23</b>
<b>Grassland 2</b>	<b>5.74</b>	<b>14.9</b>	<b>4.53</b>	<b>2.78</b>	<b>638</b>	<b>12778</b>	<b>641</b>	<b>57</b>
<b>Grassland 3</b>	<b>6.22</b>	<b>16.48</b>	<b>6.33</b>	<b>2.72</b>	<b>527</b>	<b>11352</b>	<b>572</b>	<b>54</b>
<b>Heathland 1</b>	<b>4.01</b>	<b>18.22</b>	<b>5.53</b>	<b>3.23</b>	<b>569</b>	<b>10407</b>	<b>1626</b>	<b>12</b>
<b>Heathland 2</b>	<b>4.22</b>	<b>15.9</b>	<b>6.05</b>	<b>3.2</b>	<b>437</b>	<b>7423</b>	<b>1071</b>	<b>15</b>
<b>Heathland 3</b>	<b>4.42</b>	<b>17.42</b>	<b>6.06</b>	<b>3.05</b>	<b>385</b>	<b>7142</b>	<b>1060</b>	<b>20</b>
<b>Woodland 1</b>	<b>5.75</b>	<b>17.13</b>	<b>5.79</b>	<b>2.75</b>	<b>649</b>	<b>13030</b>	<b>2133</b>	<b>14</b>
<b>Woodland 2</b>	<b>5.88</b>	<b>16.05</b>	<b>6.05</b>	<b>2.76</b>	<b>472</b>	<b>10136</b>	<b>859</b>	<b>26</b>
<b>Woodland 3</b>	<b>6.22</b>	<b>16.47</b>	<b>6.33</b>	<b>2.72</b>	<b>527</b>	<b>11351</b>	<b>572</b>	<b>23</b>

**Butterflies and nitrogen**

- **Principal Component Analysis** (all data)

	<u>PC1 (50% of variation)</u>	<u>PC2 (27.1%)</u>
• SNVI	<b>-0.434</b>	<b>0.258</b>
• Species Richness	0.370	-0.331
• Simpson Index	0.340	0.231
• SCVI	0.466	-0.212
• Population	-0.395	-0.455
• Biomass	-0.419	-0.326
• nCLE	<b>0.096</b>	<b>-0.642</b>

**Butterflies and nitrogen**



- **PCA analysis for yearly data in 6 or 5 year runs example:**

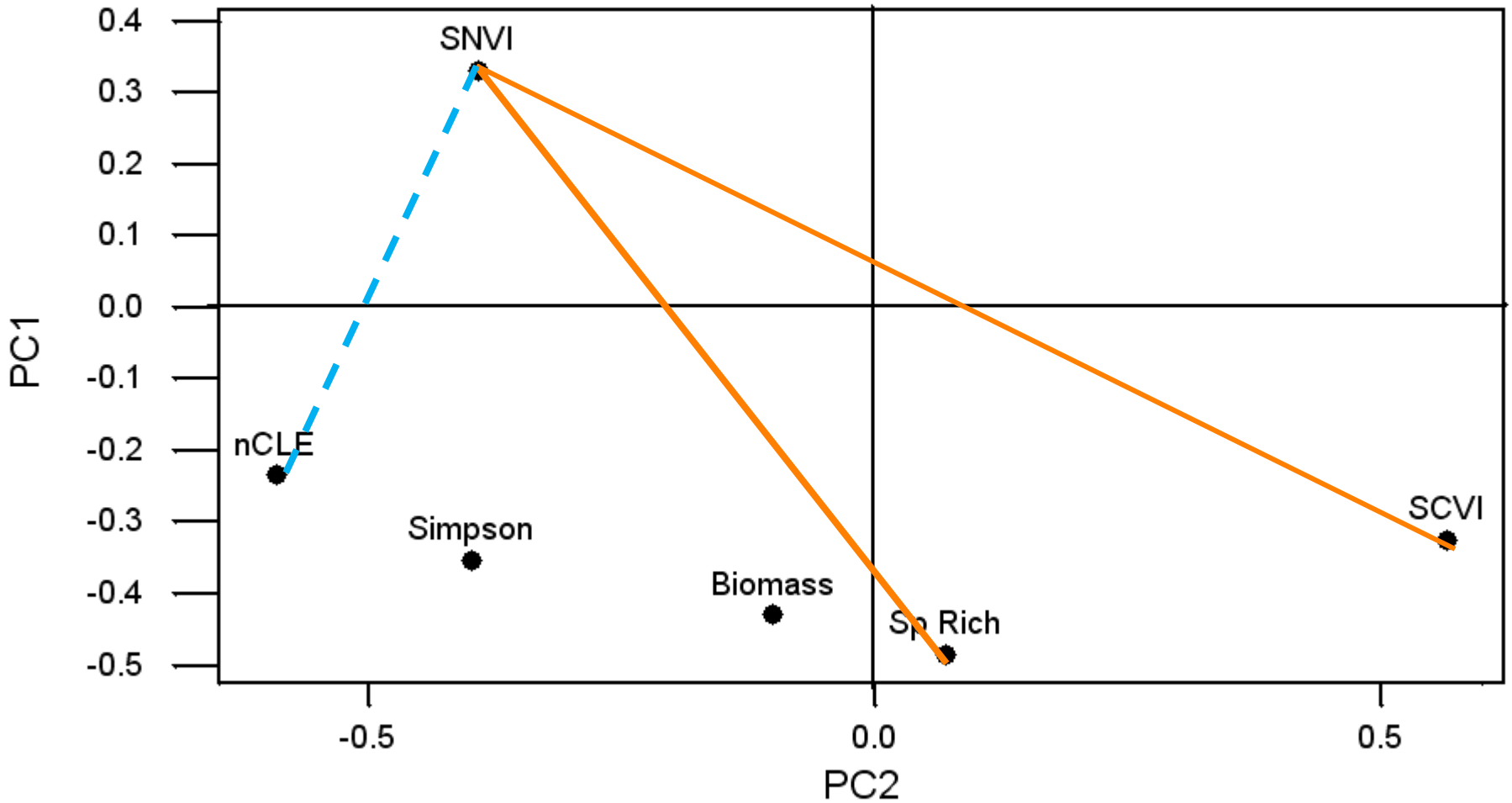
- **Woodland 1996-2001**

	<u>PC1 (66.6%)</u>	<u>PC2 (16.5%)</u>
• <b>SNVI</b>	<b>0.332</b>	<b>-0.392</b>
• Species Richness	-0.484	-0.069
• Simpson Index	-0.352	-0.399
• SCVI	-0.324	-0.565
• Population	-0.433	0.057
• Biomass	-0.429	0.101
• <b>nCLE</b>	<b>-0.234</b>	<b>-0.592</b>

- **This pattern of relationship for PC1 was found in 11/12 (3 time periods in four habitats) analyses**
- **Whilst nCLE is declining SNVI is increasing!**

**Butterflies and nitrogen**

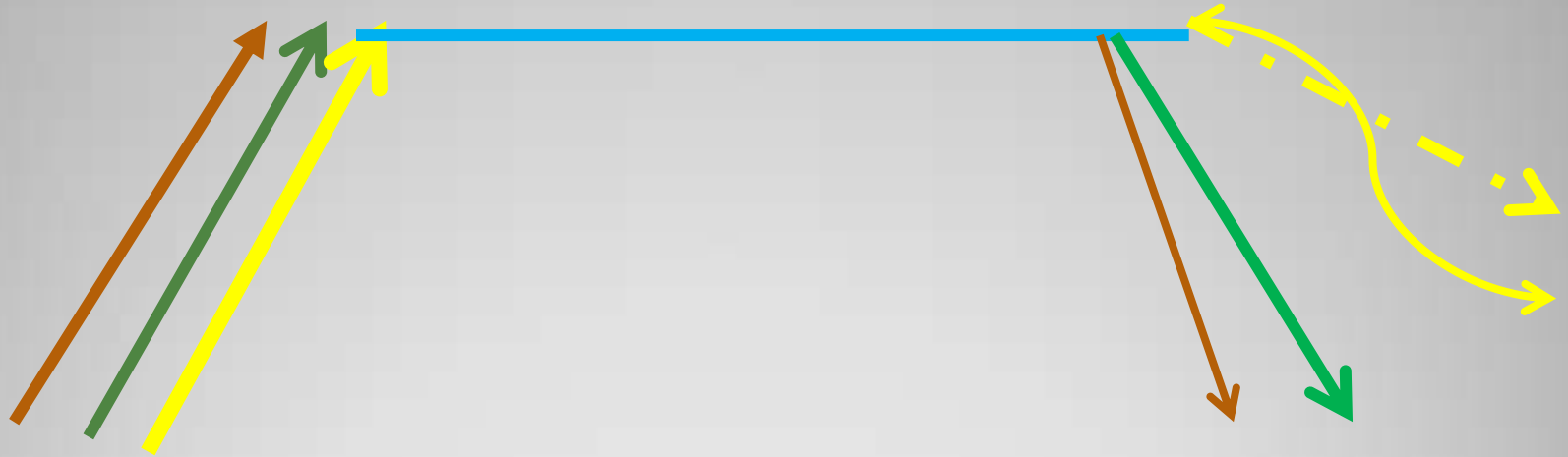
# PCA Woodland butterflies 1996-2001



- In this presentation the data shows there is a problem in that the nCLE and SNVI appear to be not related strongly. This is because whilst nCLE is declining rapidly it is still positive and having an effect
- The one site/period where nCLE was not in decline showed a different PCA 1 picture (heathland period 3).

## Butterflies and nitrogen

- nCLE —————
- Environmental n —————
- Biodiversity impact —————



# Nitrogen and butterflies

- **CONCLUSIONS:**

- 1. Butterfly populations are affected by nCLE deposition (H1) but at a time of declining levels, that remain positive, this may become a complex situation and species need to be scored for nitrogen sensitivity to detect the picture of events.

**Butterflies and nitrogen**

- 2. All biodiversity quality indices seem to be in decline in Dutch butterflies. The one exception is for a very nitrogen sensitive habitat which may have reached a high plateau level given the nCLE model assumptions.

**Butterflies and nitrogen**

- 3. Hypotheses of action:
- A: Wallis de Vries and van Swaay hypothesise that nitrogen induced vegetation structure also has an effect. Increased growth action occurs in the earlier spring and cools soil surface where eggs and larvae overwinter despite warmer air temperatures.
- B: In session 13-4 (Saturday) Gert-Jan van Duinen hypothesises that plant nitrogen content imbalance (nitrogen/amino acid ratio) resulting from nitrogen deposition induces reduced growth due to lack of amino acid intake. Please be sure not miss this lecture!

## Butterflies and nitrogen

- 4. Restoration of oligotrophic habitats and nitrophobic species may be compromised by nCLE and this needs to be accommodated in any restoration programme.
- In habitat restoration nitrogen deposition is one of the elephants in the room (along with mycorrhizae and they interact)!!!!

**Butterflies and nitrogen**