LUXEMBOURG GRASSLAND BUTTERFLY INDEX

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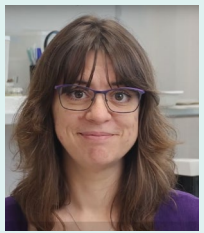

eBMS Meeting, Laufen, 2-5 December 2025

THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG
Ministry of the Environment,
Climate and Biodiversity

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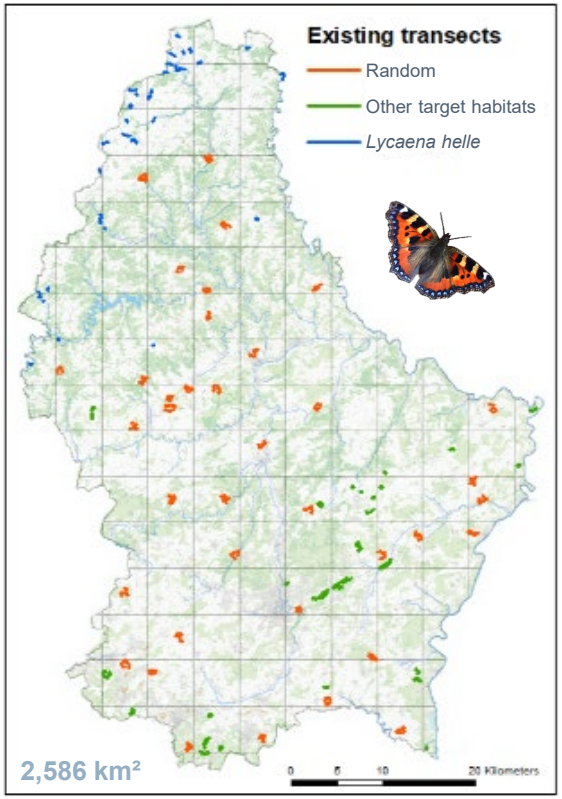
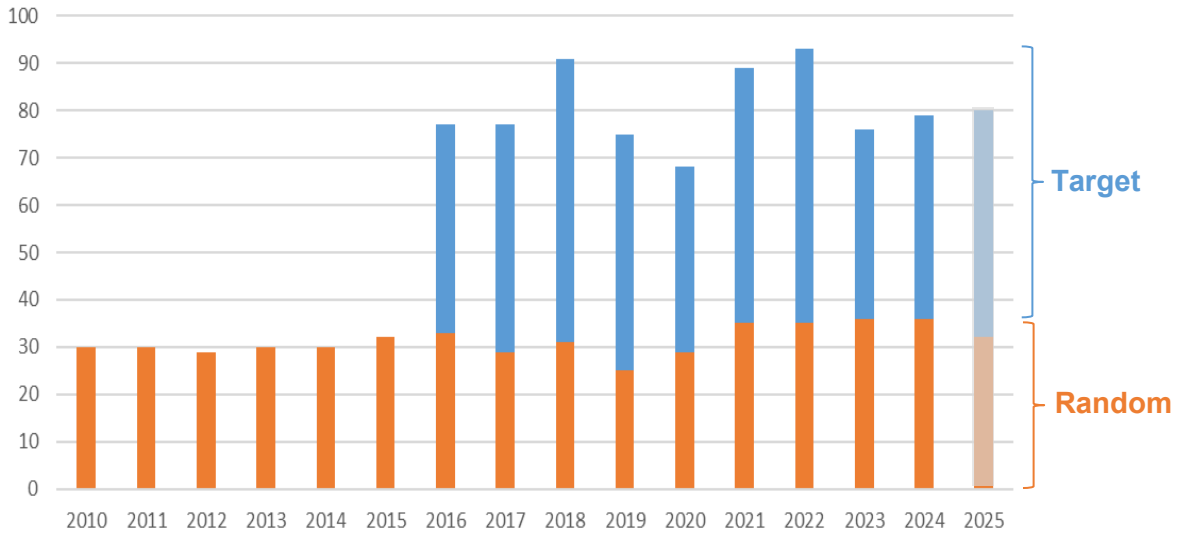
LUBMS

Random
Stratified random sampling

36 transects

Target
biotopes e.g. dry grassland
species e.g. *Lycaena helle*
40-60 transects





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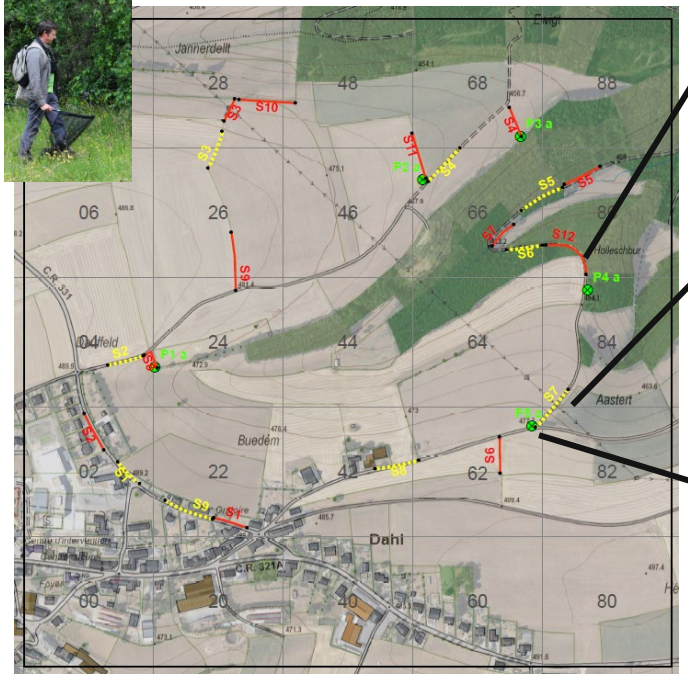
LUBMS (RANDOM)

1 km²



2x/month; Average 1,365 m length

2x/month; Average 1,225 m length

4x/year; 5x per square

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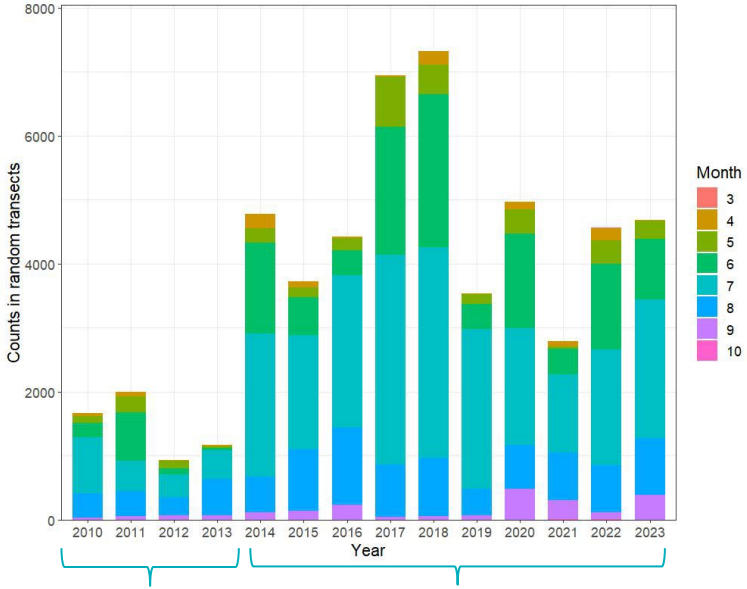
BUTTERFLY POPULATION TREND ANALYSES

LUBMS (transect-based) data

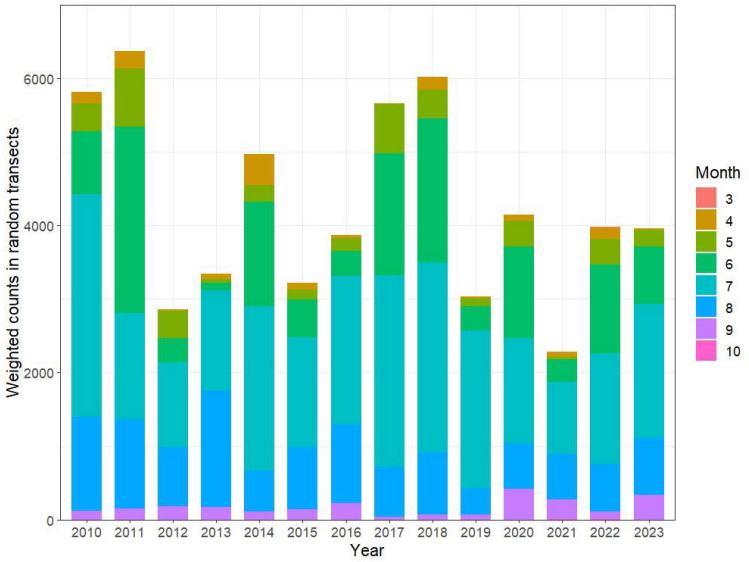
Butterfly rough counts



1 transect
≤ 8 sections

1 transect
≤ 16 sections

Butterfly counts standardized to 1km



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BUTTERFLY POPULATION TREND ANALYSES

The modelling steps for a given species (rbms package)

Estimate species flight curve → **Estimate site indices** → **Combine to collated indices** → **Estimate species trend**

The curve describes the species flight pattern across sites for each year.

Annual abundance indices = sum of observed + imputed weekly counts, for sites with ≥10% of the flight curve covered by the visits.

Combine each site index into an **annual collated index** = the mean total butterfly count expected along a 1km transect during a given year.

Fit a linear regression to the collated indices across years.

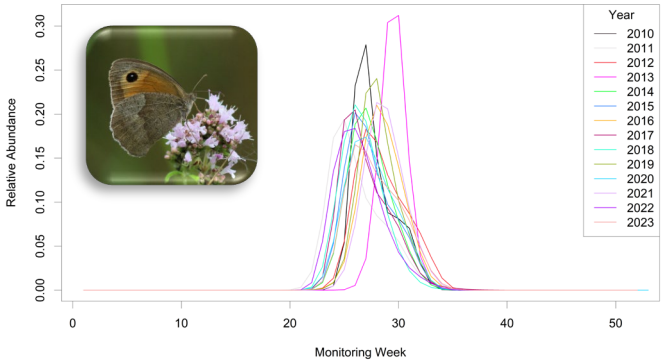
Data from **ALL transects** (incl. target transects)

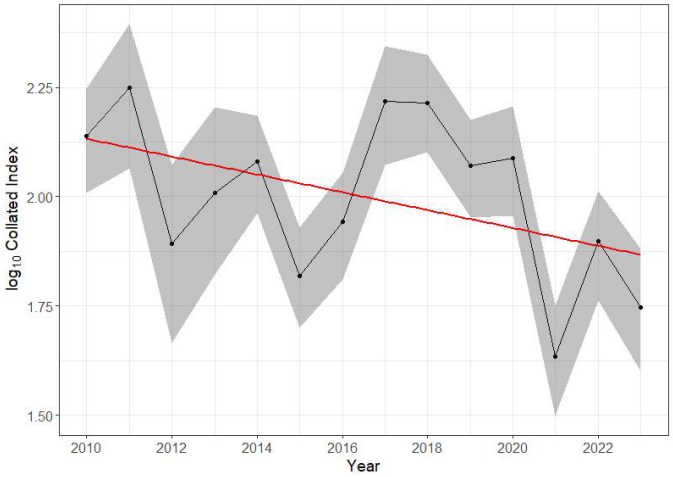
Data from **RANDOM transects** only, to reflect the various environmental conditions across the countryside in Luxembourg (target transects are too recent and site-specific).

BUTTERFLY POPULATION TREND ANALYSES

The modelling steps for *Maniola jurtina* (in LUBMS random transects)

Estimate species flight curve → Estimate site indices → Combine to collated indices → Estimate species trend





The time series average is centered to 2

% change over the 14 years	-46%
Trend	Moderate decline

= Significant decrease but less than 5% per year

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BUTTERFLY POPULATION TREND ANALYSES

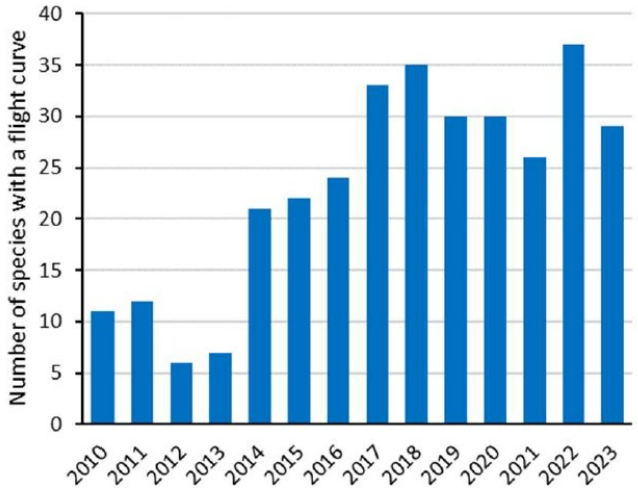
The modelling steps

Estimate species flight curve → Estimate site indices → Combine to collated indices → Estimate species trend

✓ **47 species** (in all LUBMS transects)

Minimum 5 sites with:
- >= 3 visits
- >= 2 occurrences of the species

For each year



BUTTERFLY POPULATION TREND ANALYSES

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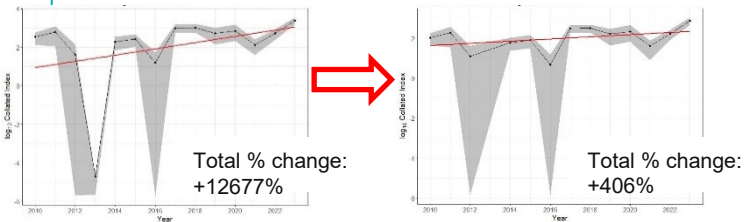
For each year

Excluded 15 species with >3 years with 0 record (causing extreme CI values and overestimated % change and sometimes trend)

Removed years with 0 record for the other species.



Aricia agestis

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BUTTERFLY POPULATION TREND ANALYSES

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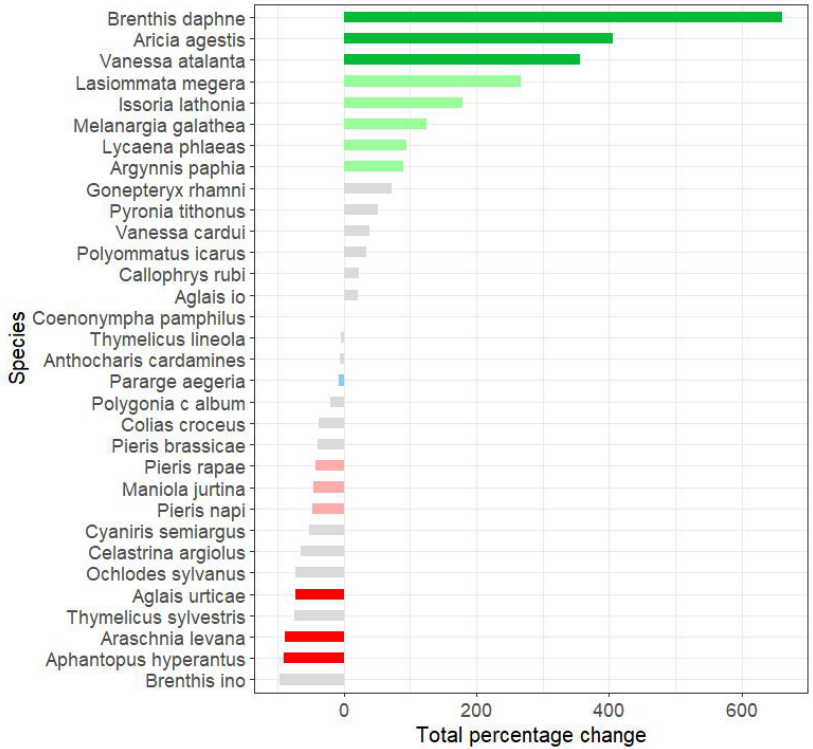
Excluded 15 species with >3 years with 0 record (causing extreme CI values and overestimated % change and sometimes trend)

Removed years with 0 record for the other species.

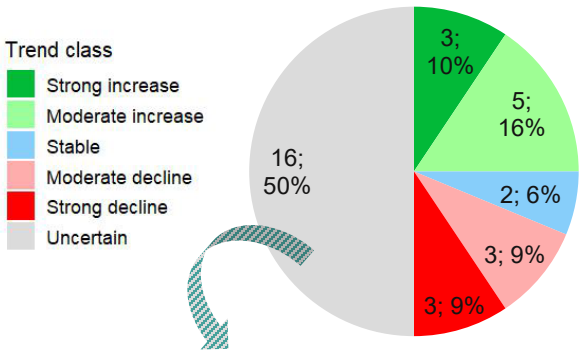
✓ **32 species** in LUBMS random transects = **41%** of the 78 species present and breeding in Luxembourg (after 2010).

BUTTERFLY POPULATION TREND ANALYSES

Species population trends in LUBMS random transects (32 species)



16 species with an uncertain trend



Large year-to-year fluctuations
and/or
low number of transects with species occurrences
(→ large Confidence Interval).

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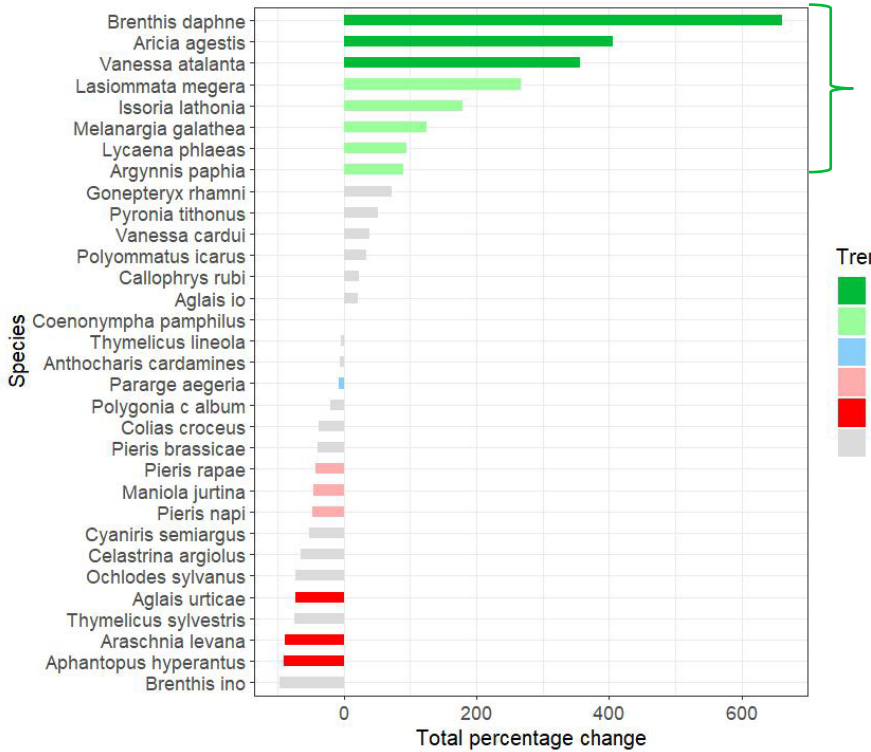
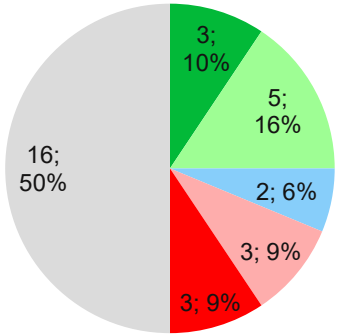
BUTTERFLY POPULATION TREND ANALYSES

Species population trends in LUBMS random transects (32 species)



Could have been overestimated (very few transects with occurrences of the species before 2014 => large CI)



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BUTTERFLY POPULATION TREND ANALYSES

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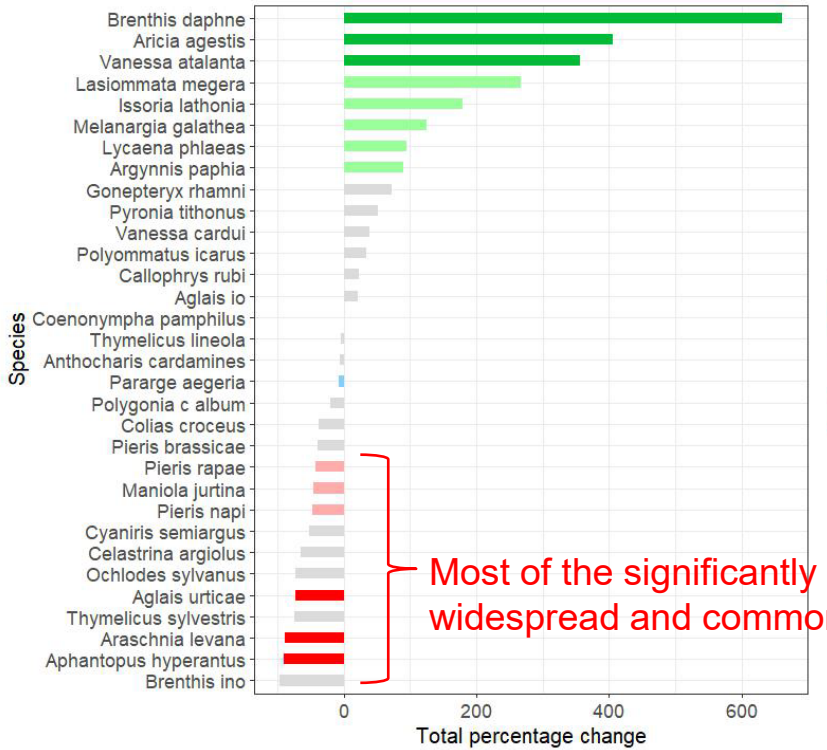

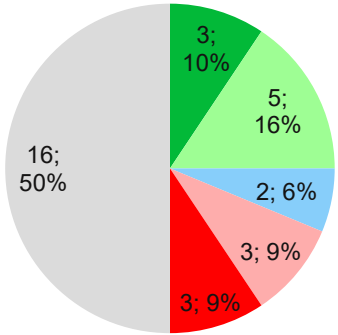

Most of the significantly declining species are widespread and common

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GRASSLAND BUTTERFLY INDICATOR FOR LUXEMBOURG

Towards a multi-species indicator…

Estimate species flight curve → Estimate site indices → Combine to collated indices

↓

Combine to a multi-species indicator

↓

Estimate the indicator trend

Geometric mean of the species collated indices → all species have the same weight.

GRASSLAND BUTTERFLY INDICATOR FOR LUXEMBOURG

Two approaches

- **GBI 1**
  - Predefined list of species
  - All sections
- **GBI 2**
  - All species
  - Only grassland sections

GRASSLAND BUTTERFLY INDICATOR FOR LUXEMBOURG

Luxembourg GBI 1 - based on a predefined list of species in all sections

Species	Included in the European Grassland Butterfly Indicator	Included in the Luxembourg Grassland Butterfly Indicator
Anthocharis cardamines	Yes (widespread)	Yes
Aphantopus hyperantus	No	Yes
Aricia agestis	No	Yes
Coenonympha pamphilus	Yes (widespread)	Yes
Cupido minimus	Yes (specialist)	No (data deficient)
Cyaniris semiargus	Yes (specialist)	Yes
Erynnis tages	Yes (specialist)	No (data deficient)
Euphydryas aurinia	Yes (specialist)	No (data deficient)
Lasiommata megera	Yes (widespread)	Yes
Lycaena phlaeas	Yes (widespread)	Yes
Lysandra bellargus	Yes (specialist)	No (data deficient)
Lysandra coridon	Yes (specialist)	No (data deficient)
Maniola jurtina	Yes (widespread)	Yes
Melanargia galathea	No	Yes
Ochlodes sylvanus	Yes (widespread)	Yes
Phengaris arion	Yes (specialist)	No (data deficient)
Phengaris nausithous	Yes (specialist)	No (absent from Luxembourg)
Polyommatus icarus	Yes (widespread)	Yes
Spialia sertorius	Yes (specialist)	No (data deficient)
Thymelicus acteon	Yes (specialist)	No (data deficient)
Thymelicus lineola	No	Yes
Thymelicus sylvestris	No	Yes

→ 13 species

→ From the original European selection, only one specialist species could be included.

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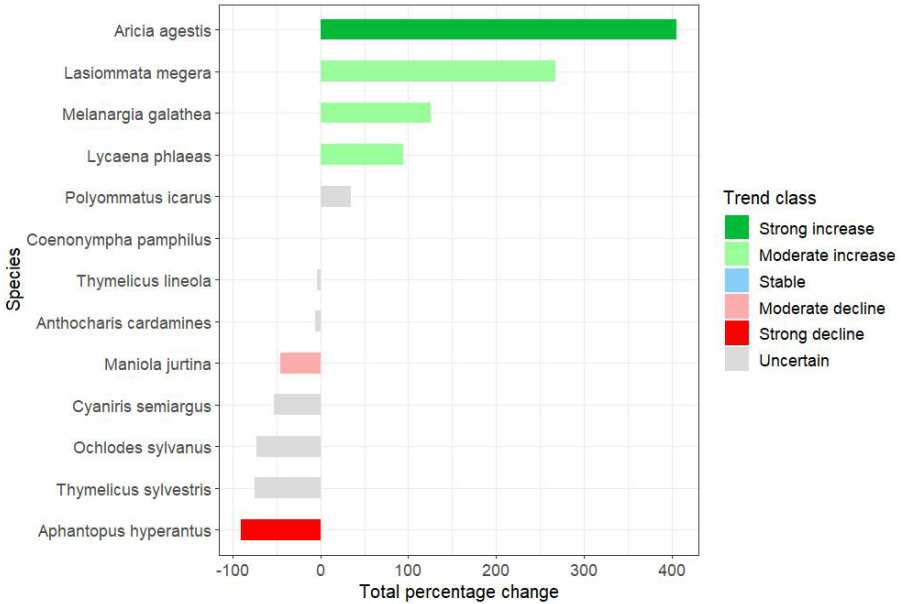
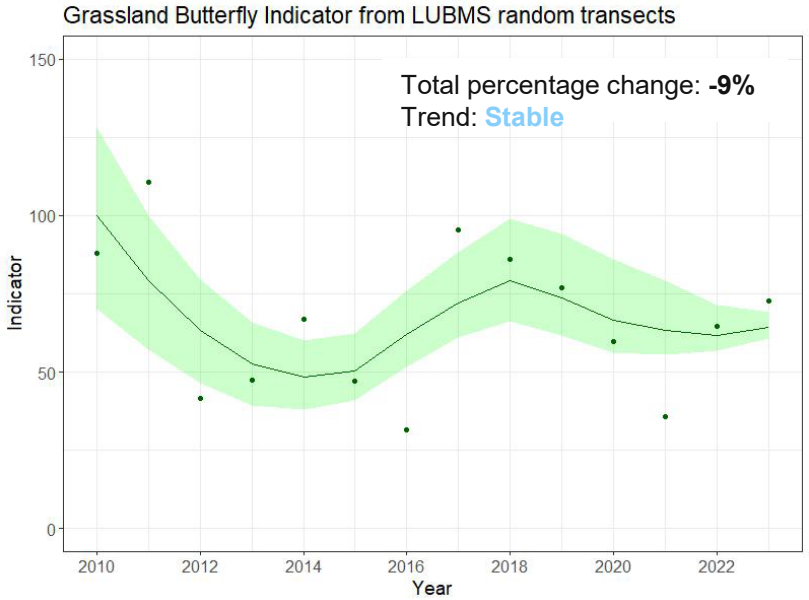
GRASSLAND BUTTERFLY INDICATOR FOR LUXEMBOURG

Luxembourg GBI 1 - based on a predefined list of species in all sections

Combined population trends of the 13 selected grassland species





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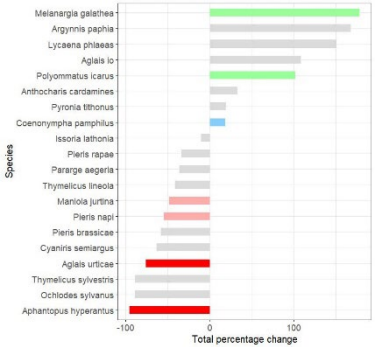
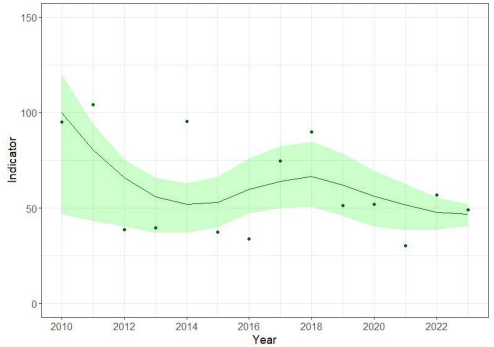
GRASSLAND BUTTERFLY INDICATOR FOR LUXEMBOURG

Luxembourg GBI 2 - based on all species abundance in grassland sections

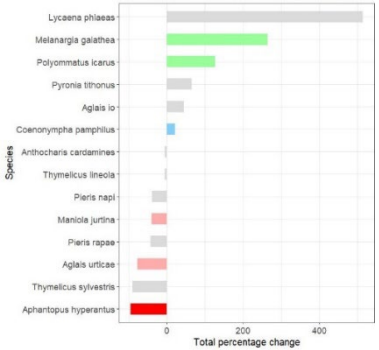
Sections with at least **50%** of grassland cover
→ **20 species**

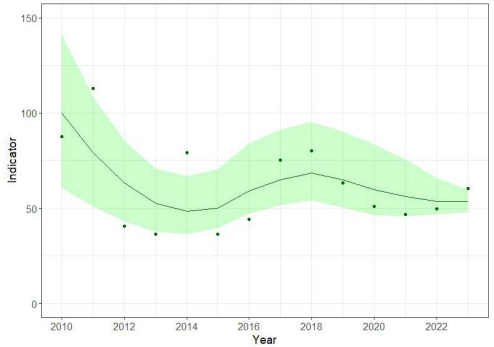




Total percentage change: **-37%**
Trend: **Stable**

Sections with at least **75%** of grassland cover
→ **14 species**





Total percentage change: **-25%**
Trend: **Stable**

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BUTTERFLY POPULATION TREND ANALYSES & INDICATORS

Conclusion and perspectives

- **Random transects** provide a trend for **32 species** (out of 78+aggregates), mostly common and widespread.
- Further investigation are needed to explore the use of **target transects,** use **occupancy modelling** and **15min counts**.
- Test a **3rd approach for the Luxembourg GBI** based on **Ubach & Stefanescu 2025** → include all species but weight their contribution based on their degree of association with grassland.
- Functions and default parameters were initially developed for large European datasets
  → **more adjustments** are needed to account for the various cases that can appear in smaller national datasets like LUBMS, and to better understand parameters influence on trend outcomes.

LUBMS VS EU-POMS

LUBMS		EU-PoMS
1. Professional surveyors	✓	1. Professional surveyors
2. 2x/month	✓	2. 1x/month
3. 36 sites	→ +4	3. 40 sites
4. Stratified (10 strata)	✓	4. Stratified (min 3 strata)
5. All ecosystems	✓	5. All ecosystems
6. Butterflies	→ +day-active moths	6. Butterflies and day-active moths
7. Average length 1,365m	?	7. Fixed 1km
8. Variable duration (one way)	?	8. Fixed duration (60 min)

GBI

LU= YES

?

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Thank you

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These outcomes have been produced in the frame of the BIOLYS project undertaken by LIST, thanks to a co-funding of the Ministry of the Environment, Climate and Biodiversity of Luxembourg