Investigation of the Biomass of flying insects in the Orbroich Bruch Nature Reserve using Malaise Traps in the years 1989 and 2013

By Sorg, M.; Schwan, H.; Stenmans, W & A Müller

Report of the Proceedings of the Krefeld Entomological Society, Vol., 1 (2013), pages 1 – 5.

Translated by Eric McArthur MIL

What follows is a description of measured Insect-Biomasses from samples collected in the Orbroich Bruch Nature Reserve, near Krefeld, using Malaise Insect Traps.

The results show that, in the same two areas, sampled in the years 1989 and 2013, there was a dramatic fall in the number of flying insects.

Using the same traps, in the same areas, significant reductions of insect populations, of more than 75%, were found.

Our data confirms, that in the areas studied, less than 25% of the original number of flying insects collected in 1989, were still present in 2013.

Orboicher Bruch Area

The Orboicher Bruch, to the Northwest of Krefeld, is a designated Nature Reserve of around 100 hectares (220 acres). Due to the reserve's relatively remote location and its rugged landscape, intensive farming came to the area only recently.

Fig 1 Malaise Trap on the day it was assembled in May 2013,
protected by fencing in the grassland adjacent to the edge of a wood in the Orbroich Bruch

Fig 2: Section from the topographical ***'Record of the Rhineland'*** byJean Joseph Tranchot.
The map was begun in 1815, for the Prussian Government, by Karl von Müffling and was completed in 1828.

The historic map by Tranchot and Müffling (fig 2) shows some of the present features. Cultivation of crops is concentrated in just a few areas, where the relatively sandy soil allows the ground to be farmed. Cultivation is enabled by so called 'Dykes'. These 'way systems' consist of a raised bank landscaped on both sides with ditches and hedgerows to enclose the grazing areas.

The grassland areas have been managed with artificial fertilisers and herbicides in recent times. In adjacent farming areas, similar pesticides were used, and pesticide-coated seeds were also planted. Reed beds (Rohrglanzgras) and water meadows of oat-grass, which developed along the banks of a stream, have been partially restored in recent years. The grassland area includes fertile meadows, as well as rough pastures; there are also small areas of water-meadows, wet-meadows and wet-grazing.

Many conservation measures for nature reserves were undertaken to conserve the ecology of the Orboicher Break, (Thies & Malschützky 2007). Taken as a whole, the area presents a typical lower-Rhine farming landscape, with many native trees (Kopfbaumzeilen).

The conservation aims for its management as a nature reserve include:

- Maintenance of a large area of highly structured grassland complexes, with wetlands and typical habitats for native plants and animals.
- Maintenance of this lowland environment as a natural flood plain
- Management of the area to serve as an outstanding 'Centre of Excellence' for a local habitat network, including further conservation of the owl population and extensive use of the grasslands.

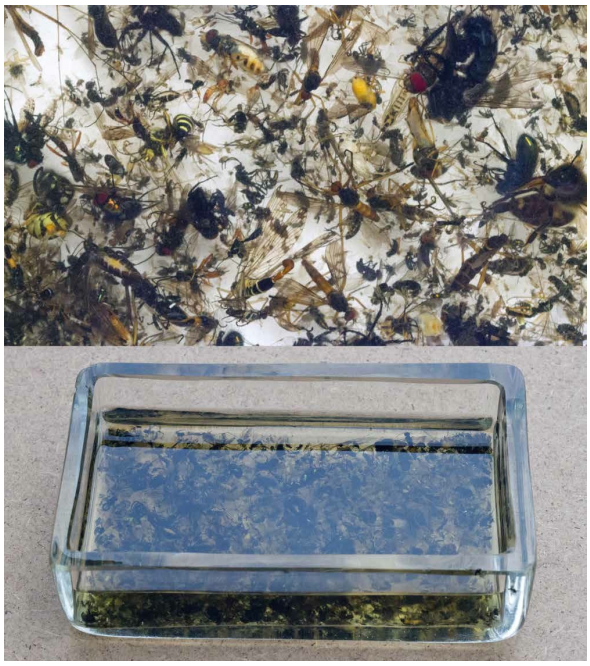
In 1989 and 2013 mapping and sample measurements of the insect fauna was undertaken by the agricultural department of Krefeld .

Methods

Malaise traps, of the 1972 'Townes design', which were first used on the original sites in 1989, were erected on the same sites again in 2013. They were made of marquisette (100% polyester mesh) with a mesh aperture of approx., 0.8mm.

Similar to the original design, the lower parts of the trap are black and the upper parts are white. Deviations from the original design are: the supports for the ‘capture’ head which are made from stainless steel, which enclose a 0.5 litre, polyethylene flask. The clear opening at the ‘capture’ head is approx., 5 cm diameter. The captured arthropods are preserved in 70 – 80% alcohol contained in the 0.5 litre, polyethylene flask which is screwed into the ‘capture head’.

The mouth of the flask faces South, in order to optimise efficient trapping of photo-tactic insects. The Malaise Trap is a relatively non selective , semi-quantitative trapping device. Normal sampling involves measuring the biomass of living or dry weight of animals or plants. In the present trap, alcohol is used as a preservative, since the animals have to be prepared for species determination. Investigation of the biomass species can only be made prior to the preparation of the samples.



Measurement of trapped insect biomass

As in 1989, the 2013 the weekly catch-total was weighed using the same method, as follows:

The alcohol containing the trapped-insects was poured into a sieve.

The sample was allowed to drain in the sieve, until more than 10 seconds elapsed, since the last drop of liquid fell. The mass of insects obtained, defined as the **‘drained mass’** gives an indication of the relative mass of the ‘active’ sampled insects, in a controlled time, for each of the trap sites.

Due to the limitations of the Malaise Trap design, the ‘drained mass’ samples, mainly comprised flying insects.

Results

Table 1 gives an overview of the determined values of both trapping positions and the year of the project. In 1989 during the sampling period disturbance of Trap 1 occurred twice (4/6 and 10/9/89). These disturbances caused no samples to be taken for these weeks. Ignoring the lost two weeks in 1989, as well as the installation of the trapping procedure two weeks later, a biomass of 1,117.1g was collected from Trap 1 and Trap 2 gave a result of 1,425.6g.

Table 1 Biomass ('Drained Mass') of the collections from the Malaise Traps 1 and 2 in 1989 & 2013

	date	MF1	MF2	date	MF1	MF2
	Leerung	MF1	MF2	Leerung	MF1	MF2
1	08.05.89	42,6	26,5	05.05.13	5,7	9,1
2	14.05.89	38,6	36,2	12.05.13	5,2	11,4
3	21.05.89	64,3	101,4	19.05.13	4,8	10,5
4	28.05.89	40,5	98,3	26.05.13	7,2	11,5
5	04.06.89	0	60,1	02.06.13	16,1	13,9
6	11.06.89	36,8	68,3	09.06.13	18,9	18,0
7	18.06.89	41,5	79,5	16.06.13	12,6	22,0
8	25.06.89	83,3	129,8	23.06.13	13,8	20,7
9	02.07.89	51	91,4	30.06.13	8,2	8,5
10	09.07.89	114,1	137,5	07.07.13	19,2	17,8
11	16.07.89	76,9	94,6	14.07.13	18,9	16,4
12	23.07.89	122,5	145,4	21.07.13	22,1	22,1
13	30.07.89	73,5	83,3	28.07.13	19,7	21,2
14	06.08.89	61,2	49,1	04.08.13	27,3	30,5
15	13.08.89	63,4	40,3	11.08.13	13,6	17,0
16	20.08.89	77,4	63,7	18.08.13	14,3	11,5
17	27.08.89	39,9	34,5	25.08.13	10,1	12,3
18	03.09.89	31,3	26,6	01.09.13	5,6	4,1
19	10.09.89	0	15,3	08.09.13	4,0	3,5
20	17.09.89	11,2	11,9	15.09.13	2,1	3,4
21	24.09.89	9,9	8,8	22.09.13	1,8	2,7
22	01.10.89	16,5	6,7	29.09.13	2,7	2,6
23	08.10.89	12,1	10,5	06.10.13	2,1	2
24	15.10.89	8,6	5,9	13.10.13	1,3	1,7
	Summen	1117,1	1425,6		257,3	294,4

The trapping procedure in 2013 had no gaps. The resulting biomasses were **257.1 g** for Trap 1 and **294.4 g** for Trap 2.

Using this method, the data reveals a fall in the biomass of flying insects to 23.0% for Trap 1 and 20.7% for Trap 2.

The loss of biomass for both trapping positions in comparison with reference year,1989 is more than 75%

The following figures illustrate the order of magnitude of the investigated values,
relative to the individual weekly collections from both traps and the respective year.

Table 2

Comparison of the measured biomasses (Drained Mass) of the individual collection intervals for Trap 1; Difference of the measured losses (g) and the residues (%) per collection interval in the respective years.

	MF1-89	MF1-13	Verlust (g)	Rest (%)
1	42,6	5,7	36,9	13,4
2	38,6	5,2	33,4	13,5
3	64,3	4,8	59,5	7,5
4	40,5	7,2	33,3	17,8
5	0	16,1	n.b.	n.b.
6	36,8	18,9	17,9	51,4
7	41,5	12,6	28,9	30,4
8	83,3	13,8	69,5	16,6
9	51	8,2	42,8	16,1
10	114,1	19,2	94,9	16,8
11	76,9	18,9	58,0	24,6
12	122,5	22,1	100,4	18,0
13	73,5	19,7	53,8	26,8
14	61,2	27,3	33,9	44,6
15	63,4	13,6	49,8	21,5
16	77,4	14,3	63,1	18,5
17	39,9	10,1	29,8	25,3
18	31,3	5,6	25,7	17,9
19	0	4,0	n.b.	n.b.
20	11,2	2,1	9,1	18,8
21	9,9	1,8	8,1	18,2
22	16,5	2,7	13,8	16,4
23	12,1	2,1	10,0	17,4
24	8,6	1,3	7,3	15,1
Summen	1117,1	257,3	859,8	23,0

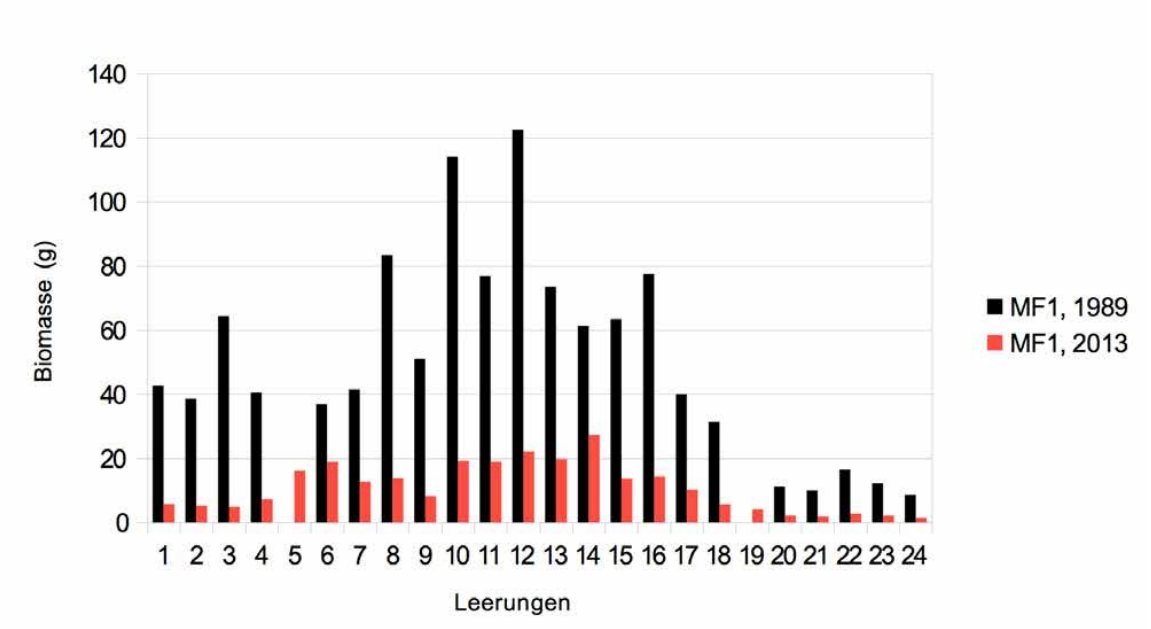


Figure 7 Comparison of the measured biomasses (Drained Mass) of the individual collection intervals for Trap 1

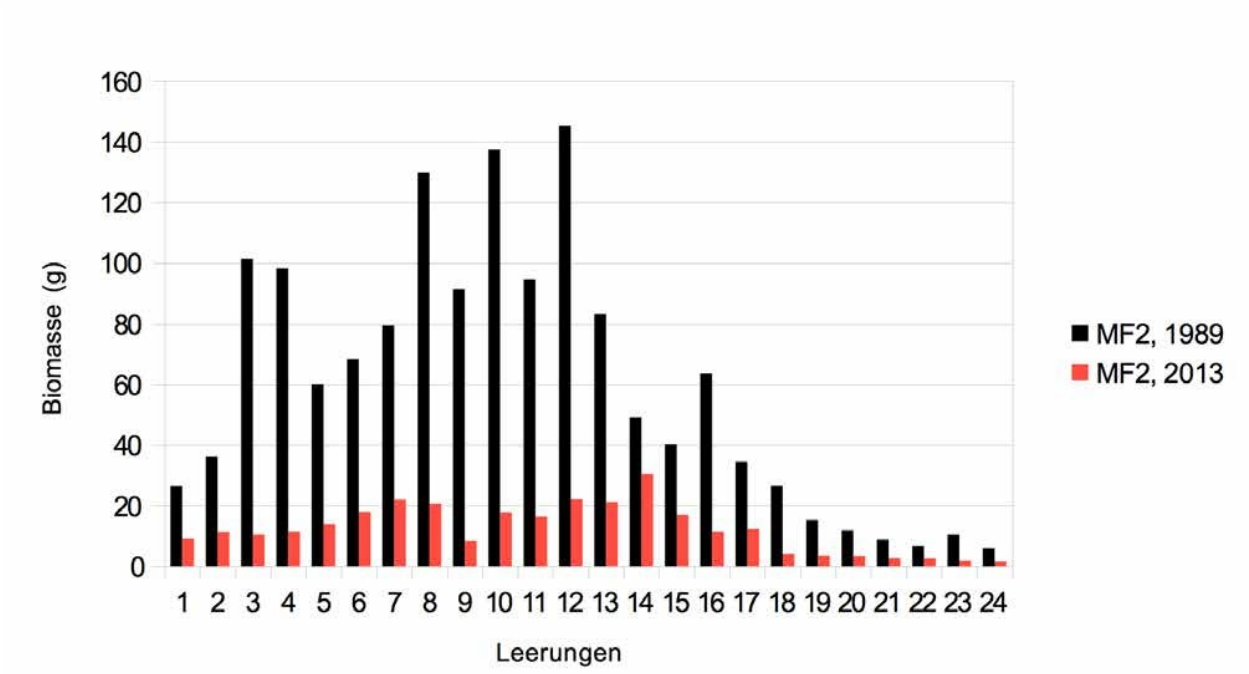


Figure 8 Comparison of the measured biomasses (Drained Mass) of the individual collection intervals for Trap 2

Table 3

Comparison of the measured biomasses (Drained Mass) of the individual collection intervals for Trap 2; Difference of the measured losses (g) and the residues (%) per collection interval in the respective years.

	MF2-89	MF2-13	Verlust (g)	Rest (%)
1	26,5	9,1	17,4	34,3
2	36,2	11,4	24,8	31,5
3	101,4	10,5	90,9	10,4
4	98,3	11,5	86,8	11,7
5	60,1	13,9	46,2	23,1
6	68,3	18,0	50,3	26,4
7	79,5	22,0	57,5	27,7
8	129,8	20,7	109,1	15,9
9	91,4	8,5	82,9	9,3
10	137,5	17,8	119,7	12,9
11	94,6	16,4	78,2	17,3
12	145,4	22,1	123,3	15,2
13	83,3	21,2	62,1	25,5
14	49,1	30,5	18,6	62,1
15	40,3	17,0	23,3	42,2
16	63,7	11,5	52,2	18,1
17	34,5	12,3	22,2	35,7
18	26,6	4,1	22,5	15,4
19	15,3	3,5	11,8	22,9
20	11,9	3,4	8,5	28,6
21	8,8	2,7	6,1	30,7
22	6,7	2,6	4,1	38,8
23	10,5	2,0	8,5	19,0
24	5,9	1,7	4,2	28,8
Summen	1425,6	294,4	1131,2	20,7

Discussion

The above trapping procedures, which were used in the two trap areas between in 1989 and 2013 respectively, each revealed a greater than 75% loss of insect-biomass when the 2013 totals were compared with 1989.

The data reveals that, in the study areas, less than a quarter of the original biomass (1989) of flying insects, survives in the local habitat today (2013). None of the 2013 trap samples, produced anything even close to the 1989 levels of insect biomass.

In a few of the collection intervals the measured insect-biomass sank to even less than 10% of the 1989 values.

As mentioned above, the trapped insect-biomass, largely consisted of flying insects, due to the design of the Malaise traps. It was not possible to differentiate the development of the various Taxa or other insect-species; the Malaise trap system does not allow such specialised measurements.

Nevertheless, the spectrum of insect taxa which the Malaise system is able to capture is very broad.

It embraces quite a wide range of species, which represent vital links in the ecological food chain; many of these Insect species perform crucial functions within ecosystems, i.e. pollination, or parasite regulation, as well as countless other roles.

The observed collapse of insect biomass in the two trapping sites, to just 23.0% and 20.7% of the original 1989 levels, was an unexpected and even frightening result.

When we analysed and compared the measurements from 1989 and 2013, for the greater part of the growing season, it is clear that, in none of the weekly collection intervals was the 1989 level of insect biomass achieved. Moreover, in some measurement cycles, the 2013 insect biomass samples reached only 7.5% and 9.3% of the respective 1989 levels.

The evaluation of the submitted data is especially difficult due to gaps in knowledge, and the lack of meaningful, comparative studies and analyses of local species-spectra.

The data presented here begs two important questions:

1. What might the scale of the biomass diversity have been in the decades before 1989.… and

2. What does this collapse of insect biomass indicate for the future

Crucial to this analysis is the time-scale of just 25 years, (from 1989 to 2013). It is clear that on the same sites, 25 years ago, demonstrably higher numbers of different species once existed.

Fig 9 (below) makes this graphically clear. How could we attempt to estimate the local measurable biomass at the time when, for example, the ornithologist Theo Schreurs mapped the population of Shrikes in this region in the1960s.

For example, up to the 1950s, the area of Staheek in the Orbroich Bruch was still, demonstrably, a good habitat for the Shrike (*Lanius collurio).* Theo Schreurs assumed that the shrike population had disappeared due to intensification of farming. (Schreur 1964).

Schreurs postulated that changes in land-use, as well as lack of food sources, had caused the decline of this bird species. By 1964, the population of insects such as: ‘running beetles’, dung beetles, butterflies and grasshoppers, which were crucial for shrike brood rearing, had fallen to less than 20% of their levels in 1936.

However, based on our results, it is not possible to make predictions of how the future ecology might change, with any certainty. Faced with a situation like this, even within a Nature Reserve, with such productive, species-rich and diverse habitats, if we observe a biomass capture of less than 10 g of insects per week, (or 200 g per year), the future is very uncertain.

Identifying the ‘root cause’ of this decline, using the observed weight of the comparative insect biomasses, is not possible, in our opinion. However, in relation to the impacts on the habitat, it is safe to assume that such a reduction in the biomass of flying insects, of this order of magnitude, will have grave consequences for: local biodiversity, the food supply chain and essential ecosystem functions.

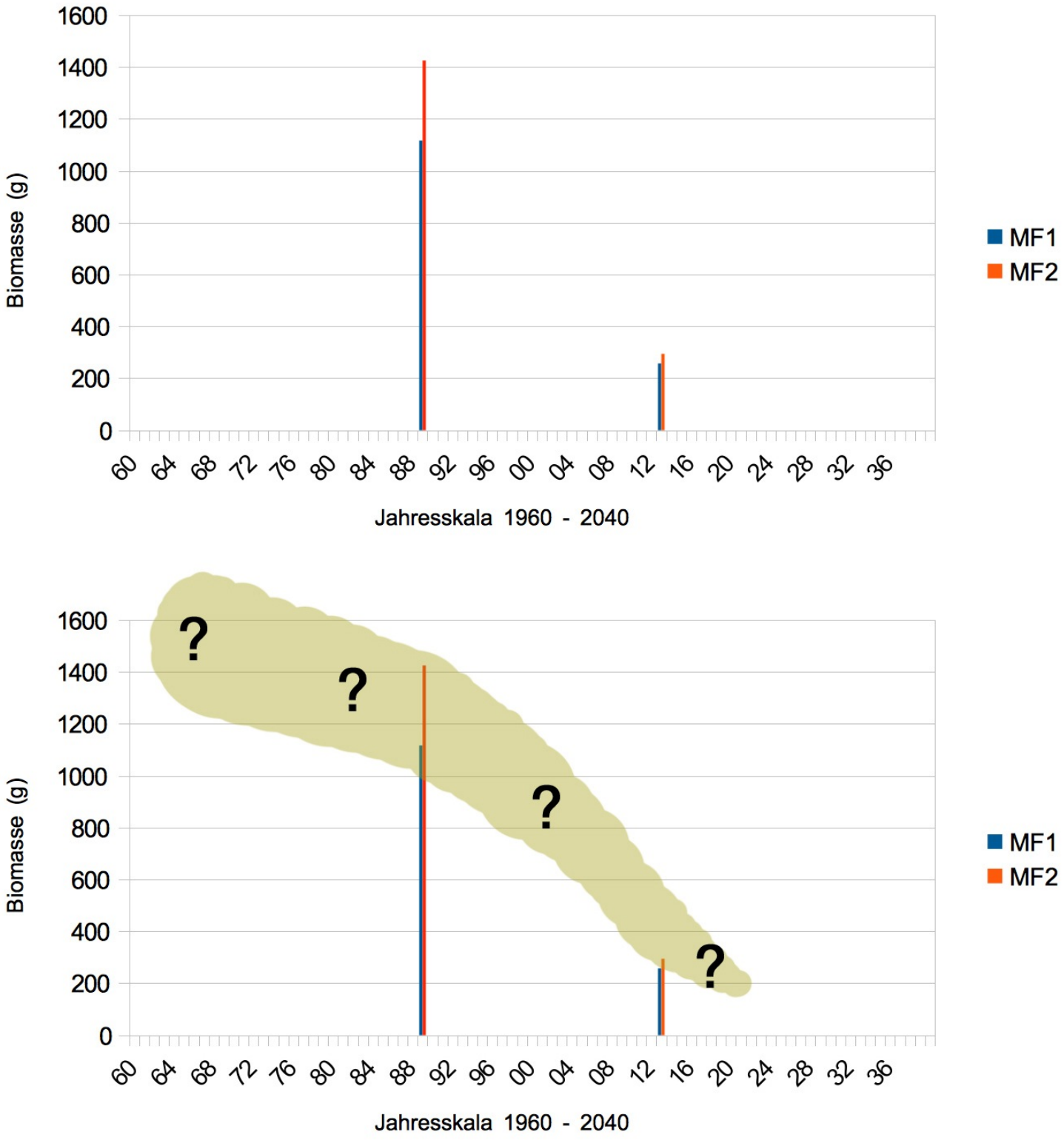


Figure 9 Upper: Biomasses (Drained Mass) from the Malaise Trap for both 1989 and 2013 years Decades 1980 - 2013

Lower: Projection of a possible trend in the trapping areas over decades 1980 - 2040

Literature

Schreurs, T. (1964): Besiedlungsdichte und Bevölkerungs- bewegung bei 53 Singvogelarten des Hülserbruch- und Hülserberggebietes.- Niederrh. Jb VII, 88-99, Krefeld.

Thies, H. O. & Malschutzky, T. (2007): Naturschutzgebiet “Orbroicher Bruch”.- Die Heimat 78/2007, 20-26, Krefeld.

Townes, H. (1972): A light-weight Malaise trap.- Ent. News 83, 239-247, Philadelphia.

Tranchot & Mu¨ffling, V. (1803 - 1820): Kartenaufnahme der Rheinlande, Bl. 36, Krefeld.