



Tiny Forest Zaanstad

Citizen Science and determining biodiversity in Tiny Forest Zaanstad

Fabrice Ottburg, Dennis Lammertsma, Jaap Bloem, Wim Dimmers, Hugh Jansman and Ruut Wegman

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The Tiny Forest concept the Indian engineer Shubhendu Sharma was brought to the Netherlands by IVN (*Instituut voor Natuur- en Milieu Educatie* - Institute for education on nature and environment) and at the end of 2015, two Tiny Forests plots were realised in the Darwin Park in Zaandam. With the realisation of both Tiny Forests, two main questions emerged: 1) Does a Tiny Forest provide biodiversity? 2) Can an overview of the biodiversity be developed using Citizen Science? To answer these questions, a year-round research was carried out in 2017, in which volunteers and experts from Wageningen Environmental Research developed an overview of the biodiversity of the Tiny Forests plots each month. The results of this research will be presented in this report.

Keywords: biodiversity, Citizen Science, municipality of Zaanstad, Gouwse Bos, Groene Woud, IVN Netherlands, Shubhendu Sharma, and Tiny Forest

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Photo cover: Tiny Forest *Groene Woud* on 26 April 2017 in the Municipality of Zaanstad.
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Summary

The spiritual father of the Tiny Forest concept is the Indian engineer Shubhendu Sharma, who was inspired by the Japanese Dr Akira Miyawaki with the Miyawaki method from the 1970s. The Tiny Forest concept includes small city forests of the size of a tennis court, in which 600 trees consisting of approximately 40 tree species are planted. IVN brought this concept to the Netherlands and at the end of 2015, Europe's first formal Tiny Forest known as the *Groene Woud* and a second Tiny Forest known as the *Gouwse Bos* were created, the latter of which was created in the style of Zaanstad: that is to say that, not only were trees planted, but also fruit-bearing shrubs and plants.

With the creation of both Tiny Forests, two main questions emerged, more specifically whether Tiny Forests 1) contribute to the biodiversity in a city and 2) can an overview of the biodiversity be developed using Citizen Science?

To answer these questions, a year-round research was carried out in 2017, in which volunteers and experts from Wageningen Environmental Research developed an overview of the biodiversity of the Tiny Forests plots each month. The results of this year-round research will be presented in this report. The Tiny Forests plots in the municipality of Zaanstad are the first in the world to be the subject of a year-round investigation of the different groups of fauna and vegetation.

The research shows that both the *Gouwse Bos* and the *Groene Woud* increase the biodiversity, compared to the nearby forest. Both the number of species groups and the number of individuals is generally higher than in the reference forests. There is no substantial difference in numbers between the *Gouwse Bos* and the *Groene Woud*. However, a difference can be observed on the basis of ecological species/species groups. In short, both Tiny Forests contribute to the biodiversity in the Darwin Park.

This research has shown that, by using Citizen Science, the biodiversity can be mapped out at a high level of aggregation. However, a side note is that a large group of volunteers is needed in order to ensure a sufficient monitoring intensity. In addition, the (taxonomic) knowledge of the observers determines the level of detail with which the monitoring can take place. A systematic count of species groups was possible at a high level of aggregation (class, order, family), but counts on species level are more difficult to perform. For many species groups, this requires more training and facilities, and the feasibility depends on the interest, specialisation, and skills of the volunteers. In addition, interchangeability of experts is important to ensure the continuity of the monitoring.

1 Introduction

All kinds of organisms, such as plants and animals, perform (ecosystem) services for our society. When the biodiversity decreases or species become less vital, this eventually also affects our chances of survival. According to the Stockholm Resilience Centre, biodiversity loss is the greatest threat to the viability of our Earth, more so than climate change (Rockström et al. 2009). In short, there is an urgency to maintain the biodiversity in our living environment at sufficient levels, starting with species that are currently threatened with extinction (Red List species). In addition, it is also important to prevent species that are still common from seeing their numbers reduced and to enable people to experience this biodiversity, so that they continue to see the value of it. The WWF "Living Planet Report" (World Wildlife Fund 2015) for the Netherlands stated that terrestrial biodiversity is still decreasing. The same goes for urban areas.

The Tiny Forest project, also referred to as the small wilderness or urban forests (Bleichrodt et al. 2017), stems from a societal initiative that emerged on the implementation agenda for natural visions (now: Second Nature programme) in 2016. The purpose of the construction of a Tiny Forest is to halt the loss of biodiversity in urban areas. Another recognised problem is that people in urban areas are increasingly distanced from nature and are therefore difficult to involve in nature. The same goes for young people.

In Zaanstad, the first Dutch and European Tiny Forest, called *Groene Woud*, has been constructed in accordance with the principles of Shubhendu Sharma. According to this principle, Tiny Forests are dense mini forests in urban areas, in which up to 40 native tree species have been planted with a total of approximately 600 trees. To accelerate their development, the bottom has been modified with biomass (wood chips and straw).

In addition, a second Tiny Forest, called *Gouwse Bos*, has been constructed in the style of Zaanstad. This means that here, not only were trees planted, but also fruit-bearing shrubs and plants. The soil here was not modified with biomass. Both lots are approximately 250 m² in size.

To (further) substantiate the policy relevance, Wageningen Environmental Research (WENR) performed research on this initiative. The research was carried out by experts of WENR in cooperation with IVN Netherlands, with which the intention was to make use of volunteers (Citizen Science) and to make the applied research approach easily transferable. This project investigated:

1. Does a Tiny Forest provide biodiversity?
2. Can an overview of the biodiversity be developed using Citizen Science?

The monitoring of the biodiversity was carried out by professionals and volunteers in order to get insight into what biodiversity this type of Tiny Forests currently brings as well as to bring citizens in their immediate environment in touch with nature. By contributing to the monitoring, they experience the ecological values of the Tiny forests more directly. This experience aligns with the mission of IVN Netherlands which is to bring nature in the hearts of people, so that they start taking better care of it. Experiencing nature is educational and fun, and necessary in order to understand the importance of its preservation. Creating a small piece of wilderness in the city establishes a place for young and old to jointly discover nature and learn to love it.

The ultimate goal is to create 100 Tiny Forests in the Netherlands, which are expected to be achieved in stages. In order to monitor these as well, the experiences in this study were used to develop a method to work with volunteers to monitor biodiversity. This method makes it possible to let volunteers and secondary school students undertake inventories of biodiversity. The two Tiny Forests in Zaanstad are the first in the world that have been monitored year-round on the prevalence of biodiversity.

2 Research location

The two Tiny Forests are located at the Twiskeweg in the Darwin Park of the Municipality of Zaanstad (Figure 1). The first plot, called *Groene Woud*, has been arranged completely in accordance with the principles of Shubhendu Sharma (Bleichrodt et al. 2017). The second plot deviated from this and here, the municipality of Zaanstad has chosen to not only plant native trees, but also fruit-bearing shrubs, partly in the form of a Zeeland hedge, and one- and two-year-old plants (source: *Het Gouwse Bosje. Een bosje voor vogels door vogels*. A publication by the Municipality of Zaanstad). Both Tiny Forests are provided with a French fence in order to keep dogs away during the investigation (Figure 2).

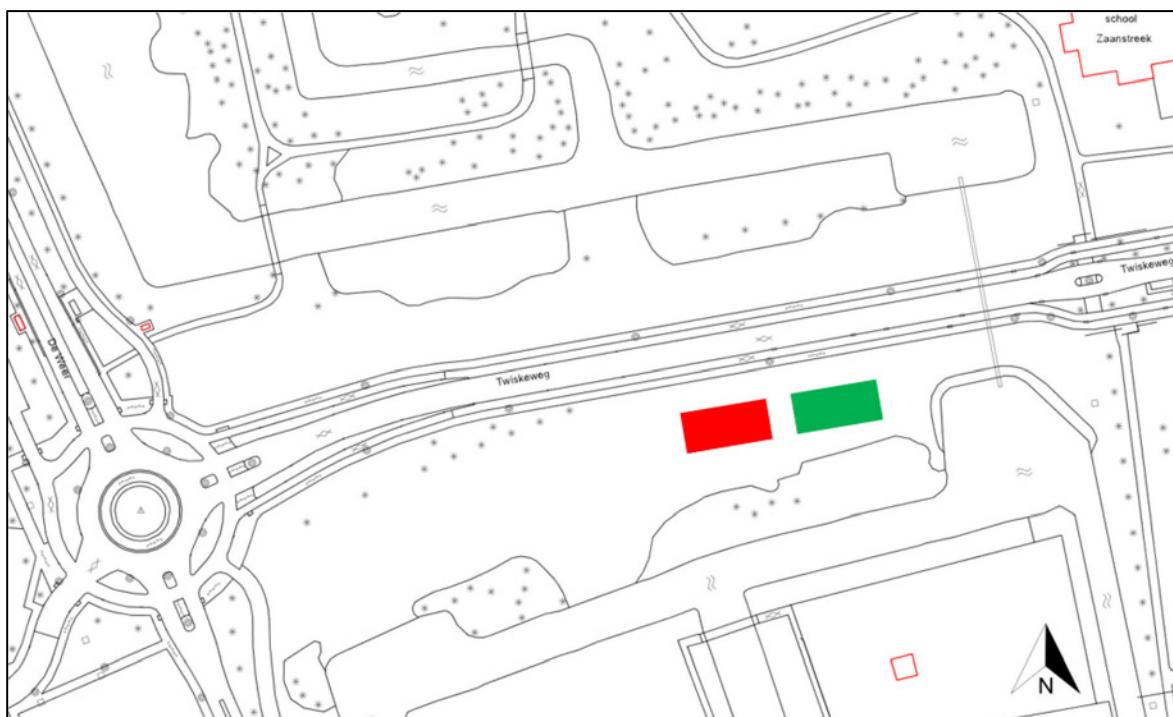


Figure 1 Location of the two Tiny Forests along the Twiskeweg in Zaanstad. Green is the *Groene Woud* and Red is the *Gouwse Bos*.



Figure 2 Dog owner is taking her dog for a stroll along the fence of the *Gouwse Bos*.

In the *Groene Woud*, 36 native tree species have been planted, amounting to a total of 600 trees (Table 1). In the Gouwse Bos, 16 shrub and tree species have been planted, amounting to a total of 583 shrubs and trees. In addition, 12 species of plants have been sown (Table 2).

Table 1 Tree types and quantities that have been planted in the *Groene Woud*.

No.	Scientific name	English name	Number
1	<i>Salix triandra</i>	Almond willow or almond-leaved willow	12
2	<i>Salix daphnoides</i>	European violet willow	12
3	<i>Fagus sylvatica</i>	Beech	24
4	<i>Salix purpurea</i>	Purple willow or purple osier	12
5	<i>Salix caprea</i>	Goat willow, pussy willow, or great sallow	12
6	<i>Fraxinus excelsior</i>	Ash	24
7	<i>Salix aurita</i>	Eared willow	6
8	<i>Salix cinerea</i>	Grey willow or grey sallow	6
9	<i>Carpinus betulus</i>	Hornbeam	6
10	<i>Ilex aquifolium</i>	Holly	12
11	<i>Salix viminalis</i>	Osier or common osier	12
12	<i>Salix fragilis</i>	Crack willow or brittle willow	6
13	<i>Salix pentandra</i>	Bay willow	12
14	<i>Mespilus germanica</i>	Medlar or common medlar	12
15	<i>Populus tremula</i>	Aspen tree or trembling poplar	48
16	<i>Betula pendula</i>	Silver birch or warty birch	6
17	<i>Ulmus glabra</i>	Wych elm, Scotch elm, or Scots elm	48
18	<i>Salix alba</i>	White willow	48
19	<i>Rhamnus frangula</i>	Alder buckthorn	6
20	<i>Ulmus laevis</i>	European white elm, fluttering elm, spreading elm, or stately elm	48
21	<i>Taxus baccata</i>	Yew tree	12
22	<i>Acer campestre</i>	Field maple	12
23	<i>Crataegus laevigata</i>	Midland hawthorn, English hawthorn, woodland hawthorn, or mayflower	12
24	<i>Rhamnus catharticus</i>	Buckthorn, common buckthorn, or purging buckthorn	6
25	<i>Malus sylvestris</i>	European crab apple	12
26	<i>Pyrus communis</i>	European pear or common pear	18
27	<i>Sorbus aucuparia</i>	Rowan or mountain-ash	18
28	<i>Quercus petraea</i>	Sessile oak	24
29	<i>Tilia cordata</i>	Small-leaved lime, small-leaved linden, or little-leaf linden	6
30	<i>Alnus sindicana</i>	Grey alder or speckled alder	6
31	<i>Betula pubescens</i>	Downy birch	6
32	<i>Prunus avium</i>	Wild cherry, sweet cherry, or bird cherry, or gean	12
33	<i>Quercus robur</i>	Common oak, pedunculate oak, European oak, or English oak	24
34	<i>Tilia platyphyllos</i>	Large-leaved linden	6
35	<i>Alnus glutinosa</i>	Black alder	6
36	<i>Populus nigra</i>	Black poplar	48

Table2 Fruit-bearing shrubs and tree species that have been planted in the Gouwse Bos and the amount of one- and two-year-old plants that have been sown.

No.	Scientific name	English name	Amount and gram
1	<i>Crataegus monogyna</i>	Common hawthorn or single-seeded hawthorn	189
2	<i>Hippophae rhamnoides</i>	Common sea buckthorn	9
3	<i>Ligustrum vulgare</i>	Privet	15
4	<i>Sorbus aucuparia</i>	Rowan or mountain-ash	9
5	<i>Viburnum opulus</i>	Guelder rose	9
6	<i>Rosa rugosa</i>	Rugosa rose, Japanese rose, or Ramanas rose	125
7	<i>Rhamnus frangula</i>	Alder buckthorn	5
8	<i>Rosa rubiginosa</i>	Sweet briar rose or eglantine	9
9	<i>Rubus fructicosus</i>	Bramble or European blackberry	15
10	<i>Euonymus europaeus</i>	Spindle, European spindle, or common spindle	9
11	<i>Malus "Red Sentinel"</i>	Crab apple	9
12	<i>Prunus spinosa</i>	Blackthorn or sloe*	60
13	<i>Acer campestre</i>	Field Maple*	60
14	<i>Rosa canina</i>	Dog rose*	20
15	<i>Sambucus nigra</i>	Black elder, common elder, or European elderberry	20
16	<i>Rubus ulmifolius</i>	Elmleaf blackberry or thornless blackberry	20
17	<i>Avena sativa</i>	Oat	5 grams
18	<i>Daucus carota</i>	Wild carrot, bird's nest, or bishop's lace	10 grams
19	<i>Dipsacus fullonum</i>	Fuller's teasel or wild teasel	10 grams
20	<i>Fagopyrum esculentum</i>	Buckwheat	5 grams
21	<i>Helianthus annuus</i>	Common sunflower	15 grams
22	<i>Linum usitatissimum</i>	Common flax or linseed	5 grams
23	<i>Oenothera biennis</i>	Common evening-primrose, evening star, or sun drop	5 grams
24	<i>Panicum miliaceum</i>	Millet	10 grams
25	<i>Tragopogon porrifolius</i>	Purple or common salsify, oyster plant, vegetable oyster, or Jerusalem star	5 grams
26	<i>Verbascum phlomoides</i>	Orange mullein or woolly mullein	1 gram
27	<i>Onopordum acanthium</i>	Cotton thistle or Scotch thistle	20 grams
28	<i>Echium vulgare</i>	Viper's bugloss or blueweed	10 grams

*: species that are part of the Zeeland hedge.

The following three pages display a photo impression of both Tiny Forests in Zaanstad. A picture was taken each month in 2017. The *Gouwse Bos* is pictured on the left and the *Groene Woud* on the right.



28 January 2017



19 February 2017



20 March 2017



26 April 2017



4 May 2017



19 June 2017



6 July 2017



1 August 2017



28 September 2017



4 October 2017



8 November 2017



4 December 2017

3 Method of monitoring

For the research design, a pragmatic approach was chosen, with which volunteers could get started. What did we do?

Soil

With regard to the soil, at three points during the year in which the research was conducted, soil samples were taken from three replicas of two locations and then analysed for the presence of bacteria and fungi. Additionally, the carbon sequestration in the soil was recorded. This part was done by professionals of WENR.

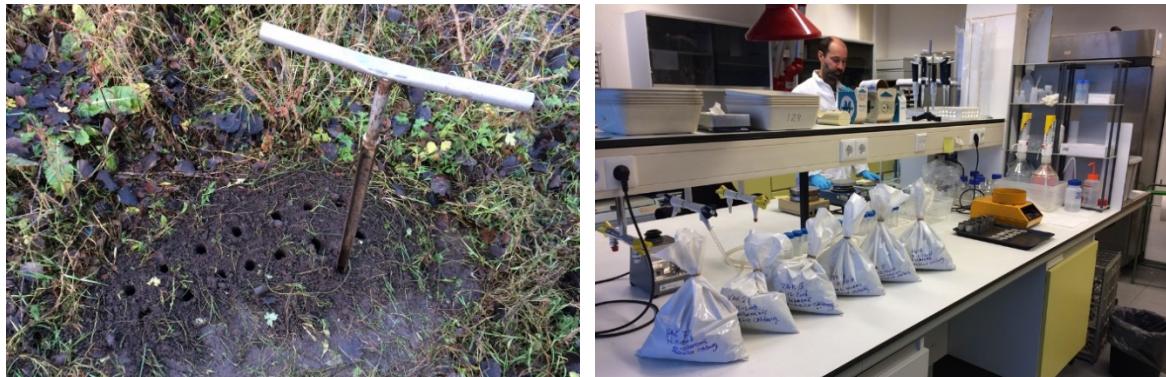


Figure 3 Taking soil samples on site and processing the soil samples in the laboratory.

Trees and plants

The tree and shrub layer were not mapped, because it became apparent in practice that there was hardly any new growth and mortality. The time frame of the monitoring (one year) insufficiently justifies developing a picture of this in general, and certainly not monthly.

However, an inventory of the herbaceous layer and the number of flowering plants species per round was taken.

Soil fauna by carpet tiles

An overview of the soil fauna was developed through the use of fifteen carpet tiles in measurement lines of three per Tiny Forest and ten laid out carpet tiles in measurement lines of two in the two reference plots, amounting to a total of fifty carpet tiles. All fauna were noted, including those that do not fall under the category of soil fauna, such as amphibians and mammals (mice), but that were observed under the carpet tiles. In addition, the rest of the fauna, such as pollinators, flies, fungi, and beetles were mapped out on the basis of what a person saw as they walked from one tile to another.



Figure 4 One of the carpet tiles under which black garden ants (*Lasius niger*) were often found.

The most important rule here is that fauna was only noted if it was situated on the soil or on the vegetation and if it was clearly visible when the fauna forages on the vegetation within the French fences. To illustrate: honey bees foraging on the flowering apple trees, but which are not on the tree itself.



Figure 5 The blackbird (*Turdus merula*) is located just outside Tiny Forest Gouwse Bos and is therefore not counted.

Songbirds

For fifteen minutes before the start of each monitoring round, both Tiny Forest plots were inventoried on the presence of birds within the boundary of the French fencing. Up until March, the birds could be observed from a single point as it was still possible to see through the vegetation (shrubs and trees were not yet flowering that much). From April on, halfway through the monitoring period, a walk around the Tiny Forest took place in order to also spot any possible birds that were present on the other side of the forest. To get a picture of the bird species and numbers present, inventory rounds were performed as well in the Darwin Park. This cannot be compared one-on-one with the method used in the two Tiny Forest plots, but as mentioned, it gives an impression of what bird species are present and in what numbers.

4 Results

4.1 Soil

Bacteria and fungi are the basis of the food web in the soil. They are very small (1/1000 mm diameter), but very numerous – up to a billion bacteria in a teaspoon of soil – and form the largest part (2/3) of life in the soil. They convert dead material into humus and minerals, sequester carbon in the soil, and provide sustenance for the plants. They also produce mucus which causes soil particles to stick to each other to form a good crumbly structure. Crumbs are further held together by networks of hyphae. In crumbs (aggregates), carbon and water are retained, while between the crumbs, water can better seep through (favourable when there is excessive rainfall). Some fungi (*mycorrhiza*) grow on plant roots and help with the absorption of nutrients and water (convenient in case of drought).

Because fungi and bacteria quickly respond to changes in the environment, they are used as “early” indicator for changes in soil quality. Micro-organisms and unstable (easily biodegradable) organic matter can already change in a couple of years, while it can take up to ten years before the total organic-matter content in the soil changes measurably after a change in land use.

Bacteria and fungi are measured with a microscope after they have been coloured in order to distinguish them from soil particles. After 16 hours of extraction in water at 80°C, unstable organic carbon can be measured as hot water extractable carbon (HWC). HWC consists approximately 50% of mucus from micro-organisms (polysaccharides). It is a small, unstable group that changes faster than the much larger quantity of total organic matter in the soil. In the Tiny Forests, these indicators were measured in soil samples (0-10 cm depth) in December 2016, May 2017, and September 2017.

In December and May, the amounts of fungi and HWC were considerably higher in the *Groene Woud* than in the *Gouwse Bos* (Figure 6). However, the ratios were reversed in September. The same goes for the moisture level of the soil (not shown). There was a strong correlation of moisture level with the amount of hyphae ($r^2 0.86$) and with the HWC ($r^2 0.63$). The amounts of bacteria were fairly constant.

On average, the biomass of fungi and bacteria, expressed in micrograms of carbon (C) per gram of soil, was comparable with the quantities measured in mixed forests on sandy soil in the *Landelijk Meetnet Bodemkwaliteit* (national soil quality monitoring network) (Table 3). The percentage of active fungi, measured by colouring nucleic acids, and the ratio between fungal and bacterial biomass are also comparable. Thus, within a short period of time, soil in the Tiny Forests was developed which match the quantities of fungi and bacteria of that in mature forests.

Table 3 Tiny Forests compared to 10 forests on sand, Soil-organic Indicator in national monitoring network (Rutgers et al. 2007).

	Biomass of fungi (μ C/g)	Active fungi (%)	Biomass of bacteria (μ g C/g)	Fungi/bacteria ratio
<i>Groene Woud</i>	113	1.7	26	4.5
<i>Gouwse Bos</i>	94	2.8	24	3.9
Mixed forest on sand	119	5.9	28	5.2
Bobi 2007				

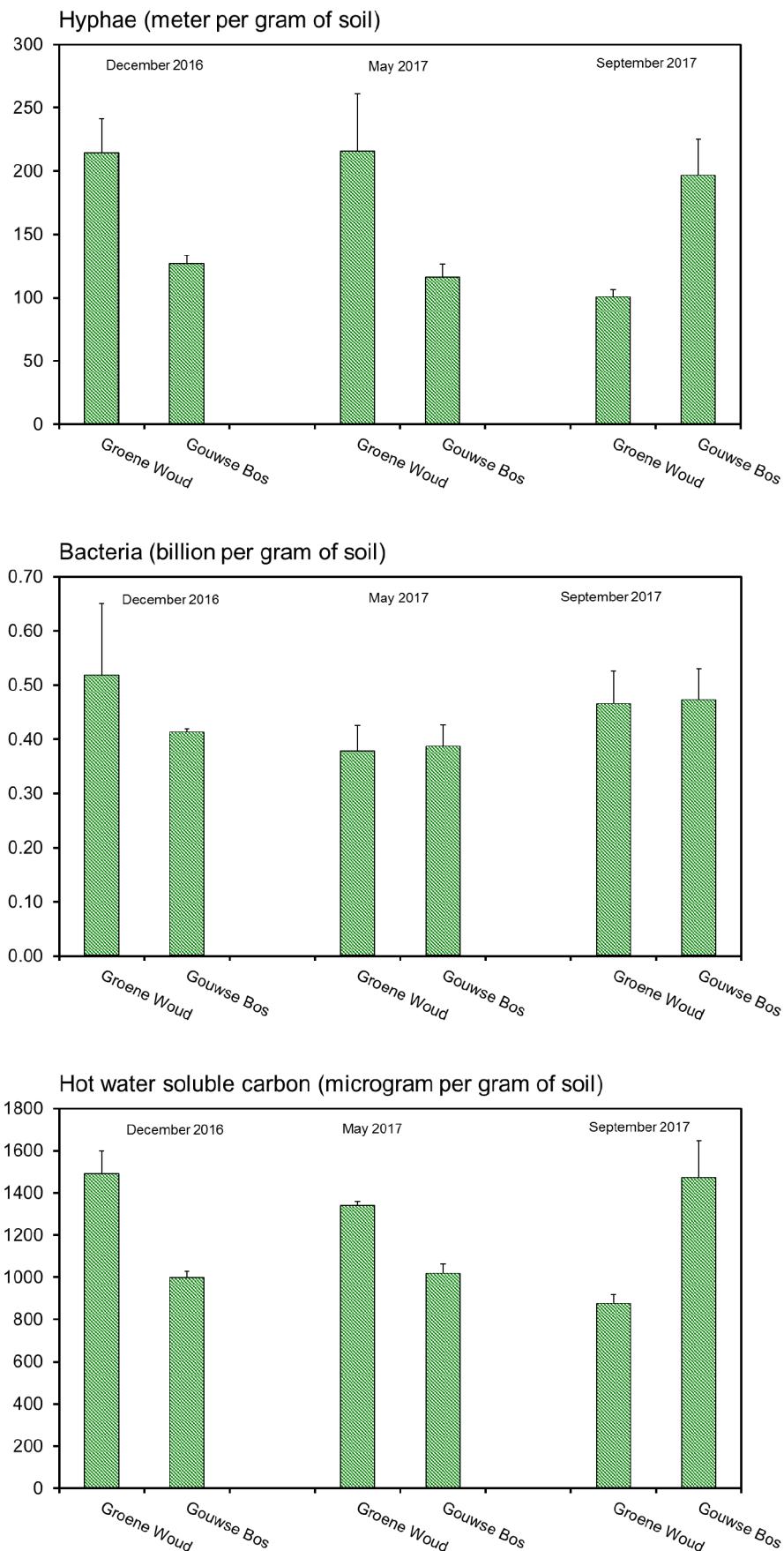


Figure 6 Quantities of fungi, bacteria, and hot water extractable carbon (HWC) in the Groene Woud and the Gouwse Bos in December 2016, May 2017, and September 2017. Error bars represent the standard error of three repetitions.

4.2 Biodiversity

In total, 43,441 fauna individuals were observed, of which 18,533 in the *Gouwse Bos*, 18,357 in the *Groene Woud*, 4,825 in the reference plot of the *Gouwse Bos* and 1,726 in the reference plot of the *Groene Woud* (Figure 7 and Table 4). The largest share was represented by the presence of ants. If it has been omitted (Figure 8), then the following numbers were observed: 4,885 animals in the *Gouwse Bos*, 3,569 animals in the *Groene Woud*, 1,325 animals in the reference plot of the *Gouwse Bos*, and 1,726 animals in the reference plot of the *Groene Woud*. Appendix 1 provides an overview of the individuals that have been classified up to the species. A total of 176 species were observed, spread over 30 groups.

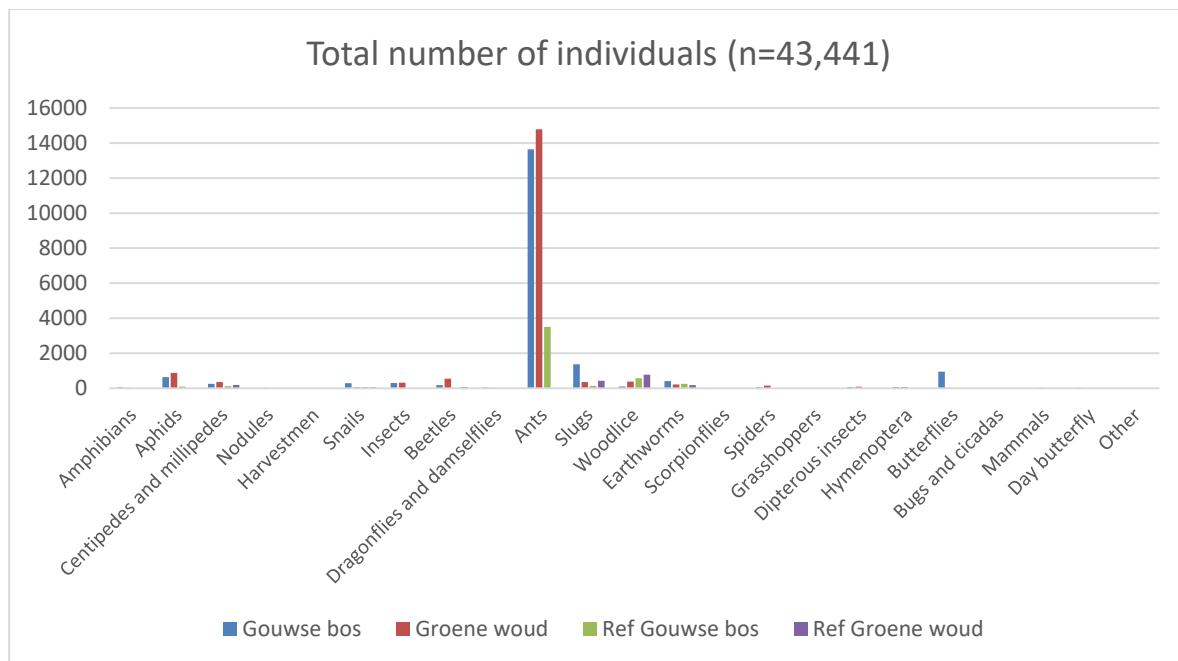


Figure 7 Total number of individuals for the locations *Gouwse Bos*, *Groene Woud*, and the two reference plots.

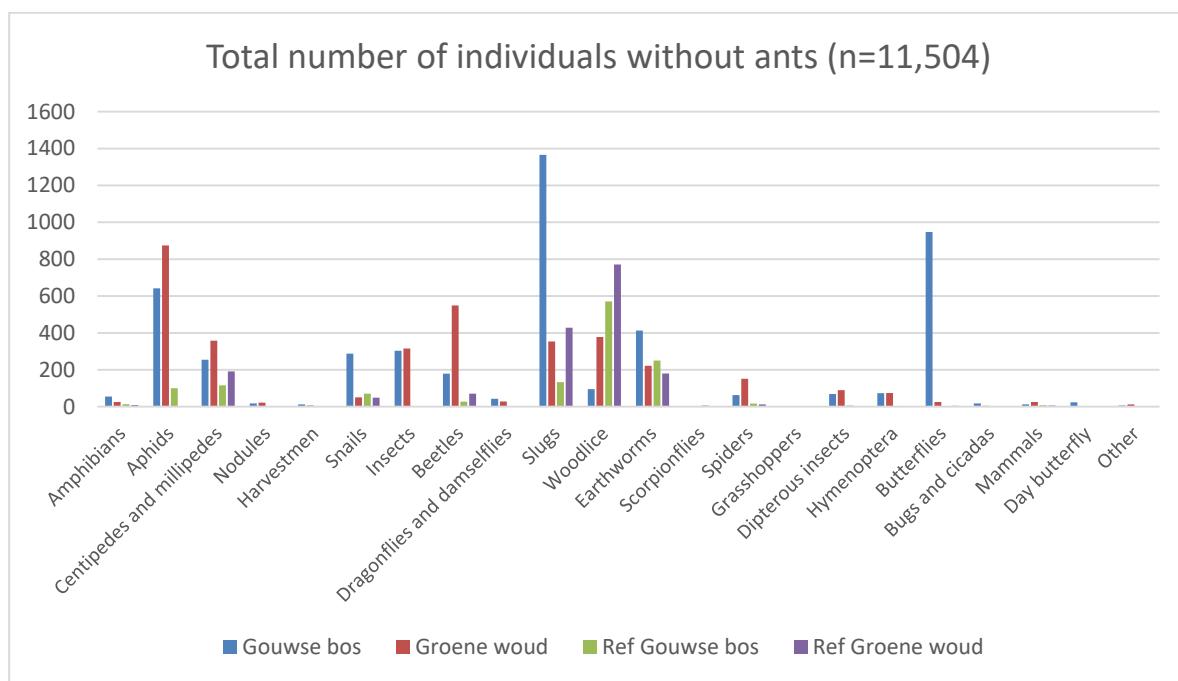
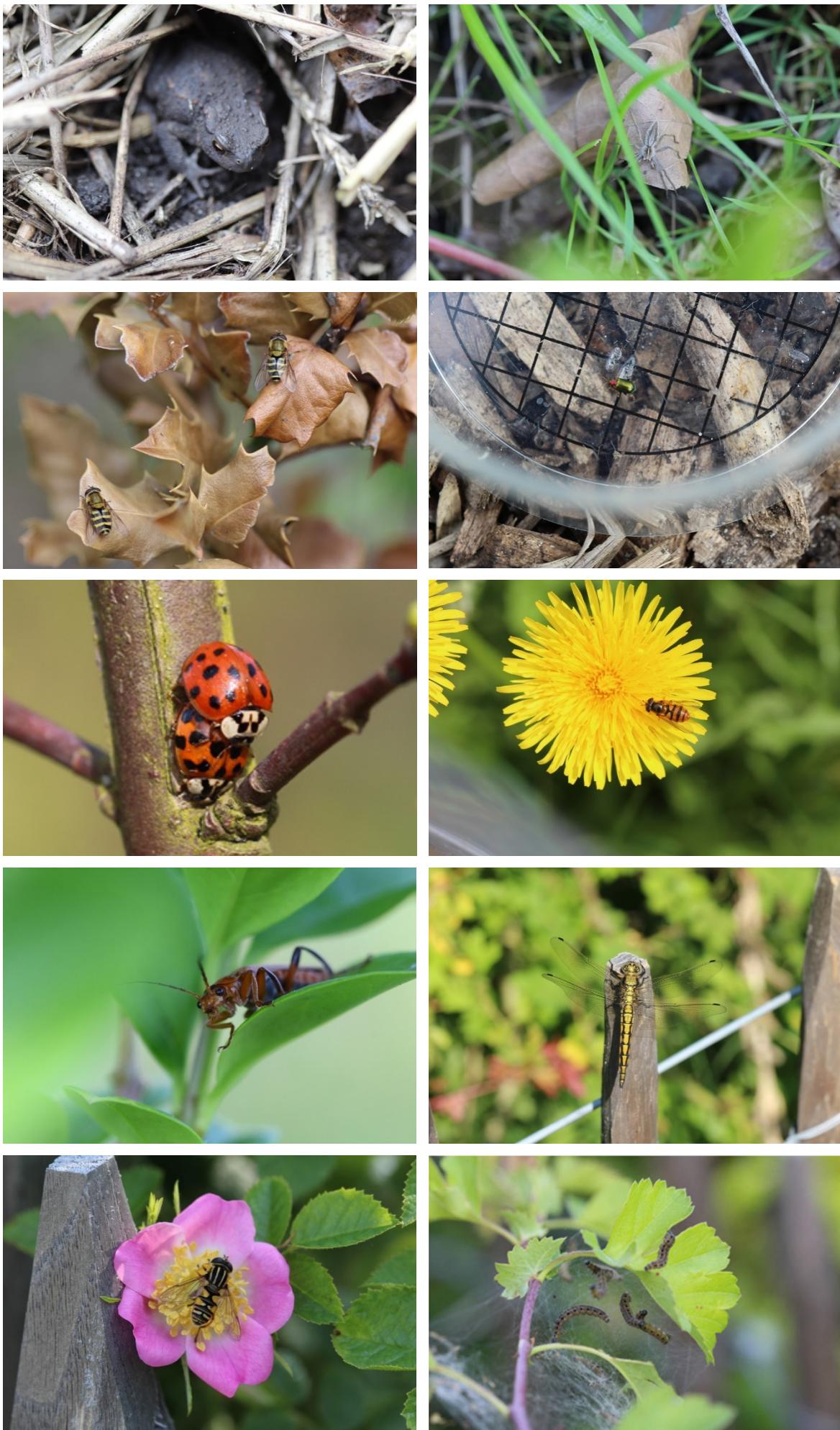


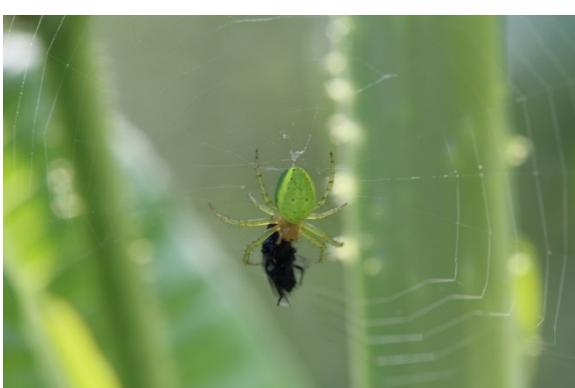
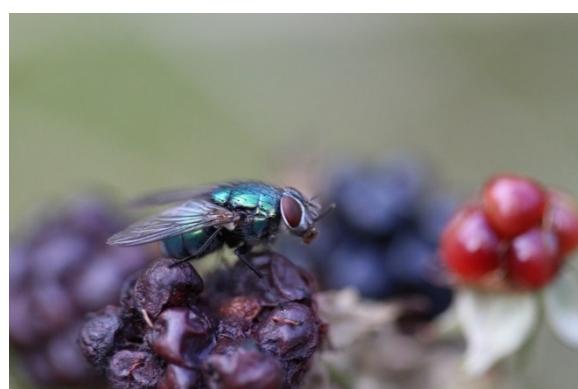
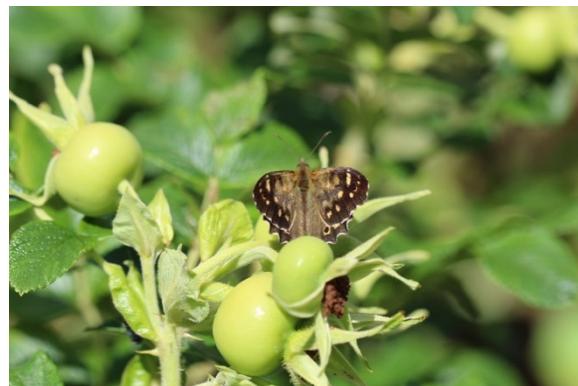
Figure 8 Total number of individuals for the locations *Gouwse Bos*, *Groene Woud*, and the two reference plots without ants.

Table 4 Total number of individuals for the locations Gouwse Bos, Groene Woud, and the two reference plots.

Groups of species	Gouwse Bos	Groene Woud	Ref Gouwse Bos	Ref Groene Woud
Amphibians	55	25	13	9
Aphids	642	874	100	0
Centipedes and millipedes	255	358	116	191
Nodules	18	22	0	0
Harvestmen	12	6	1	0
Snails	288	51	71	49
Insects	303	289	0	0
Beetles	179	549	27	71
Dragonflies and damselflies	43	28	0	0
Ants	13,648	14,789	3,500	0
Slugs	1,366	354	133	428
Woodlice	95	378	571	771
Earthworms	413	222	250	180
Scorpionfly	3	1	7	0
Spiders	63	151	17	12
Grasshoppers	1	3	0	0
Dipterous insect	69	90	6	2
Hymenoptera	73	74	4	0
Butterflies	947	25	1	5
Bugs and cicadas	18	5	0	0
Mammals	12	25	8	6
Day butterfly	24	0	0	0
Other	6	12	0	2

The next two pages give a photo impression of some of the many species that were found in the Gouwse Bos (GB) and Groene Woud (GW). From left to right and from top to bottom it concerns: common toad (*Bufo bufo*) GW, nursery web spider (*Pisaura mirabilis*) GB, common banded hoverfly (*Syrphus ribesii*) GB, willow flea beetle (*Crepidodera aurata*) GB, Asian ladybeetle (*Harmonia axyridis*) GB, hoverfly (*Eupeodes corollae*) GW, blue bottle fly (*Cantharis calliphora livida*) GB, black-tailed skimmer (*Orthetrum cancellatum*) GB, marsh hoverfly (*Helophilus pendulus*) GB, orchard ermine (*Yponomeuta padella*) GB, flesh fly (*Sarcophaga carnaria*) GB, marmalade hoverfly (*Episyrphus balteatus*) GB, green emerald damselfly (*Chalcolestes viridis*) GB, speckled wood (*Pararge aegeria*) GB, St. Mark's fly (*Bibio marci*) GB, stone centipede (*Lithobius forficatus*) GB, Diplocarpon rosea (*Diplocarpon rosea*) GB, common green bottle fly (*Lucilia cf. sericata*) GB, cucumber green spider (*Araniella cucurbitina*) GB, and field buff snail killer (*Tetanocera elata*) GB.





If one looks at the distribution of the number of individuals over the months during which the monitoring took place, then one would see that the highest numbers are found in the months of April to July (Figure 9 and Table 5). In August, September, and October, four monitoring rounds took place, as opposed to June and July, in which three monitoring rounds were carried out. In Figure 9 and Table 5, the numbers have been adjusted for the monitoring intensity.

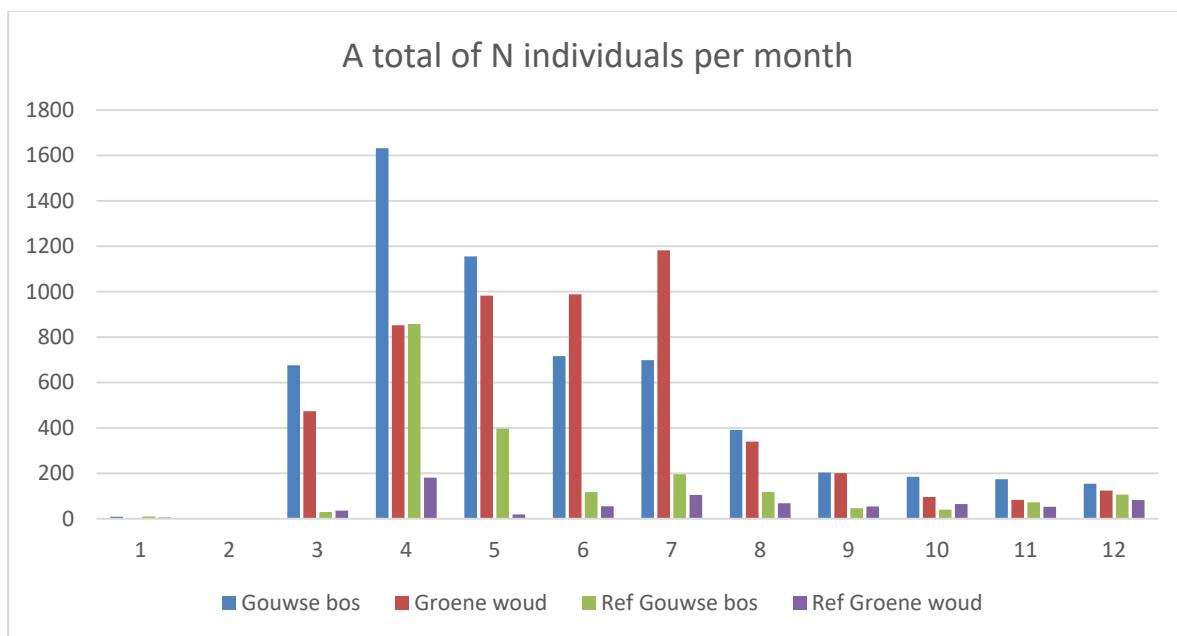


Figure 9 Total number of individuals observed per month in the Gouwse Bos, Groene Woud, and the two reference plots. The figure has been adjusted for the monitoring intensity.

Table 5 Total number of individuals observed per month in the Gouwse Bos, Groene Woud, and the two reference plots. The table has been adjusted for the monitoring intensity.

Forest/months	1	2	3	4	5	6	7	8	9	10	11	12
Gouwse Bos	9		75	International Development Studies (MID)	1,155	716	698	391	204	185	174	154.5
Groene Woud	3		474		852	983	988	1,182	340	201	96	83
Ref Gouwse Bos	10		30		858	397	118	196	118	46.3	40	73
Ref Groene Woud	6		36		181	19.3	55.3	105	68.7	54.5	65	53
Total per month	28		1,216		3,523	2,554	1,877	2,182	918	506	385	383
												467.5

The monitoring started with 12 volunteers and the setup was that every month, starting from the field introduction April, in groups of 2 people (so basically 6 groups) each group would carry out one observation round. More frequently was also allowed, of course. Due to illness, one of the volunteers quit prematurely, as a result of which the number of groups went down from six to five.

In theory, one would thus expect five observation sets each month from April on. With the observation round of the authors added, that makes six in total. In other words: from April to December, all bars in Figure 10 should ideally end at line six. Although volunteer work is not entirely without obligation, people feel that there is no obligation attached to it and this is then also reflected in the figure. Not all groups went each month and practice showed that two groups (always the same) have gone all months and one group (also always the same) has gone almost all months. The observation peak in the month of May is caused by the television recording of *Vara's Vroege Vogels* (Vara's early birds) and extra introduction rounds with the volunteers, due to which, in addition to the usual rounds, additional rounds took place on the day of the recordings.

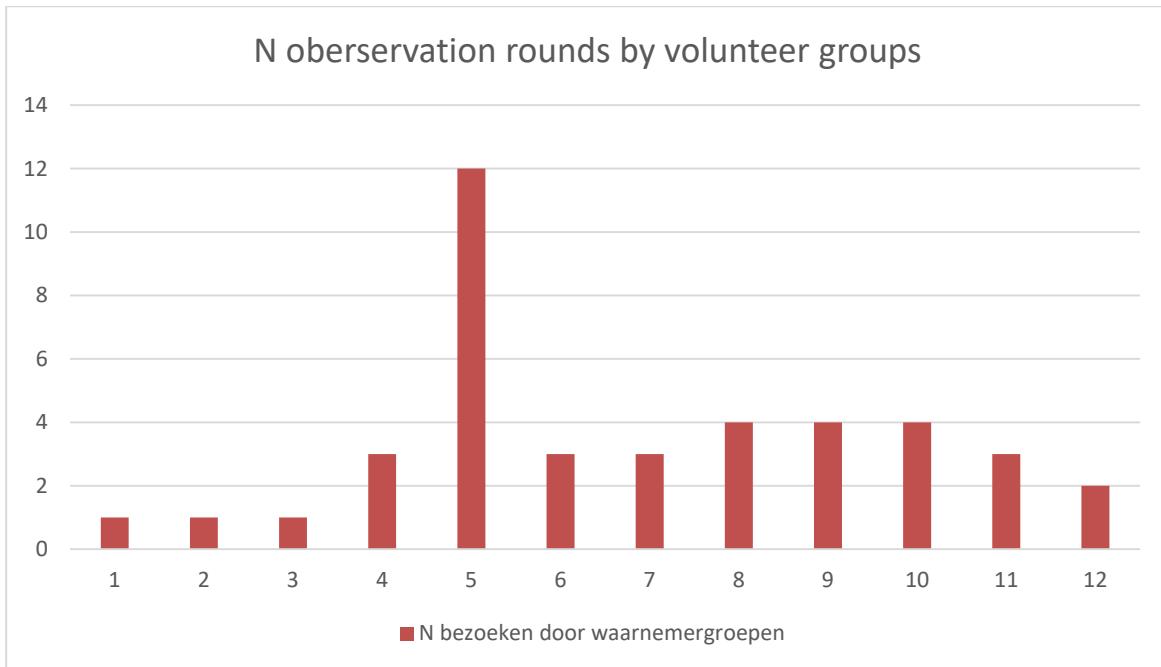


Figure 10 Number of observation rounds of the volunteers per month, including the rounds of the WENR researchers.



Figure 11 Volunteers during the monitoring of the Tiny Forests in Zaanstad.

During the monitoring rounds, the number of flowering plant species was also focused on by the researchers, in order to get an impression of which one of the two Tiny Forests had food available for pollinators and whether or not this differed among them. No flowering plants were observed for the first three months. For such a young Tiny Forest that is still in the starting phase, this is not strange. As the season continued, more flowering plants species were found, with the *Gouwse Bos* having the higher numbers.



Figure 12 Number of flowering plant species observed by WENR in the *Gouwse Bos* and *Groene Woud* per monitoring round.

Regarding the *Gouwse Bos*, the following species are no longer are found in relation to the plants that were sown (Table 2): oats, buckwheat, sunflower, flax, millet, common salsify, orange mullein, and cotton thistle. This is primarily the result of the further development of this Tiny Forest and the fact that the species which disappeared could not persevere in the dense structure.



Figure 13 Wild teasel (*Dipsacus fullonum*) in the *Gouwse Bos* on the left and silverweed (*Argentina anserina*) in the *Groene Woud* on the right.

While pollinators haven been found in both Tiny Forests, a greater variety of pollinators could be found in the *Gouwse Bos* (Figure 14). If one would carefully look at both Tiny Forests, then this is not very remarkable. The *Gouwse Bos* reflects much more of a so called “mantel-zoom” structure (with a clear delineation of the borders of the forest) in terms of layering (construction) of herbs, shrubs, and trees than the *Groene Woud*. The latter is mainly an up and coming young forest, in which no layer of herbs has been inserted. In contrast, this was done in the *Gouwse Bos* by sowing an herbal mixture: with species such as wild teasel, wild carrot, orange mullein, common salsify, and cotton thistle, suitable food plants for pollinators are present. The diversity of stratification and structure ensures a diversity of microclimate with windless, warm, and hotspots with sufficient sun exposure in the *Gouwse Bos*. A similar picture can also be seen in the presence of snails and amphibians (Figure 15). Also, here, the variation of structure and vegetation ensures that diversity is present for these species.

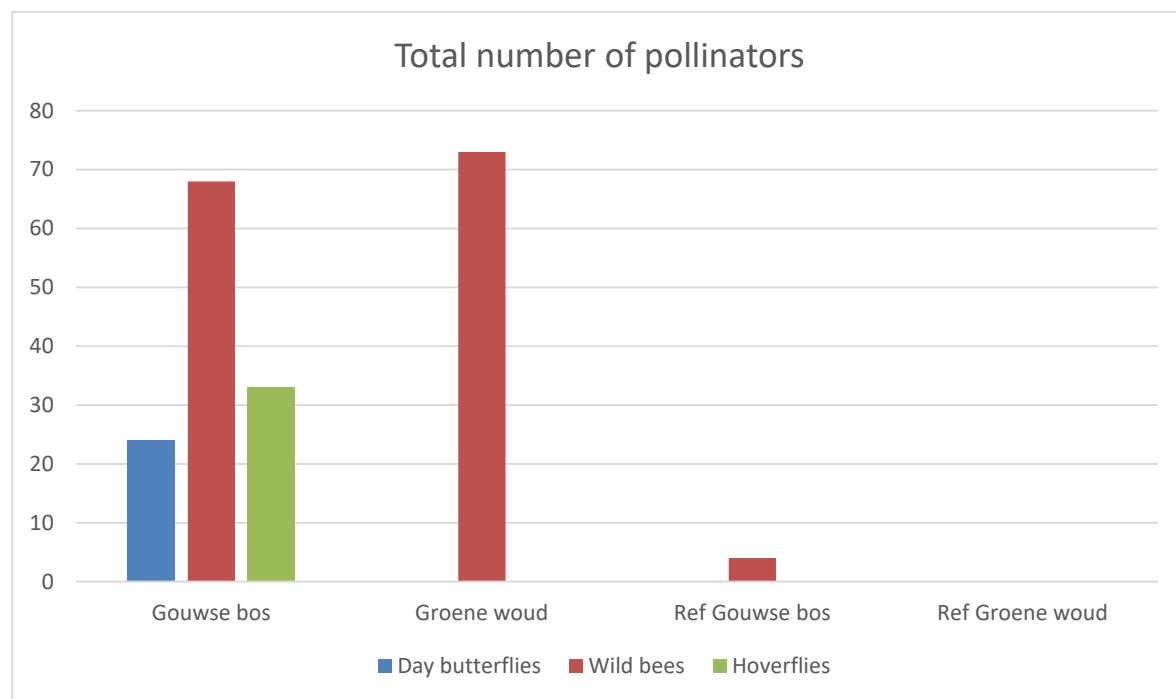


Figure 14 Total number of pollinators in the *Gouwse Bos*, *Groene Woud*, and the two reference plots.

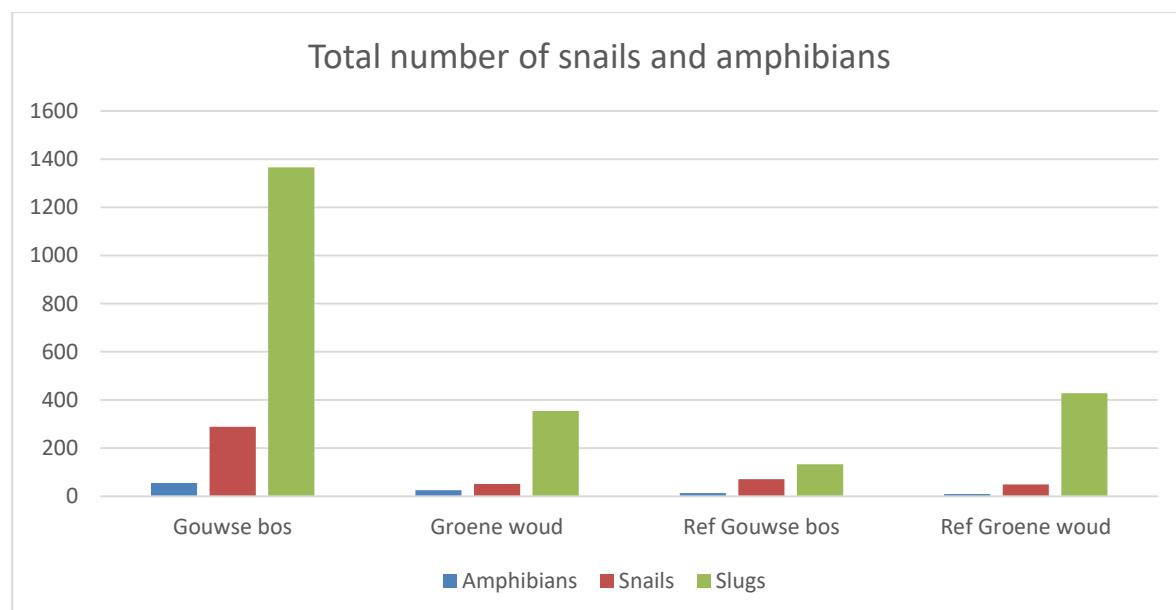


Figure 15 Total number of snails and amphibians in the *Gouwse Bos*, *Groene Woud*, and the two reference plots.



Figure 16 During the investigation, several types of slugs were found, such as the Dusky Arion (*Arion fuscus*), which is pictured here.

In contrast to the pollinators, amphibians, and snails, we observe an inversely proportional image with the beetles and spiders. Both of these groups are much more observed in the *Groene Woud* than in the *Gouwse Bos* or the two reference plots. This most likely has to do with the landscaped path of wood chips and straw in the *Groene Woud*, allowing for a favourably warm structure to be present for beetles and spiders, in which the animals can hide quickly and can find sufficient food. As the *Groene Woud* grows older and the undergrowth shows more similarity with both of the reference plots, the share of both groups of species will also decrease.

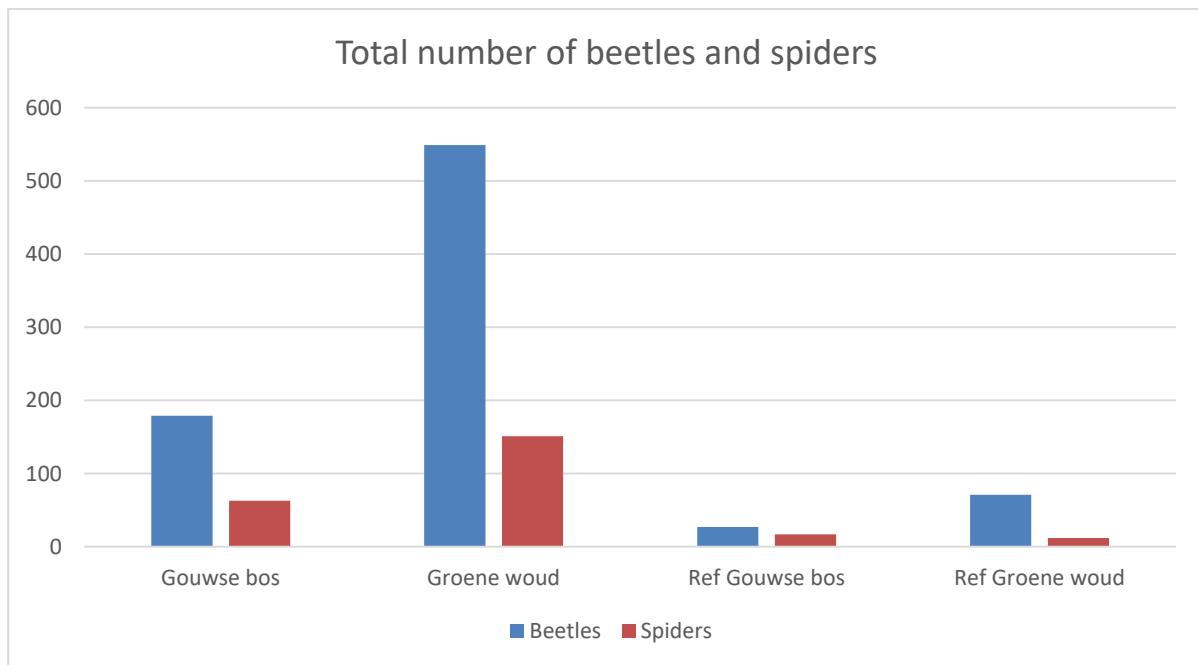


Figure 17 Total number of beetles and spiders in the *Gouwse Bos*, *Groene Woud*, and the two reference plots.

In the Gouwse Bos, a total of 41 birds, divided over 7 bird species, has been observed and in the Groene Woud, 28 birds have been spotted, divided over 7 bird species as well (Figure 18 and Table 6). To get insight into the types of birds in the Darwin Park and with that, the potential for both Tiny Forests, 4 inventory rounds took place in the Darwin park. This was done on 4 April 2017, 19 April 2017, 11 May 2017, and 23 May 2017 (Figure 21 up to and including Figure 24). The fact that the number of species and the quantities in the Darwin Park are higher, is self-explanatory. The scale, as well as the presence of various partial habitats such as water, thickets, forest edge, and forest resources also influence this. In the Darwin Park, 27 species were observed. Of the species in Table 7 (birds in the Darwin Park), 7 species were also observed in both Tiny Forests. In addition, in the Darwin Park, there are 14 species (with the exception of aquatic birds) that potentially could have been seen in the *Gouwse Bos* and *Groene Woud*. Three species were observed in the Tiny Forests, but not in the Darwin Park (kingfisher, European goldfinch, and long-tailed tit). The observation of European goldfinches was made in the autumn. This species also possibly occurs in the Darwin Park, but the inventory there only took place during the breeding season.

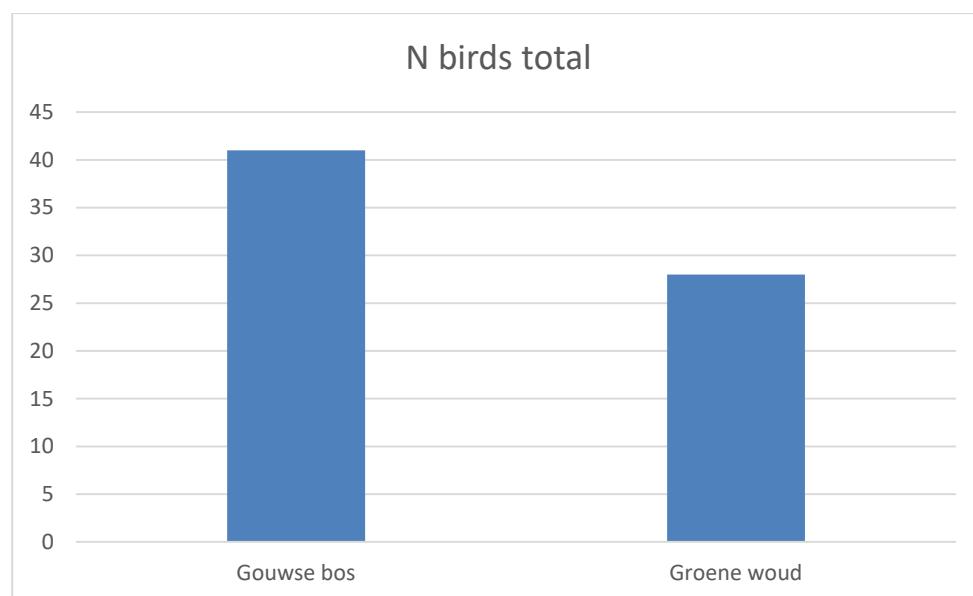


Figure 18 Number of birds in Gouwse Bos and Groene Woud.

Table 6 Observed bird species and numbers in the Gouwse Bos and the Groene Woud.

	Magpie	Wood pigeon	Blackbird	European goldfinch	Eurasian blue tit	Great tit	Long-tailed tit	Robin	Chiffchaff	Kingfisher
Gouwse Bos	1	1	6	26	0	3	0	2	2	0
Groene Woud	0	1	11	0	3	9	2	0	1	1



Figure 19 The presence of European goldfinches in the Gouwse Bos in the fall can be attributed to the dead wild teasels, which the birds forage on.



Figure 20 In the Darwin Park, common (city) birds such as the rose-ringed parakeet (*Psittacula krameri*), black-headed gulls (*Chroicocephalus ridibundus*), mallard ducks (*Anas platyrhynchos*), and the Egyptian goose (*Alopochen aegyptiaca*) were observed. The rose-ringed parakeet and Egyptian goose are non-native species.

Table 7 Bird species in the Darwin Park and abbreviations that correspond to the Figures 13-15: ¹ birds that were observed both in the Darwin Park and in the Tiny Forests; ² birds that were observed in the Darwin Park, but not in the Tiny Forests; ³ aquatic birds which are not directly expected in the Tiny Forests.

Species	Abbreviation	Species	Abbreviation
Grey heron ²	BIR	Egyptian goose ²	NGa
Short-toed tree creeper ²	BKr	Parakeet (rose-ringed) ²	PK
Magpie ¹	E	Eurasian blue tit ¹	P
Jay ²	Jay	Robin ¹	R
Great spotted woodpecker ²	GBS	Mallard duck ³	SE
Dunnock ²	HM	Starling ²	S
Wood pigeon ¹	HD	Chiffchaff ¹	Tj
House sparrow ²	H	Eurasian collared dove ²	TT
Jackdaw ²	Ka	Moorhen ³	WH
Great tit ¹	K	Mallard duck	WE
Gadwall ³	KrE	Eurasian wren ²	W
Tufted duck ³	KE	Carrion crow or black crow ²	ZKr
Common coot ³	MK	Eurasian blackcap ²	ZK
Blackbird ¹	M		



Figure 21 Result of bird inventory, round one, on 4 April 2017 in the Darwin Park. Legend from top to bottom: Built-up area, Forest, Water, Grassland, Infrastructure, Petting zoo, Tiny Forest Groene Woud en Tiny Forest Gouwse Bos.



Figure 22 Result of bird inventory, round two, on 19 April 2017 in the Darwin Park. Legend from top to bottom: Built-up area, Forest, Water, Grassland, Infrastructure, Petting zoo, Tiny Forest Groene Woud en Tiny Forest Gouwse Bos.



Figure 23 Result of bird inventory, round three, on 11 May 2017 in the Darwin Park. Legend from top to bottom: Built-up area, Forest, Water, Grassland, Infrastructure, Petting zoo, Tiny Forest Groene Woud en Tiny Forest Gouwse Bos.



Figure 24 Result of bird inventory, round four, on 23 May 2017 in the Darwin Park. Legend from top to bottom: Built-up area, Forest, Water, Grassland, Infrastructure, Petting zoo, Tiny Forest Groene Woud en Tiny Forest Gouwse Bos.

4.3 St. Michaël College in Zaandam, TV, and the Nationale Postcode Loterij

St. Michaël College Zaandam

On Monday 20 March 2017, lessons were provided to four classes at the St. Michaël College in Zaandam, in order to bring the students into contact with the Tiny Forest concept. Roughly 120 students learned what biodiversity is, how they can measure this with Citizen Science, how the data obtained can be easily sent back to IVN, and how they should design such a tool for measuring biodiversity. During the lessons, the pupils received immediate feedback from teachers and the WENR expert.



Figure 25 Impression of the lessons about Tiny Forests at the St. Michaël College in Zaandam.

Media

The Tiny Forests are regularly in the spotlight and by now, it has already appeared in regional and national newspapers, as well as on local and national TV, several times. The mention of the recordings that *Vara's Vroege Vogels* (Vara's early birds) has made on 4 May 2017 during the study was especially delightful. These recordings were broadcasted on 16 May 2017 and can be rewatched via: <https://vroegevogels.bnnvara.nl/media/373123>. The broadcast starts at minute 08:00.



Figure 26 The camera crew of *Vara's early birds* filming and interviewing the volunteers in the Groene Woud.

Nationale Postcode Loterij

Together with and in the province of North Holland, IVN Netherlands organised the Tiny Forest Conference on 7 February 2018. Here, more than 100 guests and speakers were received by Provincial Executive Adnan Tekin of the province of North Holland. In the afternoon, two presentations took place. The first was provided by Daan Bleichrodt of IVN and was about "Tiny Forest from zero to now". The second presentation was provided by Fabrice Ottburg and Dennis Lammertsma (WENR), in which the results of the research from the present report were presented. The whole thing concluded with a biodiversity market and networking reception.

During the presentation of Daan Bleichrodt, Daan was raided by a camera crew of the Nationale Postcode Loterij, led by Nicolette van Dam. On behalf of the Nationale Postcode Loterij lottery, he received a cheque with an amount of more than 1.8 million euros. This amount will be used to realise the 100 Tiny Forests in the coming years.



Figure 27 In the top picture, Provincial Executive Adnan Tekin is welcoming everyone. In the lower pictures, Daan Bleichrodt is pleasantly surprised by Nicolette van Dam with a cheque for €1,850,000.

5 Monitoring methodology

Under the guidance of experts, each Tiny Forest is monitored by volunteers. It is important to have a sufficiently large pool of volunteers with exchangeable expertise, so that monitoring can take place year-round. The monitoring consists of:

- Soil: 3 replica soil samples in which fungi, bacteria, and carbon sequestration are determined. Measurements are carried out 3 times a year in January, May, and September in accordance with the method in this report.
- Soil fauna: 15 carpet tiles are laid out and at least 1 time per month per observer group, the fauna located below the tiles is registered in accordance with the method in this report.
- Transects: during the inventory of the carpet tiles, all other biodiversity on the intermediate route will be noted on sight, likewise at least once per month per observer group.
- Birds: at least once per month per observer group, prior to taking stock of the soil fauna and other fauna, an inventory of the presence of birds within the boundary of the Tiny Forest will take place for 15 minutes.
- Flora: flowering plants in the herbaceous layer are enumerated on 3 permanent squares at least 4 times a year (spread over the growing season). Covering all areas one by one, all types of flowering plants will be counted at least once per month per observer group.
- In addition to this, other inventory methods can be applied, depending on the volunteers' expertise and the possibilities for the use of resources (e.g. pot traps, camera traps, malaise traps, availability of classification keys, and binoculars).

Determination of organisms will take place at the least on the basis of class/order or family level, depending on the simplicity with which the groups of species can be differentiated, according to the groups of species list in this report (Appendix 1). Birds and flowering plants are always classified on species level. Where possible, the other organisms will be classified up to the species level as well, depending on the knowledge/facilities of volunteers. To safeguard the quality of the data that are collected by volunteers, a good manual as well as guidance and assistance are essential. Often, volunteers have different levels of expertise. Training by giving courses, walking together during the study, and guidance and assistance by species experts is therefore important. In addition, it is essential to take pictures – or to collect a specimen copy if this is allowed under the applicable legislation – which can be used to validate the accuracy of the classifications.

Data storage and entry will take place by means of an imposed, digital format to ensure uniformity.

In addition to the monitoring of a Tiny Forest, a reference area will be included to measure the added value in relation to its surroundings. Biodiversity is measured in basically the same way as in the Tiny Forest. Normally, however, the construction of a Tiny Forest will take place in residential areas. The method of monitoring in the reference area will therefore depend on the local situation (e.g. willingness of local residents, practical feasibility).

It is expected that the contribution to the biodiversity of a Tiny Forest depends on the geographical location and the soil type. For that reason, monitoring of the biodiversity will ideally take place in a number of Tiny Forests, in different physical-geographical regions. In addition to monitoring the biodiversity, it should be registered which administrative procedures are taking place (e.g. weeding, shared use) in order to clarify explanatory factors which may indicate differences in biodiversity between different Tiny Forests. Since Tiny Forests do not only have a biodiversity objective but also play a role in children's perception of nature, it will be interesting to include both Tiny Forests that are not easily accessible to the public and those that are accessible to the public in the sample.

6 Conclusions

The following two main questions will be addressed here in more depth:

Question 1) Does a Tiny Forest bring biodiversity?

Question 2) Can an overview of the biodiversity be developed using Citizen Science?

Biodiversity

The research shows that both the *Gouwse Bos* and the *Groene Woud* increase the biodiversity, compared to the nearby forest. Both the number of species groups and the number of individuals is generally higher than in the reference forests.

There is no substantial difference in numbers between the *Gouwse Bos* and the *Groene Woud*. However, a difference can be observed on the basis of ecological species/species groups. The *Gouwse Bos* is characterised by a higher number of flowering plants species and a more closed structure with a richer undergrowth in comparison with the *Groene Woud*. The *Groene Woud* is characterised by a more open structure, less undergrowth, and a lower amount of flowering plants.

This difference is caused by the method of construction in the initial phase. For example, in the *Gouwse Bos*, many vascular plants were sown, in addition to the trees and shrubs that were planted. In contrast, this was not done in the *Groene Woud* and here, the methodology of Shubhendu Sharma was adhered to more. This makes the *Gouwse Bos* a more appropriate biotope for pollinators, snails, and amphibians, while the *Groene Woud* actually offers more biotope to heat-loving species. In the *Groene Woud*, the landscaped path of wood chips and straw provide warm, well-exposed soil that the beetles and spiders benefit from. It is expected that this effect will decrease over time, when here, too, the undergrowth will increasingly consist of native herbs. This is already the case in the *Gouwse Bos* and the undergrowth is characterised by a lush, herbs-rich vegetation. This is the reason that there are more shade-loving/moisture-loving species.

Due to the fact that both forests currently consist of young forest, they still offer very little nesting opportunities and foraging space for birds. Compared to the surroundings, the *Gouwse Bos* and *Groene Woud* do not increase the biodiversity in terms of birds. However, in the *Gouwse Bos*, more birds have been observed than in the *Groene Woud*. This, too, has to do with a more diverse range of flowering and seed-bearing plants.

A side note can be made to the fact that both Tiny Forests are constructed in the Darwin Park and not in an entirely stony environment (stone city). We assume that the spill-over effect of the present nature in the Darwin Park have influenced both plots. In fact, people should expect the numbers and species to be lower, especially in the first years after construction, if both plots are located in a stone city. Then, in all probability, the first mobile species that move through the air will colonise the Tiny Forest plots. To illustrate: now, moles and rabbits have been found during the study. Follow-up research in a stone environment seems desirable.

The measured effect on biodiversity in this study gives an indication of the added value of a Tiny Forest shortly after the construction. Due to interleaving of the trees and progressive succession, it is not yet known what the effect is on the longer term and how both types of Tiny Forests (*Gouwse Bos* and *Groene Woud*) will develop. Biodiversity is expected to increase further in the coming years due to the establishment of new species and because the trees will provide more suitable habitats for a larger number of species. For example, in the next few years, birds will have breeding opportunities which is currently still missing. However, as the trees grow even further, it is expected that, without management, the *Gouwse Bos* will develop into a forest with less and less undergrowth. In the future, the *Groene Woud* is expected to contain little undergrowth as well. Without management, the currently measured added value for flower-visiting butterflies, bees, and hover flies of the *Gouwse Bos* in particular, will then also decrease over time. For that reason, it could be considered whether to

introduce management in edges to create a *mantel-zoom* (cloak-zoom) structure, so that species that depend on them can also maintain their presence in the future. Additionally, both Tiny Forests are currently difficult to access due to the fencing. Since the Tiny Forest does not only have an objective for the biodiversity, but should also play a role in children's perception of nature, the Tiny Forest should be made accessible for people. When people and dogs can enter, this will obviously have an impact on the biodiversity due to activities such as entering, building huts, and fertilisation.

Soil

Within a small period of time, soil has been developed with quantities of fungi and bacteria which match well with those in mature forests. Probably this has to do with the generous administration of wood chips and straw on the ground in the *Groene Woud*. This stimulates the growth of fungi and leads to a fungi-dominated soil (high fungus-bacterium ratio). This is beneficial for carbon sequestration and for efficient use of nutrients, due to which little is lost through leaching and greenhouse gases. In the *Gouwse Bos*, there were no wood chips and straw inserted, which is why the biomass of fungi is a bit less. In December 2016 and May 2017, higher numbers of fungi were measured in the *Groene Woud* than in the *Gouwse Bos*. In September 2017, this was exactly the other way around. This may be caused by developments in the moisture level of the soil and/or by developments in the soil fauna. A lot of organisms are involved in the decomposition of organic matter in the soil. While the degradation is mainly done by fungi, these are, in turn, eaten by mites and springtails. The composition of the soil fauna was not measured during this research.

Citizen Science

This research has shown that, by using Citizen Science, the biodiversity can be mapped out at a high level of aggregation. However, a side note is that a large group of volunteers is needed in order to ensure a sufficient monitoring intensity. In addition, the (taxonomic) knowledge of the observers determines the level of detail with which the monitoring can take place. A systematic count of species groups was possible at a high level of aggregation (class, order, family), but counts on species level are more difficult to perform. For many groups of species, this requires more training and facilities (for example binoculars, classification keys) and the feasibility depends on the interest, specialisation, and skills of the volunteers. In addition, interchangeability of experts is important to ensure the continuity of the monitoring.

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And last but not least, we thank IVN Netherlands for the pleasant collaboration, particularly Daan Bleichrodt!



Figure 28 Sunbathing rabbit (*Oryctolagus cuniculus*) in the Gouwse Bos.

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Appendix 1 Species list

A total of 176 species in the *Gouwse Bos*, *Groene Woud*, and the two reference plots have been classified. This does not include the shrubs and trees that have been planted. The numbers displayed do not constitute total numbers. In fact, most individuals have not been determined up to the species. The numbers in the list give an indication of where the species was found and in what proportion in relation to the other areas. For mosses (1x) and vascular plants, an "x" indicates whether the species concerned was found in the *Gouwse Bos* or *Groene Woud*. For these two groups, the reference plots have not been looked at. Also for the innumerable black garden ants, only their presence has been marked with an "x" in this table.

Group	Scientific name	English name	<i>Gouwse</i>	<i>Groene</i>	Ref. <i>Gouwse</i>	Ref. <i>Groene</i>
			<i>Bos</i>	<i>Woud</i>	<i>Bos</i>	<i>Woud</i>
Amphibians	<i>Bufo</i>	Common toad	37	10	3	2
Amphibians	<i>Lissotriton vulgaris</i>	Smooth newt	1			
Amphibians	<i>Pelophylax esculenta</i>	Edible frog, common water frog, or green frog				1
Amphibians	<i>Pelophylax klepton</i>	Edible frog, common water frog, or green frog	1			
Amphibians	<i>Rana temporaria</i>	European common brown frog	3		5	4
Bees	<i>Andrena praecox</i>	Early mining bee		1		
Bees	<i>Apis mellifera</i>	European honey bee	7	1		
Bees	<i>Bombus hortorum</i>	Garden bumblebee	1			
Bees	<i>Bombus lapidarius</i>	Red-tailed bumblebee	1	1		
Bees	<i>Bombus lucorum</i>	White-tailed bumblebee	1			
Bees	<i>Bombus pascuorum</i>	Common carder bee	3		1	
Bees	<i>Bombus pratorum</i>	Early-nesting bumblebee	3	1		
Bees	<i>Bombus terrestris</i>	Buff-tailed bumblebee or large earth bumblebee	12	2	2	
Aphids	<i>Aphis fabae</i>	Black bean aphid	1			
Centipedes	<i>Lithobius forficatus</i>	Brown centipede or stone centipede	18	21	15	30
Centipedes	<i>Lithobius variegatus</i>	Common banded centipede or banded centipede	5	3		3
Harvestmen	<i>Phalangium opilio</i>	Harvestman	1	4		
Snails	<i>Cornu aspersum</i>	Garden snail	2		4	3
Snails	<i>Discus rotundatus</i>	Rotund disc	10	5	4	4
Snails	<i>Cepaea nemoralis</i>	Grove snail or brown-lipped snail	30	6	2	4
Beetles	<i>Adalia bipunctata</i>	Two-spot ladybird, two-spotted ladybug or two-spotted lady beetle	1			
Beetles	<i>Agelastica alni</i>	Alder leaf beetle		9	1	
Beetles	<i>Amara aenea</i>	Common sun beetle	2			
Beetles	<i>Cantharis fusca</i>	Soldier beetle (black)	1			
Beetles	<i>Cantharis livida</i>	Soldier beetle (yellow)	1			
Beetles	<i>Coccinella septempunctata</i>	Seven-spot ladybird	2	2		
Beetles	<i>Gastrophysa viridula</i>	Green dock beetle	1			
Beetles	<i>Harmonia axyridis</i>	Asian ladybeetle	8	16		
Beetles	<i>Phyllopertha horticola</i>	Garden chafer	1	2		
Beetles	<i>Psylllobora vigintiduopunctata</i>	22-spot ladybird	1	1		

Group	Scientific name	English name	Gouwse Bos	Groene Woud	Ref. Gouwse Bos	Ref. Groene Woud
Beetles	<i>Pterostichus melanarius</i>	Common black ground beetle	1			
Beetles	<i>Crepidodera aurata</i>	Willow flea beetle		1		
Dragonflies	<i>Aeshna isoceles</i>	Green-eyed hawker	1	1		
Dragonflies	<i>Chalcolestes viridis</i>	Willow emerald damselfly	7	2		
Dragonflies	<i>Gomphus pulchellus</i>	Western clubtail	1			
Dragonflies	<i>Ischnura elegans</i>	Blue-tailed damselfly or common bluetail	2	2		
Dragonflies	<i>Orthetrum cancellatum</i>	Black-tailed skimmer	1	1		
Ants	<i>Lasius niger</i>	Black garden ants	x	x	x	x
Millipedes	<i>Polydesmus denticulatus</i>	No English translation	2			1
Mosses	<i>Polytrichum commune</i>	Common hair cap moss	x			
Mosquitoes	<i>Dilophus febrilis cf.</i>	Common fever fly	20	5		
Mosquitoes	<i>Bibio marci</i>	St. Mark's fly	1			
Mosquitoes	<i>Chironomus sp.</i>	Chironomids, non-biting midges, or lake flies	1			
Slugs	<i>Arion ater</i>	Black slug	1		1	3
Slugs	<i>Arion fuscus</i>	Dusky Arion	1			
Slugs	<i>Arion rufus</i>	Red slug	29	16	10	48
Slugs	<i>Deroceras reticulatum</i>	Grey field slug or grey garden slug	12	3	3	7
Slugs	<i>Limax cinereoniger</i>	Black keel back slug	1			
Slugs	<i>Limax maximus</i>	Great grey slug or leopard slug	3	1	1	5
Earwigs	<i>Forficula auricularia</i>	Common earwig or European earwig		1		
Mushrooms	<i>Coprinellus disseminatus</i>	Fairy inkcap mushroom			1	2
Mushrooms	<i>Coprinopsis acuminata</i>	Humpback inkcap mushroom	1			
Mushrooms	<i>Coprinus comatus</i>	Shaggy ink cap, lawyer's wig, or shaggy mane			2	
Mushrooms	<i>Flammulina velutipes</i>	Velvet foot or winter mushroom				1
Mushrooms	<i>Ganoderma lucidum</i>	Artist's bracket, artist's conk or bear bread				1
Mushrooms	<i>Trametes versicolor</i>	Turkey tail				2
Mushrooms	<i>Tubaria furfuracea</i>	Scurvy twiglet	1			
Woodlice	<i>Armadillidium vulgare</i>	Common pill woodlouse or carpenter	6	11	12	16
Woodlice	<i>Oniscus asellus</i>	Common woodlouse	4	1	6	12
Woodlice	<i>Porcellio scaber</i>	Common rough woodlouse	9	39	14	44
Woodlice	<i>Trachelipus rathkii</i>	Rathke's Woodlouse		1		
Plants	<i>Ficus carica</i>	Common fig	1			
Earthworms	<i>Aporrectodea caliginosa</i>	Grey worm	5			
Earthworms	<i>Lumbricus rubellus</i>	Red earthworm	12	8	2	
Earthworms	<i>Lumbricus terrestris</i>	Lob worm or night crawler	9	10	6	3
Fungus	<i>Diplocarpon rosea</i>	Rose black spot fungus	1			
Fungus	<i>Uncinula tulasnei</i>	Form of powdery mildew	1			
Scorpionflies	<i>Panorpa communis</i>	Common scorpionfly	2		1	
Spiders	<i>Araneus diadematus</i>	European garden spider, diadem spider, cross spider, or crowned orb weaver	5	1		
Spiders	<i>Pardosa amentata</i>	Wolf spider or spotted wolf spider	1	12	3	
Spiders	<i>Pardosa lugubris</i>	Type of wolf spider	3	4	2	

Group	Scientific name	English name	Gouwse	Groene	Ref. Gouwse	Ref. Groene
			Bos	Woud	Bos	Woud
Spiders	<i>Pisaura mirabilis</i>	Nursery web spider	1	2		
Spiders	<i>Araniella cucurbitina</i>	Cucumber green spider	2			
Spiders	<i>Tetragnatha extensa</i>	Common stretch spider	1			
Spiders	<i>Xysticus cristatus</i>	Common crab spider	1			
Grasshoppers	<i>Chorthippus albomarginatus</i>	Lesser marsh grasshopper		1		
Grasshoppers	<i>Chorthippus brunneus</i>	Common field grasshopper	1	1		
Shrubs	<i>Rubus fruticosus</i>	Bramble or European blackberry	x			
Dipterous insect	<i>Tetanocera elata</i>	Field buff snail killer	5			
Vascular plants	<i>Oenothera parviflora</i>	Small-flowered evening-primrose		x		
Vascular plants	<i>Glechoma hederacea</i>	Ground ivy	x	x		
Vascular plants	<i>Dipsacus fullonum</i>	Fuller's teasel or wild teasel		x		
Vascular plants	<i>Ranuculus repens</i>	Creeping buttercup	x			
Vascular plants	<i>Rumex obtusifolius</i>	Bitter dock, broad-leaved dock, bluntleaf dock, dock leaf, or butter dock	x	x		
Vascular plants	<i>Epilobium hirsutum</i>	Great willowherb, great hairy willowherb, or hairy willowherb	x	x		
Vascular plants	<i>Elymus repens</i>	Couch grass	x	x		
Vascular plants	<i>Taraxacum officinale</i>	Common dandelion	x	x		
Vascular plants	<i>Bellis perennis</i>	English Daisy	x	x		
Vascular plants	<i>Urtica dioica</i>	Stinging nettle	x			
Vascular plants	<i>Plantago major</i>	Greater plantain	x			
Vascular plants	<i>Poa annua</i>	Annual meadow grass	x	x		
Vascular plants	<i>Echium vulgare</i>	Viper's bugloss or blueweed		x		
Vascular plants	<i>Epilobium sp.</i>	Alpine willowherb	x			
Vascular plants	<i>Artemisia vulgaris</i>	Mugwort	x			
Vascular plants	<i>Plantago lanceolata</i>	Ribwort plantain, narrowleaf plantain, English plantain, or ribleaf		x		
Vascular plants	<i>Holcus lanatus</i>	Yorkshire fog, tufted grass, or meadow soft grass	x	x		
Vascular plants	<i>Rumex acetosella</i>	Sheep's sorrel, red sorrel, sour weed, or field sorrel		x		
Vascular plants	<i>Trifolium pratense</i>	Red clover	x	x		
Vascular plants	<i>Cirsium arvense</i>	Creeping thistle	x			
Vascular plants	<i>Verbascum densiflorum</i>	Denseflower mullein or dense-flowered mullein		x		
Vascular plants	<i>Daucus carota</i>	Wild carrot, bird's nest, or bishop's lace	x			
Vascular plants	<i>Cerastium arvense</i>	Field mouse-ear and field chickweed		x		
Vascular plants	<i>Festuca rubra</i>	Red Fescue	x	x		
Vascular plants	<i>Equisetum arvense</i>	Field horsetail or common horsetail		x		
Vascular plants	<i>Ranunculus acris</i>	Meadow buttercup, tall buttercup, common buttercup, or giant buttercup	x	x		
Vascular plants	<i>Carex arenaria</i>	Sand sedge		x		
Vascular plants	<i>Argentina anserina</i>	Silverweed		x		
Vascular plants	<i>Phalaris arundinacea</i>	Reed canary grass		x		

Group	Scientific name	English name	Gouwse Bos	Groene Woud	Ref. Gouwse Bos	Ref. Groene Woud
Vascular plants	<i>Carex pseudocyperus</i>	Cyperus sedge or hop sedge		x		
Vascular plants	<i>Galium aparine</i>	Cleavers, clivers, bedstraw, goosegrass, catchweed, or stickyweed		x		
Vascular plants	<i>Sochus oleraceus</i>	Common sowthistle, sow thistle, smooth sow thistle, or milk thistle		x		
Vascular plants	<i>Echium vulgare</i>	Viper's bugloss or blueweed	x			
Vascular plants	<i>Solanum dulcamara</i>	Bittersweet, bittersweet nightshade, or blue bindweed	x			
Vascular plants	<i>Brassica napus</i>	Rapeseed	x			
Vascular plants	<i>Rosa canina</i>	Dog rose	x			
Vascular plants	<i>Hieracium spec.</i>	Hawkweed	x			
Vascular plants	<i>Lythrum salicaria</i>	Purple loosestrife	x			
Vascular plants	<i>Prunella vulgaris</i>	Common self-heal	x			
Vascular plants	<i>Geranium molle</i>	Dove's-foot Crane's-bill or Dovesfoot Geranium	x			
Vascular plants	<i>Verbascum spec.</i>	Mullein	x			
Vascular plants	<i>Eupatorium cannabinum</i>	Hemp-agrimony or holy rope	x			
Vascular plants	<i>Arabidopsis</i>	Rockcress	x			
Vascular plants	<i>Melilotus albus</i>	White sweet clover	x			
Vascular plants	<i>Leontodon spec.</i>	Lion's tooth	x			
Flies	<i>Episyrrhus balteatus</i>	Marmalade hoverfly	3			
Flies	<i>Eristalis tenax</i>	Drone fly	3			
Flies	<i>Eupeodes corollae</i>	No English name	1			
Flies	<i>Helophilus pendulus</i>	European hoverfly	1			
Flies	<i>Lucilia caesar</i>	Common greenbottle	1	2		
Flies	<i>Lucilia cf sericata</i>	The green bottle fly	3			
Flies	<i>Melanostoma scalare</i>	Chequered hoverfly	1			
Flies	<i>Muscidae</i>	House flies or stable flies		1		
Flies	<i>Phytomyza spinaciae</i>	Leaf miner	1			
Flies	<i>Sarcophaga carnaria</i>	Flesh fly	20	10		
Flies	<i>Scathophaga stercoraria</i>	Yellow dung fly or the golden dung fly		1		
Flies	<i>Syrphus ribesii</i>	Humming syrphus	2			
Flies	<i>Syrphus torvus</i>	Hairy-eyed syrphus	2			
Flies	<i>Xylota segnis</i>	Orange-belted hoverfly			1	
Flies	<i>Eristalis pertinax</i>	Tapered dronefly	1	1		
Flies	<i>Anthomyia sp.</i>			1		
Hymenoptera	<i>Andricus kollari</i>	Marble gall wasp	1	1		
Hymenoptera	<i>Chrysis ignita</i>	Ruby-tailed wasp	1		1	
Hymenoptera	<i>Lasius niger</i>	Black garden ants	122	131	34	
Hymenoptera	<i>Pontania proxima</i>	Willow bean gall	1	2		
Hymenoptera	<i>Vespula vulgaris</i>	Common wasp	1	5		
Butterflies	<i>Autographa gamma</i>	Silver Y				1
Butterflies	<i>Cochylis roseana</i>	Rosy conch		1		
Butterflies	<i>Geometra papilionaria</i>	Large emerald	1	1		
Butterflies	<i>Gonepteryx rhamni</i>	Brimstone butterfly	1			
Butterflies	<i>Inachis io</i>	European peacock or peacock butterfly	3			
Butterflies	<i>Lomaspilis marginata</i>	Clouded border	1			
Butterflies	<i>Pararge aegeria</i>	Speckled wood	3	3	1	
Butterflies	<i>Phyllocoptis xenia</i>	British leafminer	1			
Butterflies	<i>Pieris brassicae</i>	Cabbage butterfly,	1	1		

Group	Scientific name	English name	Gouwse Bos	Groene Woud	Ref. Gouwse Bos	Ref. Groene Woud
		cabbage white, cabbage moth				
Butterflies	<i>Pieris rapae</i>	Small cabbage white	1			
Butterflies	<i>Polygonia c-album</i>	Comma butterfly	1			
Butterflies	<i>Vanessa atalanta</i>	Red admiral	3			
Butterflies	<i>Yponomeuta padella</i>	Orchard ermine	9			
Butterflies	<i>Noctua pronuba</i>	Large yellow underwing	1	1		
Butterflies	<i>Crambus pascuella</i>	Inlaid grass-veneer		1		
Birds	<i>Pica</i>	Magpie	1			
Birds	<i>Columba palumbus</i>	Wood pigeon	1	1		
Birds	<i>Turdus merula</i>	Blackbird	6	11		
Birds	<i>Carduelis</i>	European goldfinch	26			
Birds	<i>Cyanistes caeruleus</i>	Eurasian blue tit		3		
Birds	<i>Aegithalos caudatus</i>	Long-tailed tit or long-tailed bushtit		2		
Birds	<i>Erythacus rubecula</i>	European robin	2			
Birds	<i>Phylloscopus collybita</i>	Chiffchaff	2	1		
Birds	<i>Alcedo atthis</i>	Kingfisher		1		
Bugs	<i>Coreus marginatus</i>	Dock bug	9			
Mammals	<i>Apodemus sylvaticus</i>	Wood mouse	1	1		
Mammals	<i>Crocidura russula</i>	Greater white-toothed shrew		1		
Mammals	<i>Microtus arvalis</i>	Common vole	1	1	2	
Mammals	<i>Oryctolagus cuniculus</i>	European rabbit	1			2
Mammals	<i>Sorex araneus</i>	Common shrew		1	1	
Mammals	<i>Taipa europaea</i>	Mole	1	1		

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