EXPEDITION REPORT

Expedition dates:
19 – 23 July 2020 (local Covid expedition)
25 June – 22 July 2022 (international expedition)

Report published: June 2023

Love / hate relationships: Monitoring the return of the wolf to the German state of Lower Saxony

Picture courtesy of S. van Lieshout

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Authors:

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ABSTRACT

This report details wolf *Canis lupus lupus* active monitoring fieldwork by Biosphere Expeditions in collaboration with the State Wolf Bureau of the German state of Lower Saxony and local wolf commissioners. Field work was conducted from 19 to 23 July 2020 in a small group of six people due to the Covid-19 pandemic. In 2022, field work was conducted in three groups from 25 June – 1 July (10 citizen scientists), 2 – 8 July (10 citizen scientists) and 16 – 22 July (7 citizen scientists). The aim of the expeditions was to collect samples for DNA and dietary analyses. This was done by sending small groups into the field to search for scat samples.

Due to the Covid-19 pandemic, the expedition team in 2020 consisted of six citizen scientists only (all from Germany, except one person from Belgium). In 2022, 24 citizen scientists took part in the expedition, 12 from Germany or its immediate neighbour states (50%), six people from the United Kingdom (25%), and one person each came from USA, Australia, the Netherlands, Ireland and Belgium (4% respectively). Before commencement of field work, which was exclusively conducted on public paths and bridleways, citizen scientists were trained for 1.5 days in sample detection, sampling and data collection techniques. The study area covered various priority areas in Lower Saxony as advised or requested by the State Wolf Bureau, wolf commissioners, hunters and the State Forestry Authority. Thirty-one 10 km x 10 km grid cells of the European Environment Agency (EEA) reference grid system and almost 1087 km were surveyed on foot. Some grid cells were surveyed multiple times so that they were covered a total of 52 times.

349 wolf scat samples were identified during the field work in 2020 and 2022, 196 of which were included into the official wolf monitoring programme. 145 samples were frozen for dietary analysis and 22 of those were fresh enough for DNA analysis. A number of possible wolf paw prints and scats were also found, but did not pass quality assessment procedures directly after field work. One team in 2022 actually spotted an adult wolf coming towards them on a forest trail for a few seconds just before he recognized the team members. In 2022, a longer wolf track in direct registered trot as well as a wildlife carcass (mouse) were recorded additionally to the found scat and assigned to the species wolf by the official wolf monitoring.

Twenty (5.7%) of the 349 scat samples collected were classified as C1 pieces of hard evidence on the SCALP classification system, 34 (9.7%) as C2 confirmed observation and 144 (41.3%) as C3 unconfirmed observations. The sighting in 2022 was assessed as C1 confirmed hint, based on the sighting video on hand, the wildlife carcass (mouse) was also assessed as a confirmed hint, as the species wolf could be detected based on the carcass sample.

The DNA analysis of the 22 genetic scat samples showed that 19 originated from wolf. 15 samples could be assigned to individual wolves. All in all, five male wolves and eight female wolves were identified, of which one male and two females could be confirmed twice.

Just like the 2017 and 2018 expeditions, the quantity and quality of samples collected by the active monitoring effort of the expeditions in 2020 and 2022 is remarkable. Official monitoring efforts in 2020 and 2022 yielded 1,201 scat samples of which 212 (18%) samples were found by the 2020 and 2022 expeditions. The expeditions also produced a considerable proportion of high-quality C1 and C2 records (22% in 2020 and 42% in 2022); this was roughly equivalent to, or higher than, records collected via the official monitoring programme separate from the expeditions (18% in 2020 and 15% in 2022). All of this shows again that with 1.5 days of training, contributions of citizen scientists towards wolf research, monitoring and conservation can be both high quality and high quantity.

ZUSAMMENFASSUNG

Dieser Bericht beschreibt die Geländearbeit von Biosphere Expeditions in Form eines aktiven Monitorings des großen Beutegreifers Wolf (*Canis lupus lupus*) in Zusammenarbeit mit dem Wolfsbüro des Landes Niedersachsen und einigen Wolfsberatern. Im Jahr 2020 wurde die Expedition aufgrund der Coronapandemie in einem begrenzten Rahmen umgesetzt: Die Geländearbeit fand vom 19. - 23. Juli, in einer kleinen Gruppe von sechs Personen, statt. 2022 wurde die Geländearbeit durch drei Gruppen umgesetzt: vom 25. Juni - 1. Juli (10 Bürgerwissenschaftler/innen), 2. - 8 Juli (10 Bürgerwissenschaftler/innen) und vom 16. – 28. Juli (7 Bürgerwissenschaftler/innen). Ziel war es, Hinweise auf Wolfspräsenz, insbesondere Losungen, für genetische Untersuchungen und Nahrungsanalysen, zu finden.

Von den im Jahr 2020 teilnehmenden Bürgerwissenschaftler/innen stammten alle bis auf eine Person aus Deutschland. 2022 nahmen insgesamt 24 Bürgerwissenschaftler/innen teil, wovon 12 aus Deutschland oder den angrenzenden Ländern kamen (50%) und sechs aus Großbritannien (25%). Jeweils eine Person kam aus den USA, Niederlanden, Irland und Belgien (jeweils 4,1%).

Vor Beginn der Geländearbeit, die ausschließlich auf öffentlich begehbaren Wegen umgesetzt wurde, wurden die Teilnehmer/innen 1,5 Tage im Erkennen von Wolfshinweisen, der Probenahme und Datenerfassung im Gelände geschult. Das Untersuchungsgebiet umfasste verschiedene Gebiete in Niedersachsen, die im Voraus in Zusammenarbeit mit dem staatlichen Wolfsbüro, örtlichen Wolfsberatern und Jägern sowie den Niedersächsichen Landesforsten festgelegt worden waren. In den beiden Jahren 2020 und 2022 wurden 31 der 10 km x 10 km großen Rasterzellen des EU-Gitternetzes und fast 1.087 km zu Fuß abgesucht. Einige Gitterzellen wurden mehrfach begangen, so dass sie insgesamt 52 Mal abgedeckt wurden.

Im Rahmen der Expeditionen konnten insgesamt 349 Wolfslosungen im Gelände identifiziert werden, von denen 196 Proben in das offizielle Wolfsmonitoring aufgenommen wurden. 145 Proben wurden für die Nahrungsanalyse eingefroren, 22 Proben davon waren geeignet für genetische Untersuchungen. Darüber hinaus wurden einzelne Trittsiegeln sowie weitere, vermeintliche Wolfslosungen gefunden, konnten aber aufgrund der strengen Datenqualitätsvorgaben nicht als Wolfshinweise genutzt werden. 2022 wurden zusätzlich zu den Kotproben ein Wildtierkadaver (Maus) sowie eine Spur im geschnürten Trab gefunden, dokumentiert und anschließend in das offizielle Monitoring aufgenommen. 2022 gab es außerdem eine Wolfssichtung: Ein Team sah einen Wolf auf einem Forstweg näherkommen, bevor dieser die Bürgerwissenschaftler/innen entdeckte und flüchtete.

Zwanzig (5,7%) der 349 gesammelten Losungsproben wurden im SCALP-Klassifizierungsverfahren als C1-Nachweise eingestuft, 34 (9,7%) als C2-bestätigte Hinweise und 144 (41,2%) als C3-unbestätigte Hinweise. Die Sichtung im Jahr 2022 floss auf Grundlage des vorliegenden Beobachtungsvideos als C1-Nachweis in das offizielle Monitoring ein, ebenso die Maus, an der im Nachgang, durch die genetische Untersuchung, Wolfs-DNA festgestellt werden konnte.

Die genetischen Untersuchungen der 22 eingesendeten Proben ergab, dass 19 Losungen von Wölfen stammten. 15 dieser Proben konnten bestimmten Wolfsindividuen zugeordnet werden. Insgesamt wurden fünf männliche und acht weibliche Wölfe identifiziert, von denen ein männlicher und zwei weibliche zweimal bestätigt werden konnten.

Wie bereits im Rahmen der Expeditionen 2017 und 2018, ist die Anzahl und die Qualität der gesammelten Losungsproben bemerkenswert. In den Jahren 2020 und 2022 wurden im Rahmen des offiziellen Monitorings in Niedersachsen insgesamt 1201 Losungen dokumentiert. 212 (18%) dieser Losungen wurden im Rahmen der Biosphere Expeditionen gefunden. Losungsproben, die im Rahmen der Expeditionen gefunden und als eindeutige C1-Nachweise bzw. als bestätigte Hinweise (C2) bewertet wurden, machten 22% (2020), bzw. 42% (2022) der Gesamtanzahl an Losungen, die im Rahmen der Expeditionen gefunden wurden, aus. Zum Vergleich: Der Anteil der C1- und C2-Losungen, die im Rahmen des offiziellen Monitorings gesammelt wurden, lag bei 18% (2020), bzw. 15% (2022).

Die Ergebnisse der beiden Expeditionen in den Jahren 2020 und 2022 belegen wiederholt, dass Bürgerwissenschaftler/innen mit eineinhalb Tagen Schulung einen quantitativ und qualitativ hochwertigen Beitrag zum Wolfsmonitoring sowie zur Forschung und letztlich zum Schutz der Tierart leisten können.

Contents

1. Expedition review

M. Hammer (editor)
Biosphere Expeditions

1.1. Background & research area

Background information, location conditions and the research area are as per Schütte & Hammer (2018), Schütte & Hammer (2019) and Schütte, Steinberg & Hammer (2020). The aim of the expedition was to actively monitor for wolf *Canis lupus lupus* and their signs such as scats and tracks so that wolf ecology and population dynamics (wolf and pack numbers, group sizes, movements, diet) can be elucidated to mitigate human-wolf conflict.

1.2. Dates & team

In 2020, due to the Covid-19 pandemic, only a reduced expedition took place with a team of local scientists, wolf commissioners and volunteers for five days. In 2021, due lack of funding, as well as severe travel and social distancing restrictions, no expedition took place. In 2022 the expedition returned to normal operations and ran over a period of three weeks divided into three 7-day groups, each composed of a team of national and international citizen scientists, local wolf commissioners and other helpers, two scientists and an expedition leader. Group dates were as shown in the team list below.

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence):

- 19 – 23 July 2020: Patricia Smith (Belgium), Sieglinde Dittmann, Sylvia Dittman, Anja Giles, Dorit Mersmann, Beate Stahmer (all Germany)
- 25 June – 1 July 2022: Eleanor Cope (UK), Sylvia Dittmann (Germany), Sieglinde Dittmann (Germany), Claudia Engels (Germany), Sylvia Lawson-Brown (UK), Stefan Lechner (Germany), Alistair Luckham (UK), Sybille Neumeyer (Germany), Tatjana Schütz (Germany), Patricia Smith (Belgium).
- 2 – 8 July 2022: Sylvia Dittmann (Germany), Sieglinde Dittmann (Germany), Liam Kirwan (Ireland), Aniek Lomme (Netherlands), Carlheinz Münnighoff (Germany), Anette Prelle (Germany), Martyn Roberts (UK), Paul Romijn (Netherlands), Patricia Smith (Belgium), Sandra Sons (Germany).
- 16 – 22 July 2022: Michael Bucek (USA), Veronika Ellenrieder (Germany), Kathrin Heckmann* (Germany), Andreas Keller (Germany), Ben Rees (UK), Caitlin Scott** (Australia), Stefania van Lieshout*** (UK).

*press participant: forthcoming coverage in a book (in German) I **press participant: see online article (in English) I ***press participant: see online articles in English and Dutch

In addition for some or all of the time: Peter Schütte and Charlotte Steinberg (expedition scientists), Malika Fettak and An Bollen (expedition leaders), Theo Grüntjens, Kenny Kenner, Volker Einhorn and Ulrike Kressel (wolf commissioners), and Lea Wirk (Wildlife Detection Dogs e. V.).

A medical umbrella, safety and evacuation procedures were in place, but did not have to be invoked as there were no medical incidents.

In 2020, the expedition was based at BIO-Hotel Kenner's Landlust in the Göhrde and in 2022 the project moved back to its normal base of operations at Herrenhaus Gut Sunder.

1.3. Partners

Biosphere Expeditions' main partner on this expedition was the state's environmental authority the NLWKN (Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz, Nature = Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency), which is officially responsible for the monitoring of all wildlife in the state. The authority's Wolfsbüro (wolf bureau) staff were closely involved in all expedition activities. Other partners included the Landesforsten (state forestry department), district and communal authorities, BIOHotel Kenners LandLust, Wildlife Detection Dogs e.V., Wolfcenter Dörverden and Herrenhaus Gut Sunder.

1.4. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Project updates, reports and publications:
https://www.researchgate.net/lab/Biosphere-Expeditions-Matthias-Hammer

All expedition reports, including this and previous expedition reports:
https://www.researchgate.net/lab/Biosphere-Expeditions-Matthias-Hammer

Expedition diary/blog:
2020: https://blog.biosphere-expeditions.org/category/expedition-blogs/germany-2020/
2022: https://blog.biosphere-expeditions.org/category/expedition-blogs/germany-2022/

Expedition details, background, pictures, videos, etc.
https://www.biosphere-expeditions.org/germany

1.5. Acknowledgements

We are very grateful to all the expedition citizen scientists, who not only dedicated their spare time to helping but also, through their expedition contributions, funded the research. Thank you also to those who brought their own cars and supported the expedition in this way too. Thank you to all our partners mentioned above, especially those at the 'Wolfsbüro' at NLWKN and to all those professionals who provided assistance and information. Special thanks also go to all of the 'wolf commissioners' (Wolfsberater) and helpers working on a voluntary basis in support of the expedition. Their efforts and local knowledge were crucial to the success of our field work. Thanks also to the state forestry department (Niedersächsische Landesforsten) for their co-operation. Furthermore a special thank you to the WWF (World Wildlife Fund Germany), who kindly supported the collaboration with Wildlife Detection Dogs e.V. Finally, thank you to the staff of BIO-Hotel Kenners Landlust, led by Barbara & Kenny Kenner as well as Herrenhaus Gut Sunder, led by Anja Rosenbrock, for being such excellent hosts and making us feel at home, and to anonymous reviewers for helpful comments on the manuscript.

1.6. Expedition budget for 2022*

Each citizen scientist in 2022 paid a contribution of €2,070 per person per seven-day period towards expedition costs. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	**€**
Expedition contributions	50,618
Expenditure	
Expedition base includes all food & services	12,850
Transport includes hire cars, fuel, taxis in Germany	1,721
Equipment and hardware includes research materials & gear etc. purchased internationally & locally	1,098
Staff includes local and Biosphere Expeditions staff salaries and travel expenses	10,386
Administration includes miscellaneous fees & sundries	1,341
Team recruitment Germany as estimated % of annual PR costs for Biosphere Expeditions	6,830
Income – Expenditure	**16,391**
Total percentage spent directly on project	**68%**

*The 2020 Covid local expedition was a small-scale affair with each participant covering their own cost. As a result, no budget is given here for this mini expedition.

2. Monitoring wolves in Lower Saxony

Peter Schütte
Wolf Commissioner Lower Saxony

Charlotte Steinberg
Ministry for Environment, Energy and Nature Conservation Thuringia

2.1. Introduction

The expedition's rationale, background, materials and methods, and training of citizen scientists are described in Schütte & Hammer (2018), Schütte & Hammer (2019) and Schütte et al. (2020).

Wolf territories and population dynamics in Lower Saxony from 2020 to 2022

At the end of the monitoring year 2019/20 there were 131 confirmed wolf packs, 47 couples and ten individuals in Germany (DBBW 2023a). These numbers increased by the end of the monitoring year 2021/22 to 161 confirmed wolf packs, 43 couples and 21 individuals (DBBW 2023b). The 2022 distribution is shown in Figures 2.1a & 2.1b.

In June 2020, prior to the 2020 expedition commencing, there were 32 wolf packs in the federal state of Lower Saxony, four wolf pairs and two resident solitary wolves (LJN 2020a). At the end of the first quarter of the year 2022, prior to the 2022 expedition commencing, the state reported 38 wolf packs, two wolf pairs and 4 resident solitary wolves (Fig. 2.1c, LJN 2022a). This development (Table 2.1) and wolf evidence found (Fig. 2.1d) illustrates that Lower Saxony offers suitable habitats, which are still not fully occupied by wolves.

Table 2.1. Wolf population dynamics in Lower Saxony June 2020 – March 2022 (LJN 2020a, 2020b, 2022)

Time	Wolf packs	Wolf pairs	Single wolves
June 2020	32	4	2
December 2020	35	2	0
March 2022	38	2	4

Study site and focus areas

The study area in general is described in Schütte & Hammer (2018), Schütte & Hammer (2019) and Schütte et al. (2020).

Focus areas were chosen in collaboration with local people (such as wolf commissioners, foresters, hunters) and authorities, such as the 'Wolfsbüro' at NLWKN (the wolf bureau at the state environment department). Such collaborations, especially with the wolf commissioners and the wolf bureau, are critical to the project's success. An additional and welcome side effect is that acceptance for the project, as well as citizen science projects in general and in the field of wildlife monitoring and research, are fostered.

2020: The focus area of the 2020 expedition is shown in Figures 2.1e (CORINE) and 2.1f (Google). Due to the due to COVID-19 pandemic, field work was very limited and conducted only in two areas.

2022: In 2022, after the COVID-19 restrictions had been largely lifted, field work was conducted in five areas. These are shown in Figures 2.1e (CORINE) and 2.1g (Google).

Figure 2.1a.

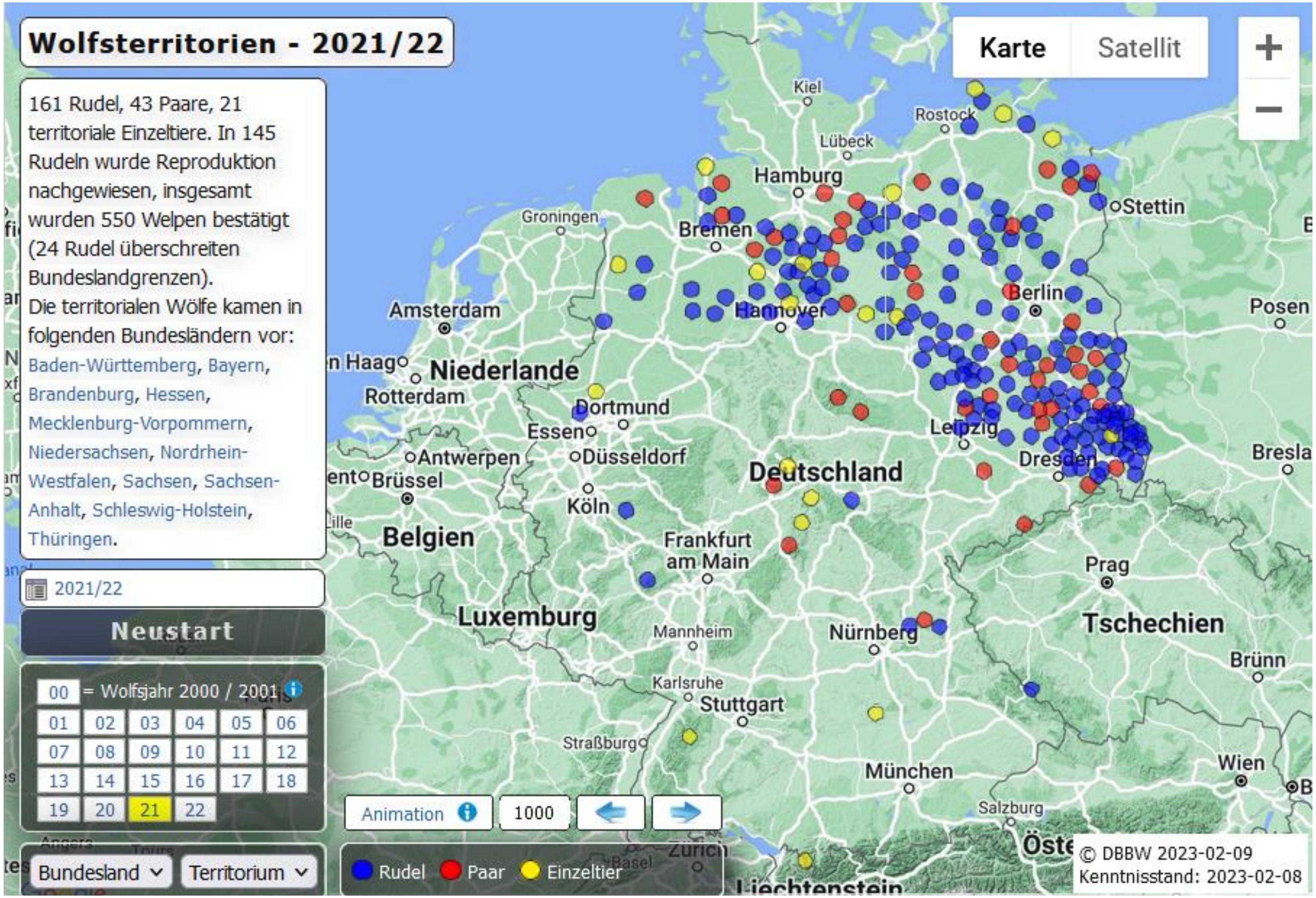
Wolf territories in Germany by the end of the monitoring year 2021/22 (DBBW 2023c).

Rudel (blue) = wolf pack

Paar (red) = wolf pair

Einzeltier (yellow) = single individual

The text reads "161 packs, 43 pairs, 21 territorial individuals are known, as well as 550 juveniles (24 packs crossing state boundaries). Territorial wolves are present in the states of Baden-Wurttemberg, Bavaria, Brandenburg, Hesse, Mecklenburg-Vorpommern, Lower Saxony, North Rhine-Westphalia, Saxony, Saxony-Anhalt, Schleswig-Holstein, Thuringia".



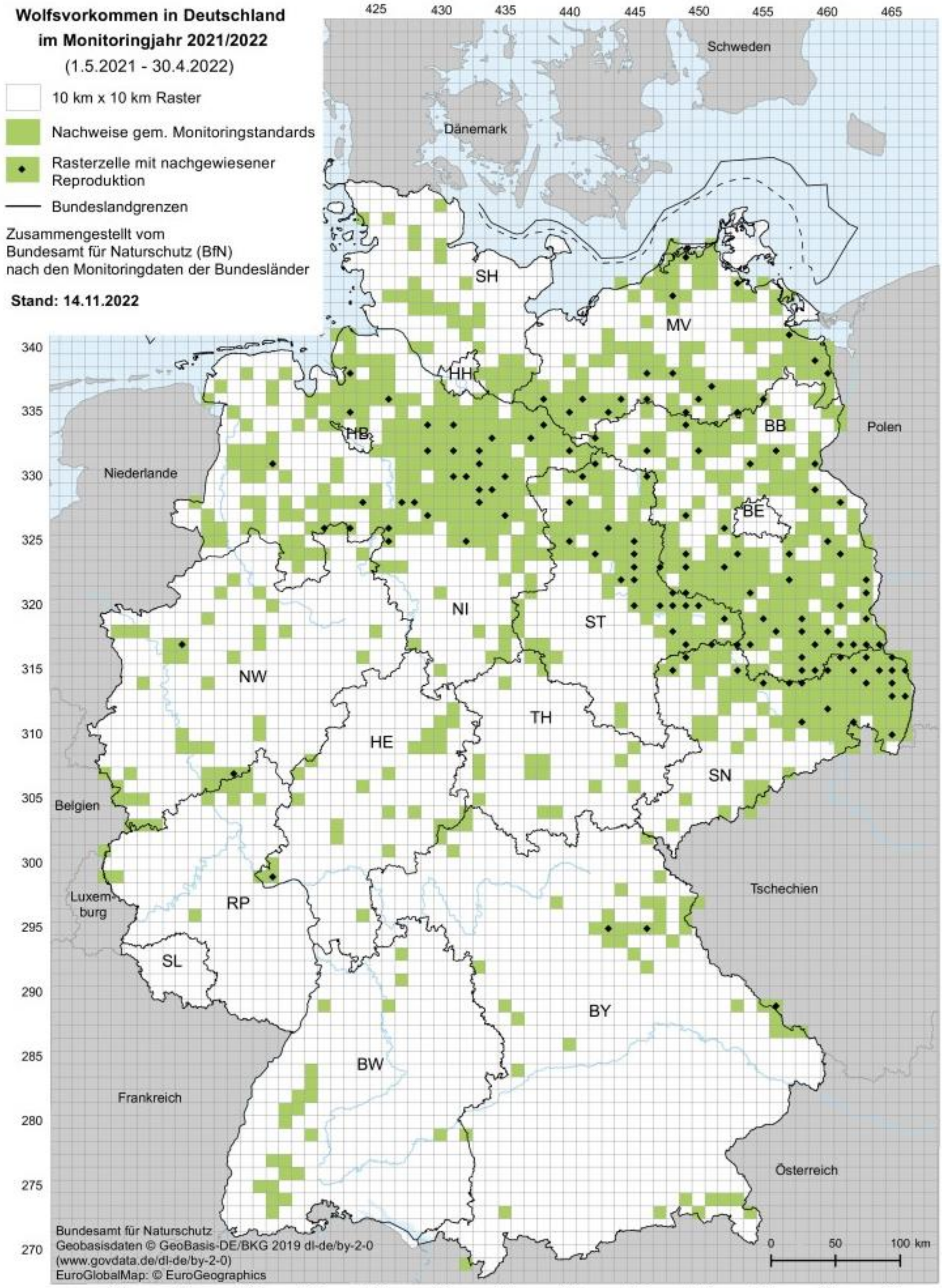


Figure 2.1b. Distribution of wolves in Germany in 2021/2022 on the EEA grid system (BfN 2022).
Green cell = wolf presence confirmed in accordance with monitoring standards.
Green cell with black dot = wolf presence and reproduction confirmed.

Figure 2.1c.

Wolf territories in Lower Saxony after the first quarter 2022 (LJN 2023a).

The legend reads:

Wolfsrudel (green) = wolf pack

Wolfsrudel (Nachbarland)* (shaded green) = wolf pack (neighbor state)

Wolfsrudel (unbestätigt)* (bright green) = wolf pack (to be confirmed)*

Wolfspaar (orange) = wolf pair

Residenter Einzelwolf (blue) = resident individual

Unklar (grey) = unclear

Unter Beobachtung (white) = under observation

*) To be confirmed = pack existence through evidence of reproduction or more than two pack members has not yet been confirmed

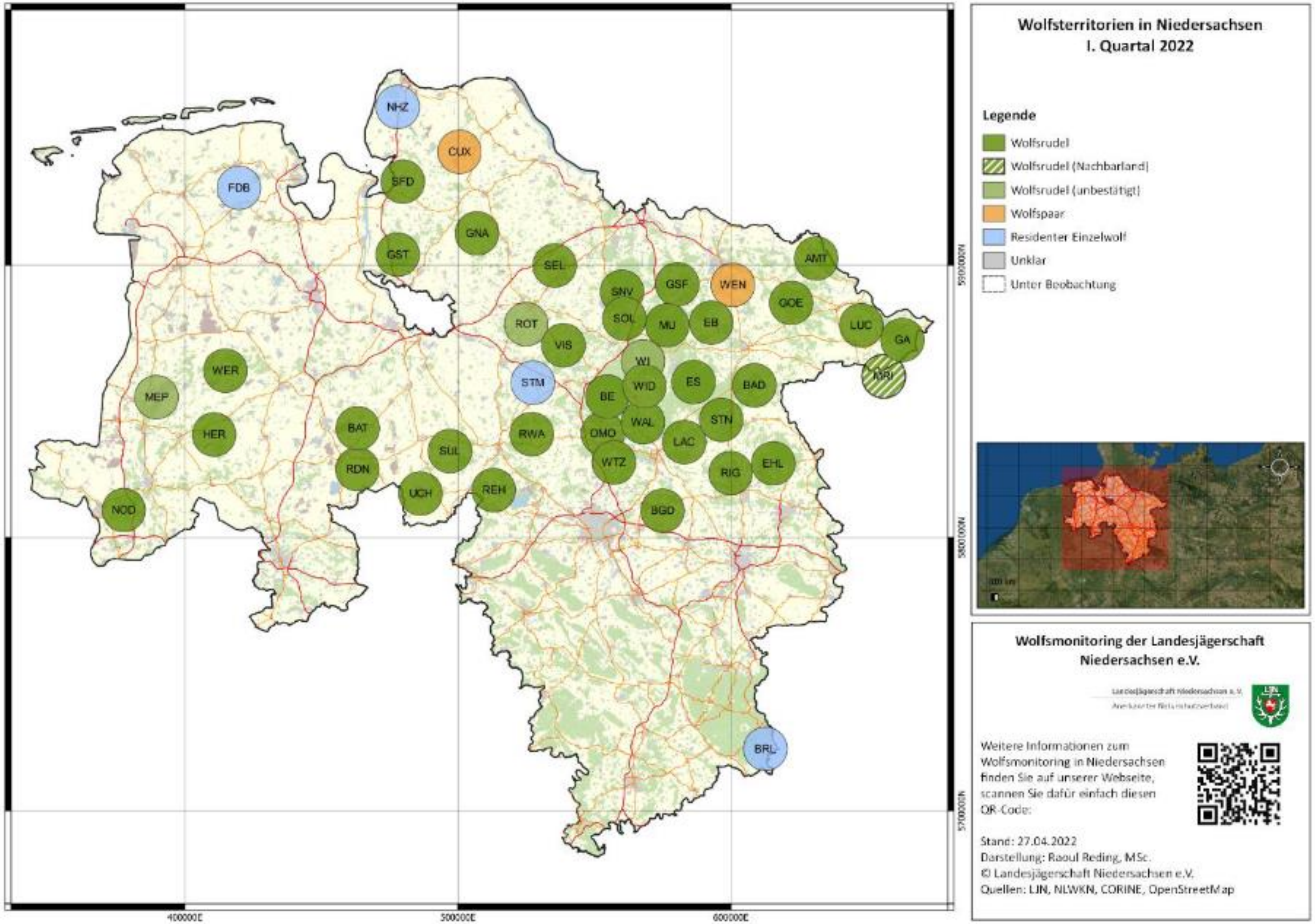


Figure 2.1d.

Distribution of wolves in Lower Saxony in 2021/22 on the EEA grid system (source).

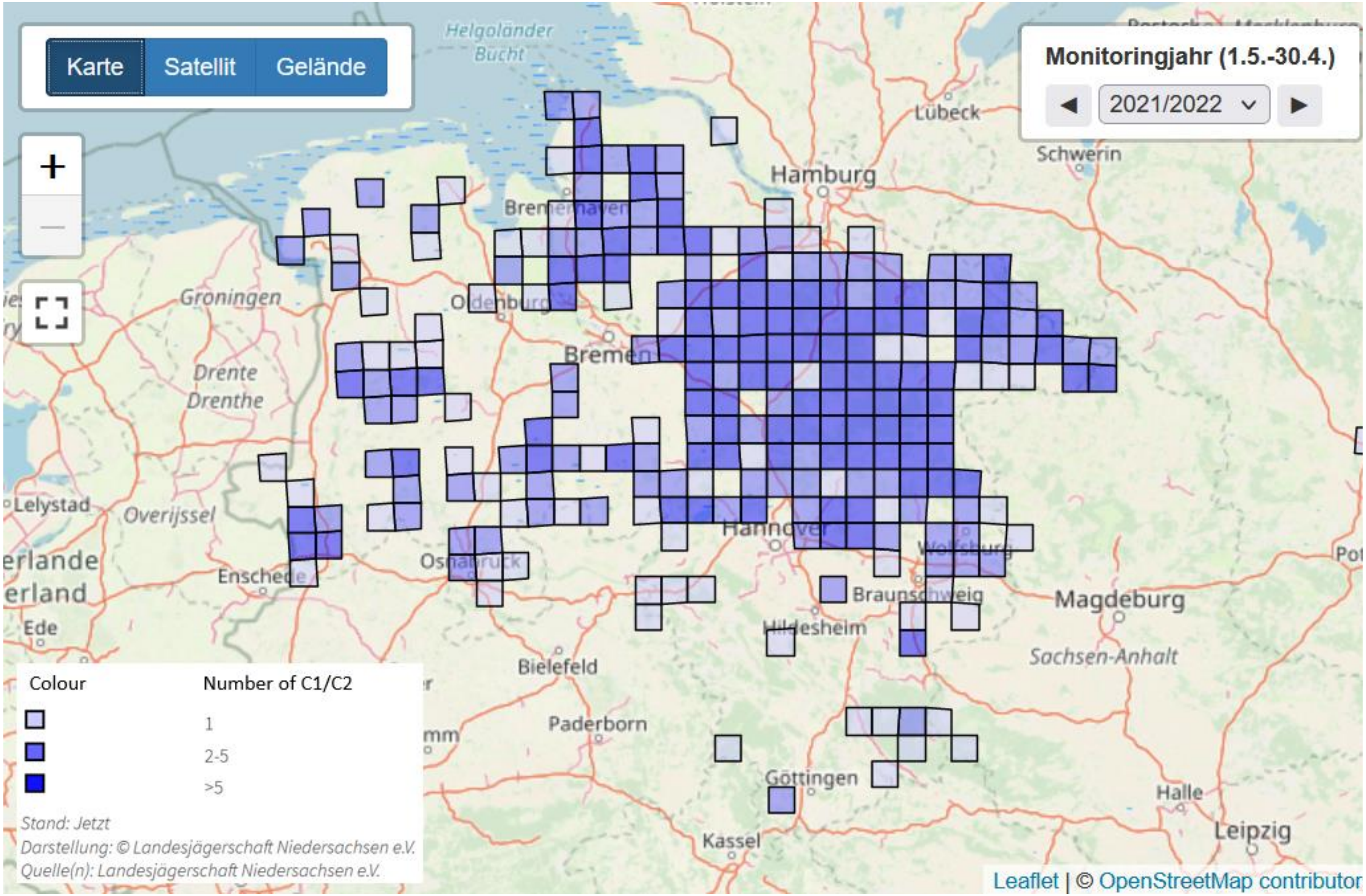


Figure 2.1e.

Land use cover in the study sites and focus areas in 2020 (blue) and 2022 (red), map adapted from CORINE.

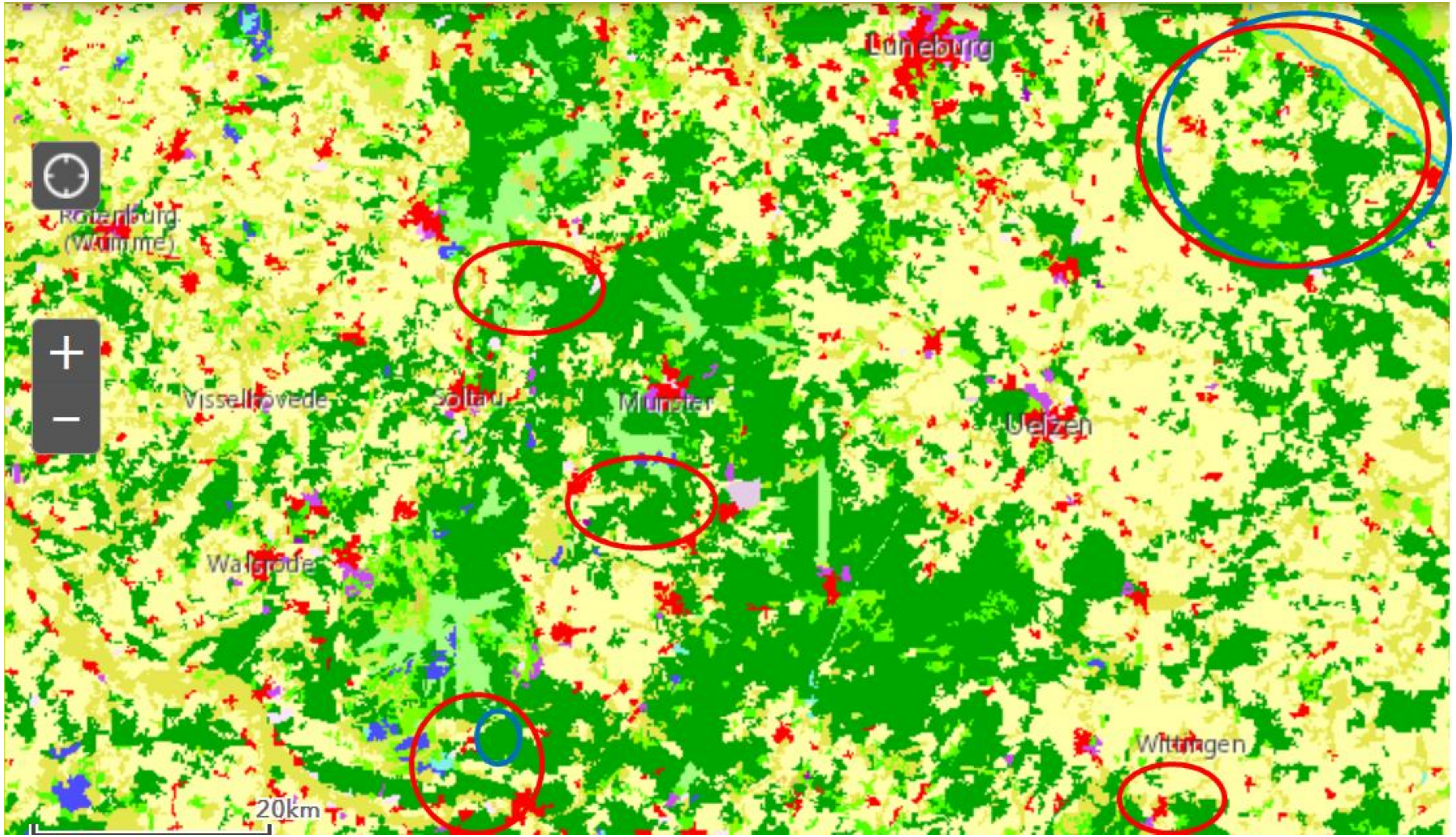


Figure 2.1f.

15 EEA grid cells covered during the 2020 surveys in two focus areas (indicated by pale shading).

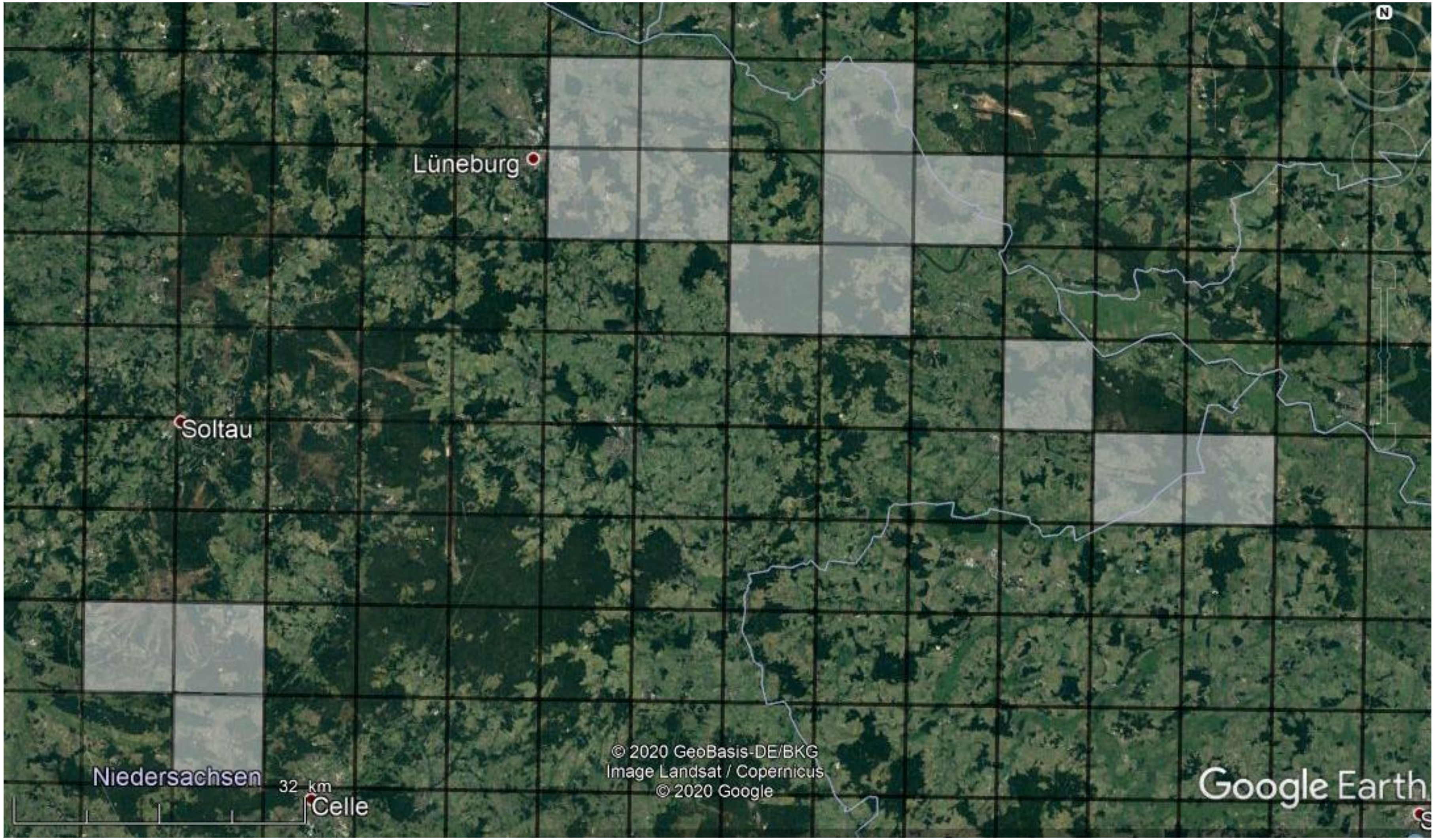
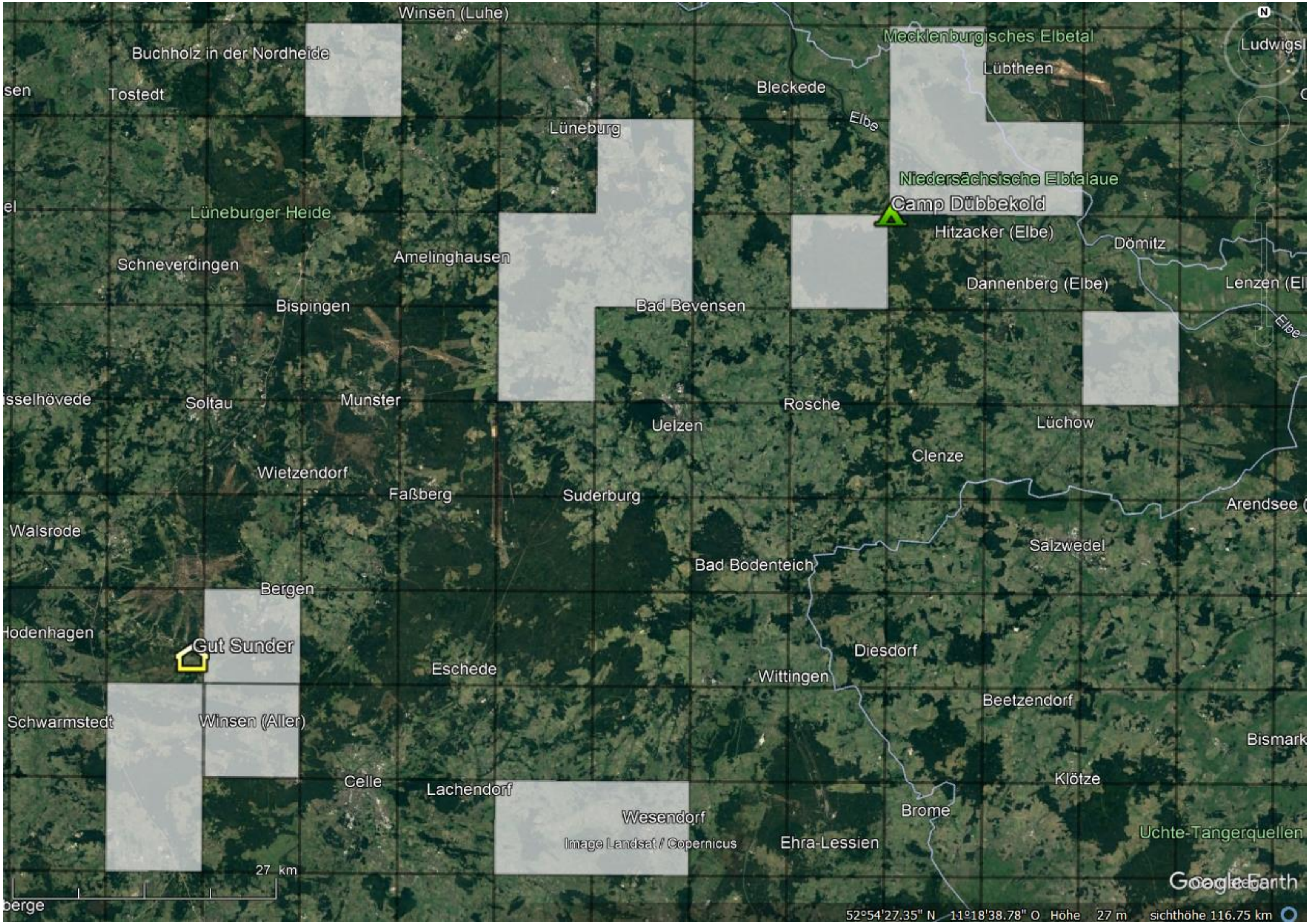


Figure 2.1g.

16 EEA grid cells covered during the 2022 surveys in five focus areas (indicated by pale shading).



2.2. Methods & results

The data gathered by this study form part of the official wolf monitoring programme of Lower Saxony. All relevant data were integrated into the official database run by the Hunters association of Lower Saxony (LJN) (LJN 2023b). Those were reviewed by the official wolf monitoring programme and assessed by SCALP categories (see Schütte & Hammer (2018) and Schütte & Hammer (2019) for a description of these). Since our data form part of the official wolf monitoring programme, they were published in the official LJN quarterly and annual monitoring reports.

2020

Over five days of surveying, participants walked almost 250 km, covering 15 cells of the EEA 10 km x 10 km grid in total, some of them multiple times so that grid cells were covered a total of 17 times (Fig. 2.1f, Table 2.2a).

Table 2.2a. Number of grid cells and length of routes surveyed by the 2020 expedition teams during the five expedition days. Note that the team split into four or fewer groups each day.

Week	Grid cells (N)	Routes total (km)	Routes day 1 (km)	Routes day 2 (km)	Routes day 3 (km)	Routes day 4 (km)	Routes day 5 (km)
1	15*	246.84	45.49	74.24	55.56	39.43	32.12

*As all surveys took place within 15 grid cells, some grid cells were surveyed multiple times = 17

2022

Over three weeks (i.e. three groups) of surveying, participants walked more than 837 km, covering 16 cells of the EEA 10 km x 10 km grid in total, some of them multiple times so that grid cells were covered a total of 35 times (Fig. 2.1g, Table 2.2b).

Table 2.2b. Number of grid cells and length of routes surveyed by the 2022 expedition teams during the three expedition weeks. Note that the team split into four or fewer groups each day.

Week	Grid cells (N)	Routes total (km)	Routes day (km)**	Routes day 3 (km)	Routes day 4 (km)	Routes day 5 (km)	Routes day 6 (km)
1	13	309.55	20.75	91.10	85.60	46.20	65.90
2	13	327.30	5.75	94.60	72.60	81.65	72.70
3	9	200.18	5.13	70.20	36.45	23.50	64.90
Total	**35***	**837.03**					

*As all surveys took place within 16 grid cells, some grid cells were surveyed multiple times, to a total of 35 cells
** Day 2: training day, survey in one group

Findings and their SCALP status

Scats that were sampled in the framework of the expeditions in 2020 and 2022 were assessed according to the nationwide SCALP categories: Scats that were shown to be from wolf by genetic analysis, were scored as a C1 piece of hard evidence. Samples with typical content such as bones, hair and teeth, as well as the right size and location in which they were found so that there was a high probability that they originated from a wolf, were scored C2 – confirmed sign. Old, rotten or bleached samples, which in appearance were likely to be from wolf were scored C3 (or C3a for those which were very likely to be from wolf). The samples that were collected in 2020 and classified to C1, C2 and C3a were frozen for dietary analysis and sent to the laboratory at the University of Veterinary Medicine Hannover (UVMH) Foundation (Institute for Terrestrial and Aquatic Wildlife Research) and LJN for analysis of wolf diet.

2020

The local/pandemic expedition of 2020 found a total 163 (putative) wolf scats in 8 EEA grid cells (Fig. 2.2b). 55 of those we kept for nutritional analysis and admitted for SCALP assessment. The remaining 108 scats were too old for laboratory analysis. 7 of the 55 samples were fresh enough (less than 48 hours old) to yield material for DNA analysis, so a small sample of these scats was put in ethanol and sent to the Senckenberg Research Institute for genetic analysis. The assessment of these scats was made only after the genetic results were on hand. Of the 7 genetic scat samples, the species wolf could be confirmed in all cases (100%). 37 of the 55 scats fulfilled the criteria for dietary analysis (Fig. 2.2c)

Table 2.2c. Samples gathered by the expedition and submitted for analysis in 2020.

Scat samples total	Scat samples for diet analysis	Scat samples for genetic analysis
55	37	7

In total, 8 (15%) of the 55 samples collected were classified as C1 pieces of hard evidence, 15 (27%) as C2 confirmed observations and 30 (54%) as C3 unconfirmed observations (Fig. 2.2a), of which 14 (25% of the total) were scored as C3a (very likely to originate from wolf). 2 samples had to be ignored due to missing information.

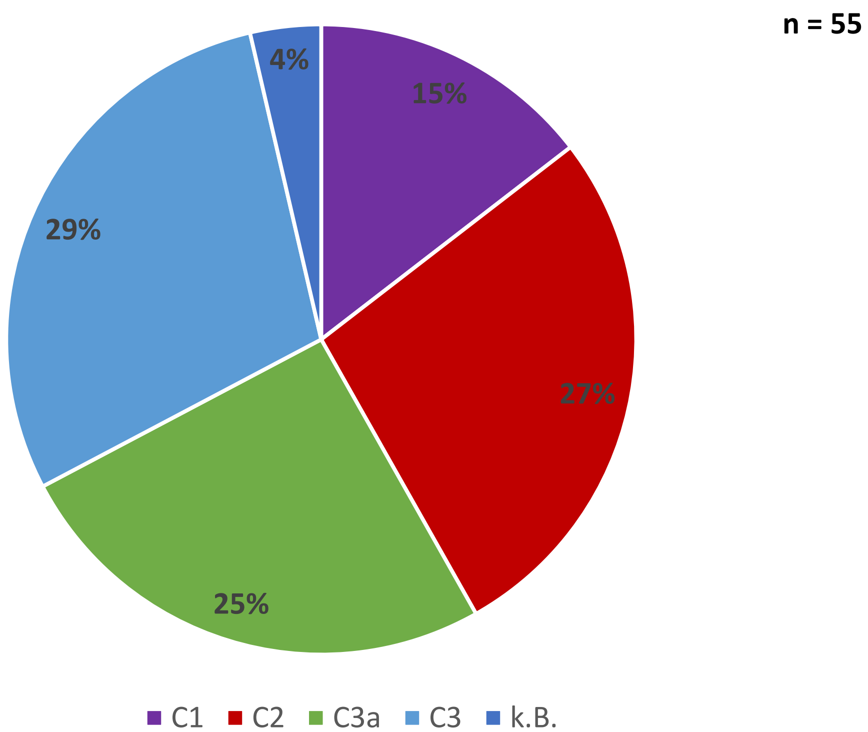


Figure 2.2a. The 55 scat samples collected by the expedition by their SCALP classification.
k.B = no assessment possible due to missing information.

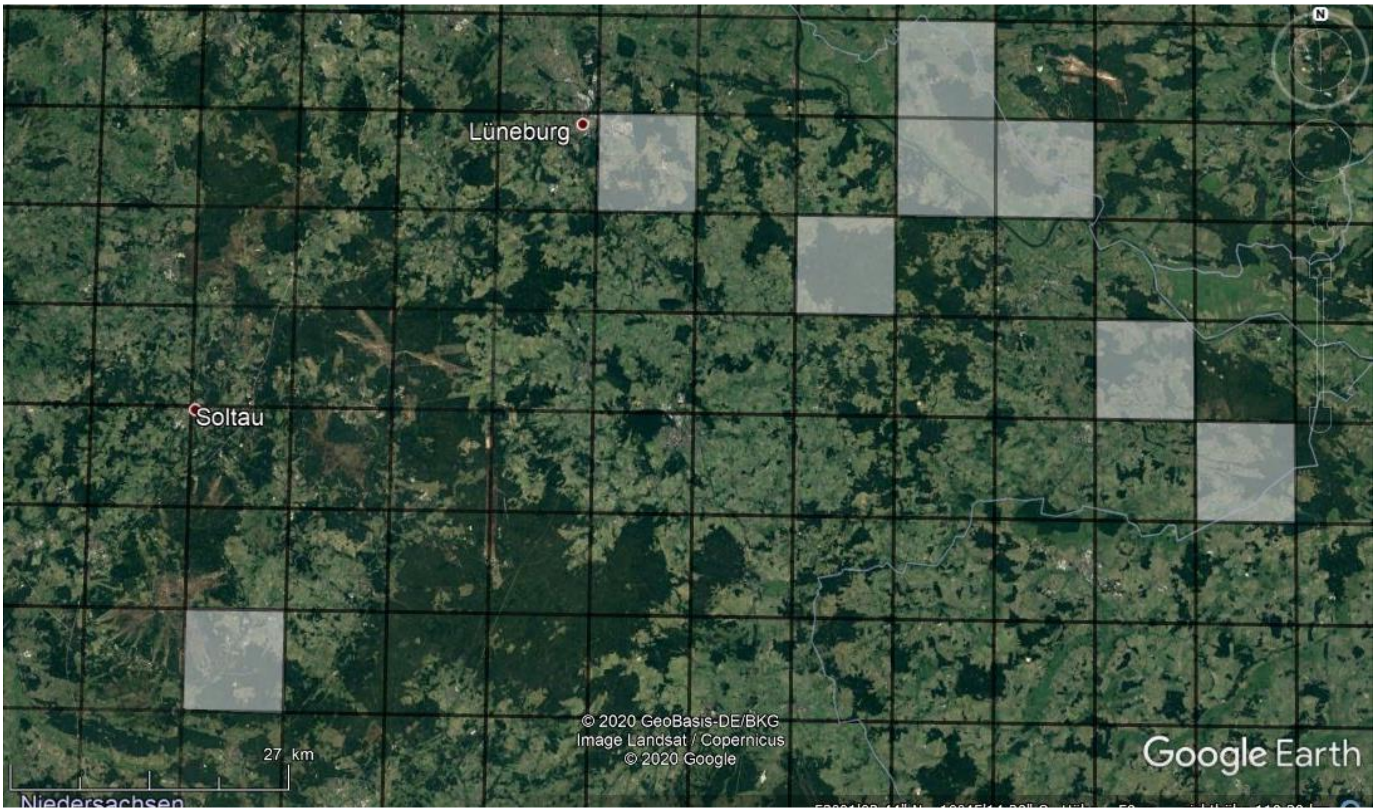


Figure 2.2b. 8 EEA grid cells in which wolf scat samples were collected in 2020

2022

A total of 186 (putative) wolf scats were found in 13 EEA grid during the normal operations/post-COVID-19 restrictions expedition in 2022 (Fig. 2.2d). 141 of those scats were kept for nutritional analysis and admitted for SCALP assessment. The remaining 45 scats were too old for laboratory analysis. Additionally, a wildlife carcass (mouse), as well as a wolf sighting were recorded. 15 of the 141 scats were fresh enough for genetic analysis and sampled. The partially eaten mouse, which was found by chance near to a potential wolf pup scat, was also sampled for genetic analysis. 108 of the 141 scats fulfilled the criteria for dietary analysis (Table 2.2d)

Of the 15 genetic scat samples, the species wolf could be confirmed in 12 cases (80%). Wolf DNA was also detected on the sample of the partially eaten mouse. Beside the scats and the wildlife carcass, a sighting in the Ebstorf territory was recorded. As the sighted wolf left a fresh scat, it could be identified as the male wolf GW1027m of the local pack.

Table 2.2d. Samples gathered by the expedition and submitted for analysis in 2022.

Scat samples total	Scat samples for diet analysis	Scat samples for genetic analysis	Wildlife carcasses for genetic analysis	Wolf sightings
141	108	15	1	1

Table 2.2e. Samples gathered by the expedition and submitted for analysis in 2022.

	Scat samples total	Scat samples for diet analysis	Scat samples for genetic analysis	Wildlife carcasses for genetic analysis	Wolf sightings
Week 1	62	43	6	0	1
Week 2	52	40	7	1	0
Week 3	27	24	2	0	0
Total	**141**	**107**	**15**	**1**	**1**

In total, 12 (9%) of the 141 scat samples collected were classified as C1 pieces of hard evidence, 19 (13%) as C2 confirmed observations and 11 (77%) as C3 unconfirmed observations (Fig. 2.2c), of which 76 (54% of the total) were scored as C3a. For one sample no DNA could be identified, two samples were assigned to other species (one red fox *Vulpes vulpes*, one pine marten *Martes martes*) (1%). As wolf DNA was detected on the partially eaten mouse, this was also classed as C1.

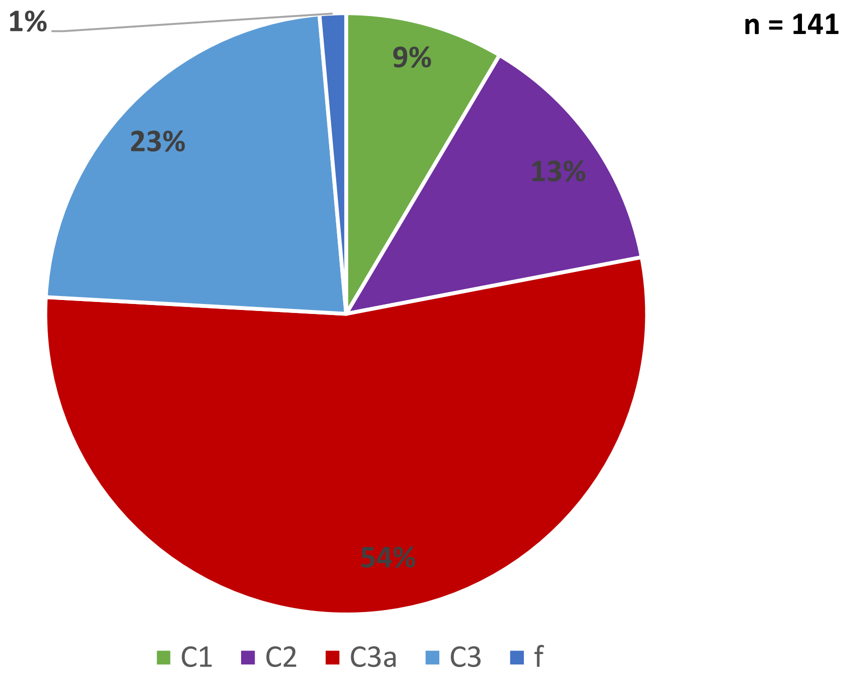


Figure 2.2c. The 141 scat samples collected by the expedition in 2022 by their SCALP classification. f (false) = scats assigned to another species.

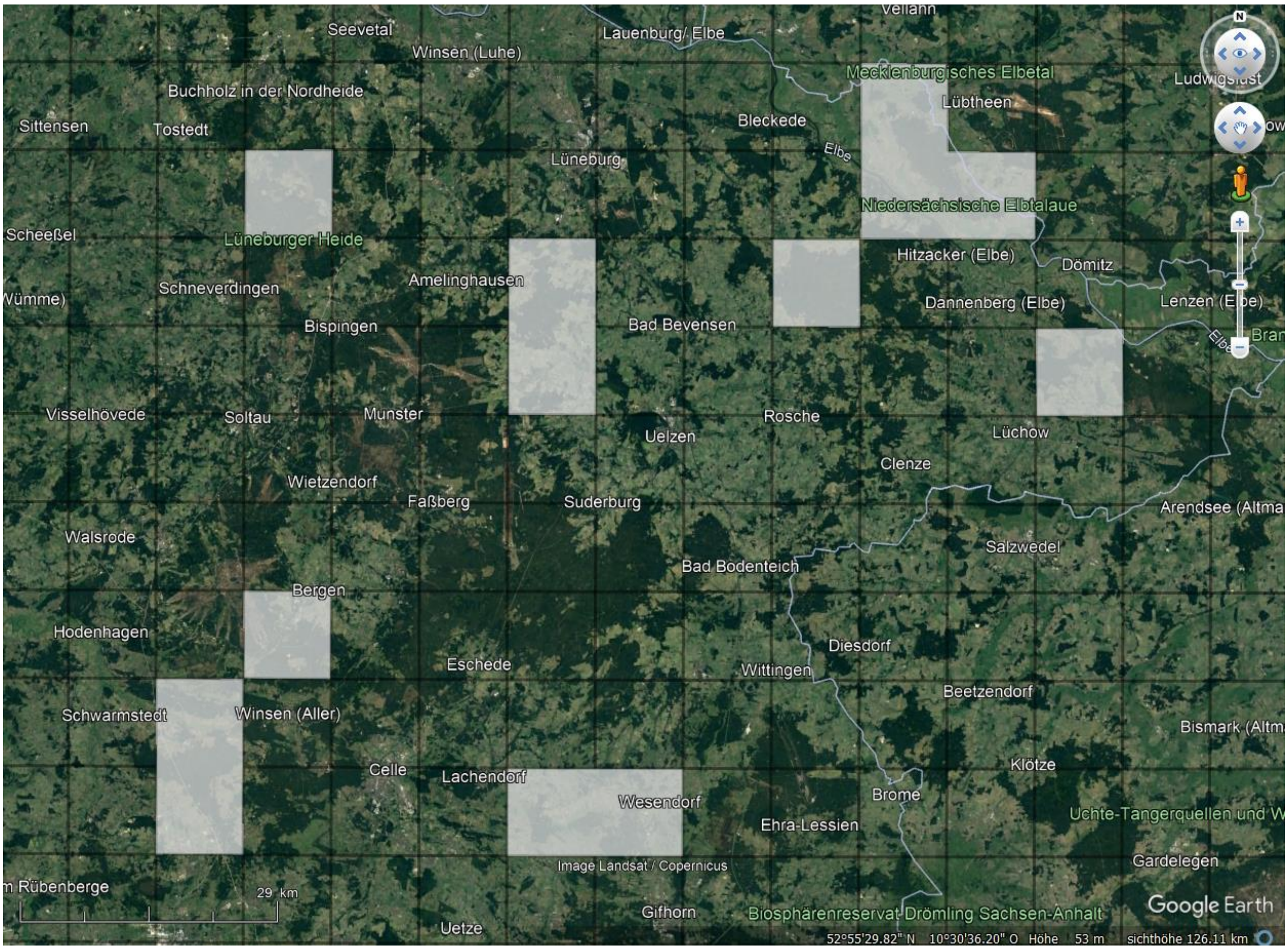


Figure 2.2d. 13 EEA grid cells in which wolf scat samples were collected in 2022.

In week 1 of 2022, 6 scat samples were scored as C1, eight as C2, 20 as C3 and 28 as C3a. In week 2, four scat samples were scored as C1, eight C2, ten as C3 and 28 as C3a (Fig. 2.2e). In week 3, two scat samples were scored as C1, three C2, two as C3 and 20 as C3a (Fig. 2.2e).

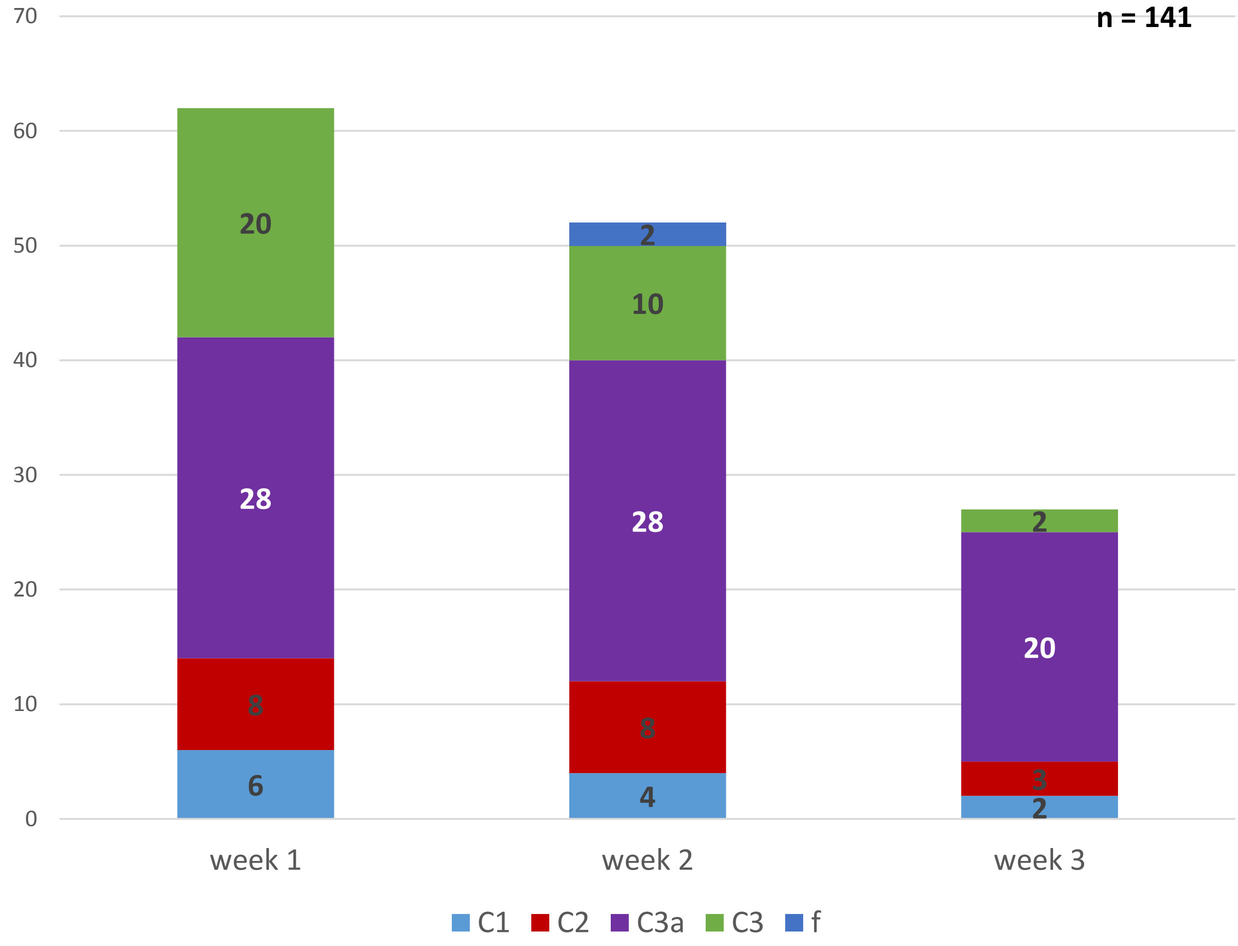


Figure 2.2e. The 141 scat samples collected by the expedition in 2022 by their SCALP classification. F (false) = scats ssigned to another species.

Food analysis

The 2019 expedition submitted 156 scat samples for wolf food spectrum analyses to the University of Veterinary Medicine Hannover (this compares to 200 scats for the 2018 and 75 scats for the 2017 expeditions) (Schütte et al. 2020). Samples from the 2020 and 2022 expeditions were also submitted for analysis. However, due to Covid and staff shortages, the analyses of samples submitted since 2018 are still ongoing and no results have been published yet. The aim is to publish results in future expedition reports. As reported in the 2017 expedition report (Schütte and Hammer 2018), the most frequent prey in the 2017 scat samples were roe deer (30%) and wild boar (29%), followed by red deer (18%), fallow deer (8%) and a general deer species category (8%) for deer remains that could not be identified down to species level. No livestock remains were found in the 2017 samples.

Genetics

2020

Seven scat samples were sent for DNA analysis of which all originated from wolves (Table 2.2f). Four samples could be assigned to known wolf individuals through comparison of existing DNA material. All in all, two male wolves and three female wolves were identified. In two cases the sex could not be detected (Table 2.2g).

Table 2.2f. Results of genetic analyses 2020.

DNA wolf	DNA no wolf	Species undetermined	Total DNA samples
7	0	0	7

Table 2.2g. DNA samples that could be assigned to individual wolves in 2020.

No.	Individual ID*	Sex	Territory membership of wolf providing DNA sample
1	GW432f	female	Göhrde
2	GW1796f	female	unknown
3	GW1865m	male	unknown
4	GW1866m	male	Lucie

*wolf ID assigned by the Senckenberg Research Institute, the reference institute for wolf genetics in Germany. The “G” stands for “genetic code”, the “W” for the species “wolf”, the “m” respectively “f” indicates the sex.

GW432f: This female wolf is a descendant of the Munster pack in the Luneburg Heath and represents the female wolf of the Göhrde pack in the very east of Lower Saxony where expedition partner Kenny Kenner works as a wolf commissioner.

GW1796f: This female wolf has not been genetically identified in Lower Saxony so far and its territory of origin is unknown. The pack of origin cannot be detected in cases where one or both parents are genetically unknown, which means that they have not been detected by genetic sampling so far. GW1796f was confirmed by a genetic scat sample collected within the Gartow territory.

GW1865m: This male individual was sampled within the Amt Neuhaus territory in the eastern part of Lower Saxony. His territory of origin is not known.

GW1866m: The genetic profile of this male indicates that it is a descendant of the Lucie female GW964f and another wolf and therefore a member of the Lucie pack.

Other possible wolf signs

During the expedition in 2020, other possible signs of wolf presence were recorded, but did not pass quality assessment procedures and as such were not submitted to official records. Instead they serve as hints for upcoming investigations and expeditions. Of this type of signs, one track (conditions or measurements for rating not met) and 25 scats (too old, not clear, no wolf-like smell) were recorded.

2022

15 scat samples were sent for DNA analysis of which 12 originated from wolves (Table 2.2h). In one case, it was not possible to determine the originating species, because the sample quality was too poor (too old, too wet) and therefore DNA could not be extracted. Additionally, one partially eaten sample of a mouse found by chance was analysed and determined to have been chewed by a wolf.

11 samples could be assigned to known wolf individuals through comparison of existing DNA material. All in all, three male wolves and five female wolves were identified (Table 2.2i), of which one male and two females could be confirmed twice. For two samples the species wolf, but no single individual, could be identified. Two of the 15 genetic samples were assigned to other species (one red fox *Vulpes vulpes*, one pine marten *Martes martes*).

Table 2.2h. Results of genetic analyses 2022.

	DNA wolf	DNA no wolf	Species not determinable	Total DNA samples
2022 week 1	6	0	0	6
2022 week 2	5	2	1	11
2022 week 3	2	0	0	2
2022 total	**13**	**2**	**1**	**16**

Table 2.2i. DNA samples that could be assigned to individual wolves in 2022.

No.	Individual ID*	Sex	Territory
1	GW2979f	female	Schneverdingen
2	GW1861f	female	Ringelah
3	GW2975f	female	Göhrde
4	GW872f	female	Amt Neuhaus
5	GW2534f	female	Ebstorf
6	GW1595m	male	Ringelah
7	GW1027m	male	Ebstorf
8	GW2980m	male	Ebstorf

*wolf ID assigned by the Senckenberg Research Institute, the reference institute for wolf genetics in Germany. The "G" stands for "genetic code", the "W" for the species "wolf", the "m" respectively "f" indicates the sex.

GW2979f: This female could be a descendant of the Schneverdingen pack (GW472f x GW317m). The situation of the pack is currently unclear. GW2979f was confirmed by a genetic scat sample collected in the Schneverdingen area.

GW1861f: This female was confirmed by a genetic scat sample collected within the Ringelah territory. Her pack of origin is not known.

GW2975f: This female was confirmed by a scat that was sampled within the Göhrde pack territory - the territory of origin of GW2975f, which resulted from the pairing of the Göhrde female GW432f and her mate GW1559m.

GW872f: This female was confirmed by a scat sample collected in the Amt Neuhaus territory. The individual is a member of the Amt Neuhaus pack.

GW2534f: The female GW2534f was confirmed in the Ebstorf territory, her territory of origin.

GW1595m: This male was confirmed by a scat sample collected in the Ringelah territory.

GW1027m: Besides the female GW2534f, GW1027m was also confirmed within the Ebstorf territory. GW1027m is the male wolf of the Ebstorf pack and mate of GW359f.

GW2980m: This male was confirmed by a scat sample collected within the Ebstorf territory, which is his territory of origin. The individual is a descendant of GW359f and her mate GW1027m.

Other possible wolf signs

During the expedition in 2022, other possible signs of wolf presence were recorded, but did not pass quality assessment procedures and as such were not submitted to official records. Instead they serve as hints for upcoming investigations and expeditions. Of this type of signs, five tracks could be recorded. One track was 356 m long and in direct register trot, which fulfils the monitoring standards. The other track conditions or measurements did not meet the requirements for recording. Additionally, 19 scats (too old, not clear, no wolf-like smell) were recorded.

Camera monitoring for permeability of wolf-deterrent fences

The 2022 expedition supported a field study by the project "Herdenschutz Niedersachsen". Wolves are very sensitive to electrical stimuli. Based on this, Fass (2018) argued that electric fences should be an effective protection of grazing animals from attacks by wolves. However, the erection of wolf-deterrent electric fences often raises fears that they represent an insurmountable barrier for other wildlife (Schoof et al 2021). Nolte and Schütte (2021), on the other hand, report all wildlife except wolf and wild boar does cross the fences. To test this initial finding and gather more data about about fence permeability, two fenced cattle pastures were monitored by up to four camera traps each between May and September 2022 (Fig. 2.2f). Four camera traps of one of these pastures were checked by citizen scientists on four occasions during the expedition. Captured photos and videos were then sorted and analysed by the citizen scientists under the supervision of the expedition scientists.

Ten of 36 observation days logged yielded 20 recordings of wildlife. In these 20 recordings one or two hares *Lepus europaeus* and in four cases a fox *Vulpes vulpes* were recorded. No other animals were recorded.

In addition citizen scientists, when checking the cameras traps, observed a pine marten *Martes martes* and a fox once. In both cases the animals quickly disappeared, crossing the fence by jumping in between the wires, which are spaced 20 cm apart.

This confirms fence permeability for this type of wolf-deterrent fence, at least for smaller species such as pine marten and fox. The previous study by Nolte and Schütte (2021) showed that roe deer also easily jump through the wires of this fence. In addition, farmers and hunters report seeing red and fallow deer jump over this fence, but this has not been recorded on camera yet. Therefore, another study will be conducted in 2023, in line with Nolte and Schütte's (2021) argument that this type of intensive camera monitoring should be conducted for at least three consecutive months in order to achieve meaningful results about wildlife behaviour, movement and crossing of wolf-deterrent fences. Assistance by expedition citizen scientists to this end was a welcome help.

Figure 2.2f. Camera trap installed at wolf-deterrent permanent electric fence.

Figure 2.2g. Hare *Lepus europaeus* on pasture land after having crossing the fence.

2.3. Discussion & conclusions

Efficiency of effort – data quantity and quality

2020

Due to the pandemic, only a local expedition took place in 2020. Nevertheless, the total number of 55 scats collected in only 5 days by a small experienced team only shows how valuable citizen science work is. According to the monitoring report for the third quarter of the year 2020, 143 scats were reported from July to September (LJN 2020b). Of these, 43% (!) were collected by the 2020 local expedition.

2022

The 2022 expedition, as with all other expeditions before, also made a very significant contribution to wolf monitoring efforts in Lower Saxony in terms of quantity: With 141 (potential) wolf scats, a quarter of wolf scats reported by the official wolf monitoring programme between January and September 2022 (the numbers for the fourth quarter October to December are not published yet) (LJN 2022a,b,c) were collected by the 2022 normal operations expedition.

In terms of quality, the work of the citizen scientists was significant too.

The proportion of all scats collected by the expeditions over the years in the C1 and C2 SCALP category is shown in Table 2.3.a. The proportion is consistently high, given the expedition is only active for one to three weeks per year. The average of 38% is not significantly different from the 40% of C1 and C2 scats collected by the official wolf monitoring programme over the whole year of 2021, when no expedition could take place due to the pandemic (LJN 2021a,b,c,d). All this shows the very significant contribution the expedition makes to monitoring efforts and that there is no qualitative difference between official collection efforts, mainly by local hunters and foresters, and those of the citizen scientists with a day and a half of intensive training prior to collection. This leaves no room for doubt that with a day and a half of training, citizen scientists can make high quality and high quantity contributions.

Table 2.3a. Total numbers and proportion of C1 and C2 scats of all scats collected by the expedition vs. others (such as the Local Hunting Association and official monitors). Year 2021 missing due to pandemic.

	2017	2018	2019	2020	2022	**All yrs**
Total number of C1/2 scats collected by expedition in year	41	82	56	23	31	**233**
Proportion of all C1/2 scats collected by expedition for monitoring in that year	54%	37%	36%	43%	21%	**38%**

The key factor for successful surveys is the availability of information about the wolf territories in the areas surveyed. A targeted and therefore highly successful search for wolf signs, such as demonstrated by this expedition, is only possible through good information flow between the expedition and local stakeholders with detailed knowledge of wildlife and wilderness, such as the local wolf commissioners, foresters and hunters.

C3 and C3a scat samples were also collected and will be sent to a laboratory in order to contribute to research about the food spectrum of wolves in Lower Saxony.

Wolf population dynamics

A total of four individual wolves were identified via DNA samples collected by the expedition in 2020, eight were identified in 2022 (ten in 2019, also ten in 2018, six in 2017), three of them twice, namely GW1027m, GW1320f and GW906m, two others three times, namely GW191f and GW359f. Two wolves were genetically identified for the first time through samples collected by the expedition in 2019: GW1429m a descendant of the Schneverdingen pack and GW1430m, a descendant of the Göhrde area pack. In addition – by identifying GW1027m (Münster/Bispingen), GW191f (Bergen) and GW906m (Wietzendorf) – insights into the movement ranges of wolves were gained.

GW1027m, originating in Münster, sampled in Amt Neuhaus during the expedition in 2018 and in the Ebstorf region in 2019, demonstrates the migration of (young) wolves through other territories in search of their own. Exact information about territory borders, kinship and offspring or migration routes can only be gleaned partially by the official wolf monitoring programme. For a comprehensive picture, there is simply not enough information in the form of DNA samples. In other words, despite considerable efforts, not least of the expedition, many more samples and well-planned active monitoring efforts are necessary.

For the monitoring year 2021/22 reproduction was detected in 91% of all wolf packs in Germany (DBBW 2023b). This means that an increase in the wolf population is highly likely and that more territories will be occupied throughout the country, Lower Saxony included. Active monitoring remains essential to track those changes, as well as shifts of territories or territory borders and changes in pack composition (which become increasingly difficult to track with increasing density of territories). This means that citizen science projects such as this have the potential of becoming an increasingly important tool to gain information about numbers of territories, wolf packs sizes and individuals, especially since the wolf population is likely to increase in future.

We therefore urge the state government and the state hunting association in charge of wolf monitoring to consider utilising the potential of citizen science to help with monitoring efforts, for example by creating a wolf monitoring citizen science programme and app. There are a myriad of examples of citizen science projects already in existence, as shown, for example, on the European Citizen Science Association (of which Biosphere Expeditions is a member) project website and Biosphere Expeditions stands ready to advise the state government and other stakeholders on this subject.

Over 837 km of survey effort and one wolf encounter were registered by the expedition in 2022 (2020: zero encounters over 246 km, 2019: two encounters over 743 km, 2018: one encounter over 750 km, 2017: zero encounters over 1,100 km). From this it is clear that the chances of encountering a wolf during daytime, even when looking for wolf signs in suitable habitat, are very small. Reports in the media and by anti-wolf campaigners of the state being “overrun” by wolves are therefore clearly exaggerated.

Local stakeholder and co-operations

Our main aim was to collect indirect wolf signs, with an emphasis on finding scat samples in order to assist official wolf monitoring efforts and supplement the wolf monitoring database. This aim was achieved. In addition, data collected by the expedition also allowed important conclusions to be drawn about some of the wolf territories and newly identified individual wolves. We conducted the 2020 and 2022 surveys by and large in areas with similar or the same survey routes as in the previous years (Schütte and Hammer 2019), but some new areas were added too. Thanks to the notable and much welcomed cooperation of local stakeholders such as wolf commissioners first and foremost, but also hunters and foresters, study areas could be selected with a high degree of specificity, so that a high number of usable scat samples could be collected. This is also the main reason why the inaugural 2017 expedition collected only 76 scats with four groups (Schütte and Hammer 2018), whereas the 2018 expedition collected 218 scats with two groups, the 2019 expedition 156 scats, also with two groups. The local/pandemic 2020 expedition collected 55 with one small group and the 2022 normal operations expedition collected 141 scats with three groups.

Summary

The expedition is now well established in Lower Saxony and conducts successful annual expeditions, now for its fifth year, in collaboration with local stakeholders such as the State Forestry Department, local wolf commissioners and tourism and other businesses. It is clear that the efforts of well-trained citizen scientists deployed as part of a well-planned fieldwork expedition can be very productive and that highly valuable data can be acquired through targeted active wolf monitoring work conducted by citizen scientists.

Taking a look at the bigger picture, it is clear that the wolf has returned to Germany and Lower Saxony to stay. The expedition is proud to play its part in providing fact-based evidence, supporting state monitoring efforts to a very significant degree. At the same time it regrets that some states (such as for example Lower Saxony and Bavaria) continue to undermine the status of the wolf as a strictly protected species by at times allowing wolves to be killed indiscriminately in the name of livestock protection. Scientific evidence shows clearly that this is a non-solution. Wolf populations continue to rise in Europe, with mobile young wolves replacing killed wolves at a rate of two to one. In France for example, 10% of wolves (about 100 individuals) are killed each year without any significant decrease in livestock kills. This is because of these replacement effects, as well as disturbing social cohesion in packs through selective killing. When thus disturbed, packs tend to hunt more livestock as less experienced animals take over. If, on the other hand, the state kept calm and allowed wolf populations to settle, then positive effects would appear. In the east of Germany, for example, where wolves have been present for longer, wolf density has peaked, because populations have reached a natural ceiling where established packs prevent other wolves from settling in the area. This natural mechanism works well and allows experienced wolves, who by and large concentrate on hunting wildlife rather than livestock, to do the bulk of hunting. It is noteworthy that this effect can also be observed in Lower Saxony, in areas where the state does not interfere with natural processes by seeking to kill wolves, despite the fact that interference through killing is almost always counterproductive. Besides, selective removal of a ‘problem wolf’ (an animal that repeatedly kills livestock) is very difficult to achieve in practice: The last time Lower Saxony attempted to kill a ‘problem wolf’ in early 2023, it had to admit that six other wolves had been shot dead instead of the target wolf. Despite all this, killing wolves - mostly in the guise of removing ‘problem animals’ - keeps being suggested as a false solution, by and large by politicians (in Lower Saxony and elsewhere) with their eyes firmly on the ballot box, rather than scientific facts and the realities of wolf biology.

We strongly believe that instead of peddling wolf kills as false solutions, a system of regionally active, trained professionals is needed, who can respond to questions about and issues around wolves directly, unbureaucratically and competently, and act close to the ground and in close cooperation with the local population and stakeholders. Those who are exposed to real risks through wolves, namely livestock owners, should be listened to, supported and compensated as necessary, ideally through an effective, unbureaucratic and nationwide support and advice system. However, so far the federal and state governments, as well as agricultural and veterinarian bodies, have failed to create the appropriate structures and processes necessary when a large carnivore returns to a cultural landscape.

We consider setting up a citizen science monitoring effort to be one of the crucial ingredients to appropriate structures and processes and urge government to accept our offer of help and expertise. In addition, we believe that more must be done to stop illegal wolf killings.

Whilst there are challenges that come with wolf presence, there are opportunities too. We see the biggest potential in rural communities generating income through tourism based on nature and wolf presence, as well as getting local people buy-in through setting up a citizen science monitoring programme. Furthermore, wolf presence can contribute to the regulation of browsing by large wild herbivores and thus be supportive to regeneration of forests (CHWOLF 2020).

Against the background of the ongoing expansion of wolves in Germany, which still has plenty of available, suitable and unoccupied habitat, we believe that the value of and need for citizen science in the monitoring of wolves will grow. With a higher wolf density, it will become increasingly difficult to obtain a clear picture of the locations of single territories, the number of wolves and relationships. A lot of staff, time and money is needed to fulfill the legal obligations of the Flora-Fauna-Habitat Directive and citizen science can – and in our opinion must - be part of the solution.

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