Misgurnus fossilis

The current distribution and abundance of *Misgurnus fossilis* in Limburg

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Study year/ semester: 2021/2022, Semester 8

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Place and date: Roermond, June 27th, 2022

UNIVERSITY OF APPLIED SCIENCES

waterschap limburg
met de omgeving, voor de omgeving

Misgurnus fossilis in province of Limburg

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Document: Final Thesis report
Place & Date of publication: Roermond, The Netherlands, June 13th 2022
Version: Final

Illustration cover page: Misgurnus fossilis (own pictures)

Preface

Presented before you lies the final thesis: "The current distribution and abundance of *Misgurnus fossilis* in Limburg", in which the distribution and density of *Misgurnus fossilis* is researched in the streams of Limburg. This thesis was written as part of my graduation from the Water Management (Aquatic Eco-Technology) programme at HZ University of Applied Sciences. This report was written from February 2022 to June 2022. During this research and the writing of my thesis, Erik Binnendijk (supervisor Waterschap Limburg) and Bram Verkruysse (supervisor HZ) assisted me in gaining vision on the subject, finding new insights, helping to conduct field research and advising me in the process. Due to their critical view and guidance, I gained a lot of new knowledge in a short timeframe, and I learned what kind of work I would like to do in the future. A special thanks also goes to the department of Area Management of Waterschap Limburg.

Janneke Janssen

June 2022

Abstract

This study examines the current dispersal and abundance of *Misgurnus fossilis* (Weather fish) in Limburg, the Netherlands. From previous research, 54 individuals of *M. fossilis* were observed but not traced since 2016. Because the distribution and abundance is not clear, it is not known how the species are developing and where (maintenance) activities may or may not be carried out. Because of its status as a Red List species, Waterschap Limburg wants to preserve *M. fossilis* in its waters. The aim of this study is to map the current dispersal and abundance of *M. fossilis* in the waters of Limburg, which is also the main question of the study. As part of this process an inventory was made based on the National Databank for Flora and Fauna to determine the already known dispersal and abundance of *M. fossilis*. These data have subsequently been validated.

The research was carried out by means of a literature study, database analysis, field research, and a comparison between the previous and current data. The field research was carried out by placing fykes, electrofishing and eDNA research.

Current research has shown that there are 7 individuals of *Misgurnus fossilis* in Broekhuizen (n=1) and Herkenbosch - Postbeek (n=6). The distribution and abundance are strongly reduced compared to previous observations. This is probably due to the decrease in sedimentary habitat as a result of human intervention. As well as the disappearance of the low dynamic floodplain due to agricultural intensification.

It is therefore advised to improve the existing habitats by doing more research on an ideal habitat for *M. fossilis* so that an improved maintenance plan can be drawn up. In doing so, the area to be improved should be identified. After the results of the eDNA research have been made known, more field research should be done in the waters to try and find *M. fossilis*.

Samenvatting

Dit onderzoek gaat in op de huidige verspreiding en abundantie van *Misgurnus fossilis* (Grote Modderkruiper) in Limburg, Nederland. Uit voorgaand onderzoek zijn er 54 individuelen waargenomen echter zijn deze niet meer getraceerd sinds 2016. Doordat de verspreiding en abundantie niet duidelijk is, weet men niet hoe de soort zich voort ontwikkeld en waar wel of geen (onderhoud)werkzaamheden mogen worden uitgevoerd. Vanwege zijn status als Rode Lijst soort wilt Waterschap Limburg *M. fossilis* behouden in haar wateren. Het doel van dit onderzoek is om de huidige verspreiding en abundantie van *M. fossilis* in de Limburgse wateren in kaart te brengen, wat tevens ook de hoofdvraag van het onderzoek is. Als onderdeel hiervan is een inventarisatie gemaakt op basis van de Nationale Databank Flora en Fauna om de reeds bekenden verspreidingen en abundantie van M. fossilis te bepalen. Deze gegevens zijn vervolgens gevalideerd.

Het onderzoek is uitgevoerd door middel van een literatuur studie, voorgaande onderzoek data te vergelijken, veldonderzoek en een vergelijking te maken tussen de voorgaande en huidige data. Het veldonderzoek is uitgevoerd door fuiken te plaatsen, elektro vissen en eDNA onderzoek.

Uit huidig onderzoek is gebleken dat er 7 individuen van *Misgurnus fossilis* zich bevinden in Broekhuizen (n=1) en Herkenbosch – Postbeek (n=6). De verspreiding en abundantie zijn sterk afgenomen in vergelijking met voorgaande waarnemingen. Dit komt waarschijnlijk door de afname van het sedimentaire habitat als gevolg van menselijke ingrijpen. Evenals het verdwijnen van de laag dynamische uiterwaarden door de intensivering van de landbouw.

Het wordt daarom geadviseerd om de bestaande habitatten te verbeteren door meer onderzoek te doen naar een ideaal habitat voor *M. fossilis* zodat een verbetert onderhoudsplan kan worden opgesteld. Hierbij moet gekeken worden welk gebied men wilt verbeteren. Nadat de resultaten van het eDNA-onderzoek bekend zijn gemaakt, moet meer veldonderzoek in de wateren worden verricht om te proberen *M. fossilis* te vinden.

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1. Introduction

Misgurnus fossilis (English: Weather fish, Dutch: Grote modderkruiper) is a rare species in Europe and is endangered in the Netherlands. *M. fossilis* was first named during research in 1758, where they were observed in Stockholm. They have also been observed in the province of Limburg, the Netherlands, where they are considered vulnerable (Lundberg & Svanberg, 2016). Research has shown that *M. fossilis* has mainly been observed around Roermond, Venlo, Venray and Weert (North and Central Limburg) (BIJ12, 2021). *M. fossilis* is native to the Netherlands and is found in the floodplains of rivers and streams. The habitat is formed by waters with a muddy bottom, with a wide zone of structure-rich marsh vegetation. These habitats are formed by peak discharges which have cut bends and shifted stream channels, causing the streams to become silted up and providing a suitable habitat for *M. fossilis*. However, the rise of agriculture has reduced the habitat of *M. fossilis*.

M. fossilis is an active nocturnal creature, yet during the day they resides in clay and sandy soils or vegetation, where they can burrow (BIJ12, 2021). Additionally, *M. fossilis* adapts easily to various water conditions. Due to their ability to breathe through their skin, they can survive low water conditions and low oxygen concentration. Furthermore, the high mobility and agility of *M. fossilis* with increasing atmospheric pressure is possibly a behavioural adaptation to disperse or colonise new habitat when water levels rise due to thunderstorms (de Bruin & Kranenbarg, 2009). *M. fossilis* lives mainly in solidarity, despite its natural occurrence in larger numbers relatively close together. *M. fossilis* is mainly sedentary and spends a large part of its life in a limited area. As a result, the species have short dispersal and migration distances (BIJ12, 2021).

1.1 Problem statement

M. fossilis is a rare species in the waters of Limburg, as well as in the rest of the Netherlands where they have been listed as “Endangered” in the European Fauna-Flora-Habitat and Natura 2000 directives (Pyrzanowski, et al., 2021; Ministerie van Landbouw, Natuur en Voedselkwaliteit, sd). Since *M. fossilis* is an endangered species in the Netherlands, research can be done to map the residence and abundance of the species, and how the species is doing in terms of extinction. The National Database of Flora and Fauna (NDFF) is a collection platform for various institutions which have mapped the current distribution of *M. fossilis*, but of which one is not sure whether the data is still correct. Since *M. fossilis* burrows in the sediment, it is difficult to check sightings. As they live in the bottom or dense vegetation in low-dynamic floodplains of rivers and streams where the species occurred in isolated cut-off river arms, creeks, marshes, and fens. As these areas have been reclaimed over the centuries, a substantial part of the Dutch habitat is found in polder ditches. The habitat of *M. fossilis* are areas with banks and rich underwater vegetation in or near rapidly warming waters. In these areas often seepage is present, resulting in good water quality (BIJ12, 2021).

Challenging in researching this species is that current information on the distribution of *M. fossilis* is not available or not clear. Often data is barred and during monitoring, *M. fossilis* is often not visually found. Since *M. fossilis* is not found, it is thought that they are probably no longer in the area. The uncertainty in the current distribution of *M. fossilis* can cause problems for maintenance work, for example, the banks and aquatic vegetation cannot be mowed or removed if *M. fossilis* is (suspected to be) present. Where *M. fossilis* has been observed, problems with waterlogging are often occurring. As the vegetation cannot be mowed due to the presence of *M. fossilis*, the water is retained by the vegetation. This reduces or blocks the flow and causes the water level to rise near the vegetation. This can cause flooding (Penning, et al., 2020).

1.2 Research questions

The aim of the study reported is to expand the current knowledge of *M. fossilis*. The research is performed in cooperation with the client Waterschap Limburg. The research question is:

- What is the current distribution and abundance of *Misgurnus fossilis* in Limburg?

To answer the main question several sub questions have been formed, namely:

- Where has *Misgurnus fossilis* previously been sighted according to the National Database of Flora and Fauna and how is the data validated?
- What is the current distribution of *Misgurnus fossilis*?
- What is the population density of *Misgurnus fossilis* at the observed sites?

1.3 Objective

The aim of the study is to investigate the current distribution and density of *M. fossils* in the waters of Limburg. Once *M. fossilis* has been properly mapped, Waterschap Limburg and other stakeholders can make a renewed and improved maintenance plan; so, the habitat remains optimal or can be recovered for the fish and their numbers can grow.

1.4 Structure of the study

This report has been written according to the following structure. A literature review was conducted, providing a solid knowledge base to build the research. This literature review has formed the theoretical framework which can be found in this report. The existing data was researched in terms of perception and validity. From this literature study, various research methods have been determined to be carried out during fieldwork. These determination techniques will be carried out to map the dispersal of the species. In addition, a literature study was done to determine whether there are possibilities for habitat optimisation to improve the habitat of *M. fossilis*.

2. Theoretical framework

2.1 Physical characteristics of *M. fossilis*

M. fossilis have an elongated, round body with a tail that is flattened laterally. They have a subterminal mouth with ten beard filaments (1). Usually, *M. fossilis* does not grow longer than 20 to 25 centimetres, however, there have been individuals observed which were 30cm maximum (BIJ12, 2021).

To distinguish sexes of *M. fossilis* it is most helpful to look at the shape and size of the pectoral fin (2). In males, the pectoral fin is long and pointed. Furthermore, the male may have a widening of the body at the level of the dorsal fin (3) and an orange spot behind the dorsal fin. During the spawning season the males may have a spawning rash on the pectoral fin. The females have a short and rounded pectoral fin compared to the males and they do not have a thickening of their body (BIJ12, 2021; De Bruin et al., z.d.; Luna & Torres, z.d.; Natura2000, 2008; OVB, 2004; Van Beek, 2003). Figure 1 shows *M. fossilis* and *Appendix 1* shows a recognition chart of the genus of *M. fossilis* (de Bruin, Herder, & Hartmant, sd).

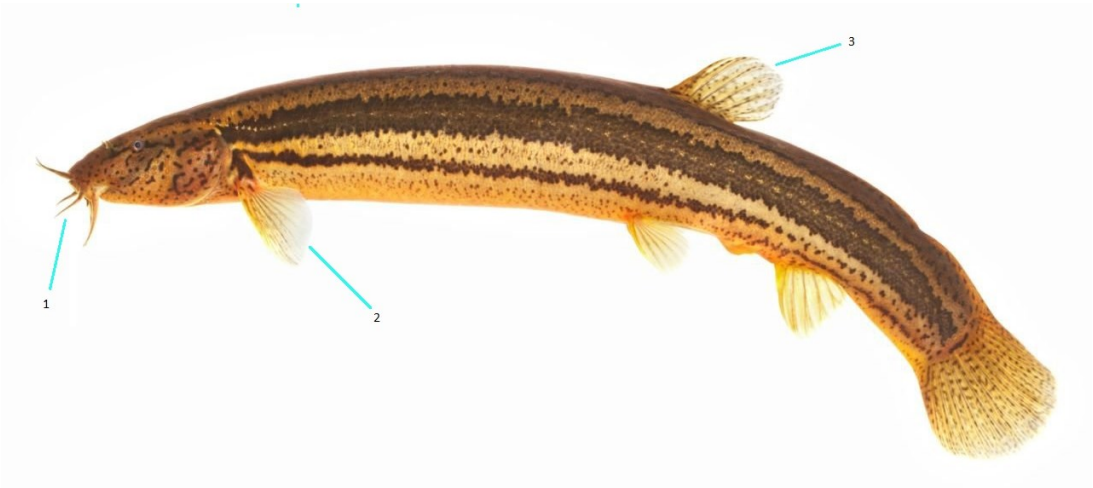


Figure 1 Misgurnus fossilis (RAVON, 2014)

2.2 Habitat characteristics of *M. fossilis*

As mentioned earlier, *M. fossilis* is an active nocturnal creature, yet they reside in clay and sandy soils or vegetation during the day, where they can burrow. However, *M. fossilis* can be active during the day if there is disturbance in the water such as, predators swimming close by (BIJ12, 2021; Beek, van, 2003). Research has shown how easily *M. fossilis* can adapt to various water conditions due to its long-shaped body, they can more easily pass-through dense vegetation and mud layers. In addition, they can store air in their intestines and breathe through their skin. This enables *M. fossilis* to survive in low water conditions, including periodic dry periods, and low oxygen concentrations. Another characteristic is the change in atmospheric pressure can be observed by a morphological adaptation of the inner ear, and swim bladder. Increases in atmospheric pressure causes behavioural change. The heightened mobility and agility of *M. fossilis* with increasing atmospheric pressure is possibly a behavioural adaptation to disperse or colonise new habitat when water levels rise due to thunderstorms (Kranenberg & de Bruin, 2009; Pyrzanowski, et al., 2021). Additionally, they have a thick mucus layer that offers protection against dehydration. If the water level drops below the sediment and it dries out completely, *M. fossilis* will not survive (BIJ12, 2021; OVB, 2004).

Inside the habitat of *M. fossilis* are four important elements which need to be available: breeding location, sufficient hiding places for the juveniles, sufficient food at the location and a sufficient place to stay during unfavourable periods for *M. fossilis* (such as drought or cold). These essential elements

are present within the water system where *M. fossilis* occurs, within migration distance from each other. In order to have these elements in the habitat, shallow spawning zones are needed, which need to be often strongly sunlit and have a rich underwater vegetation, with an absence of other fish species. Furthermore, it is important that narrow ditches are connected to wider ditches that are part of the habitat for migration possibilities (BIJ12, 2021). In Figure 2 a schematic cross-section of the ideal habitat of *M. fossilis* is shown. Point 1 shows the shallow reproduction water (green), point 2 shows the habitat of the adult *M. fossilis* (light blue) and point 3 shows the area where *M. fossilis* can be found during winter or dry periods (dark blue).

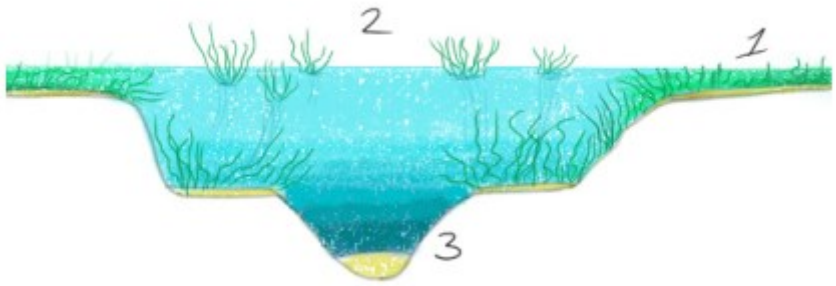


Figure 2 Schematic cross-section of the ideal habitat of M. fossilis (BIJ12, 2021)

Belpaire & Coeck (2016) describe general management strategies for the sustainable conservation of *M. fossilis*, depending on the state of the population and their habitat. Some of the issues addressed are population distribution, implementation pressures on the population and metapopulation structure. With these criteria, strategies are designed to help conserve the population and habitat of *M. fossilis*. One strategy is to secure the population by removing (potential) threats. This with the aim of optimising the current habitat. Also, strengthening, connecting and expanding the habitat is important for dispersal and spawning opportunities. When the population grows, unoccupied habitats can form a new habitat for the (growing) population (Bruin, de & Kranenberg, 2014).

M. fossilis consumes a variety of fauna, which includes worms, snails, mosquito, other insect larvae and water woodlice. They also eat flora such as decaying plants, feed on zooplankton and phytoplankton (Beek, van, 2003). Research has shown that *M. fossilis* is eaten by Esox Lucius (Pike) (MÉRO, 2015), Tinca tinca (Tench) and Cyprinus carpio (Carp), Abramis brama (Common bream), Dragonfly larvae and Reduviidea (Beek, van, 2003).

2.3 Reproduction of *M. fossilis*

M. fossilis has one period of increased activity, which is the reproductive season which takes place from April till August. Spawning (deposition of eggs) takes place on flooded riparian zones or shallow vegetation-rich riparian zones. A riparian zone is an transitional area from aquatic to terrestrial ecosystem. The deposited eggs (between 70,000 and 150,000) are placed in shallow waters, which helps the eggs to warm up quickly. Temperature plays an important role in hatching and the speed of larval development (BIJ12, 2021; van Beek, 2003).

The lifestyle during the breeding season is the same as in other periods. *M. fossilis* has a permanent breeding and resting place in the habitat. It is important that during the breeding seasons there are enough hiding places for juveniles, with sufficient food and places to stay during unfavourable periods for *M. fossilis.*

The permanent resting place is the same area in which they are during the active period, in this case the mud or sand layers or vegetation. In areas with shallow water levels in winter, deep sections can

often be found in front of culverts or in locations with strong seepage. Often, there is also a thicker layer of sludge around culverts in which the animals can overwinter (Beek, van, 2003).

The wintering grounds and places where *M. fossilis* bridge periods of drought or lack of oxygen are located within migration distance and in the same water system as where reproduction takes place. Generally, in the period from November to March (sometimes April), *M. fossilis* is clustered in these deeper parts of the stream (BIJ12, 2021).

2.4 Migration of *M. fossilis*

M. fossilis lives mainly in solidarity, despite the fact that they often occur in larger numbers relatively close together. They spend a large part of its life in a limited area. *M. fossilis* migrates over limited distances of 1 to a maximum of 3 km. Migration takes place between spawning and wintering areas and during periods of drought. Migration distances of *M. fossilis* can vary strongly between areas. In areas where there is a great deal of variation between deep and shallow areas, migration takes place over several metres. In areas where the deep parts are at greater distance from the shallow parts, migration takes place over many hundreds of metres to a maximum of three kilometres. The water level in the habitat appears to be very important in the migration of *M. fossilis.* In the original primary habitat in the floodplains of rivers and streams, the animals migrated with the rising water level. When a watercourse dries up or the water level drops again, *M. fossilis* moves to the deeper parts of the stream (van Beek, 2003; BIJ12, 2021).

2.5 Dispersal of *M. fossilis*

Dispersal is the spreading of animals in search of a new habitat. A distinction can be made between active and passive dispersal. Often dispersal takes place in juveniles or subadults stage when they have become independent and are looking for their own habitat. *M. fossilis* has a low dispersal capacity, it is likely that the most dispersal takes place during the juvenile stage. With an unnatural water level management and with obstructed water systems, passive dispersal may lead to *M. fossilis* being washed out of suitable habitats into unsuitable habitats. For example, from ditches rich in vegetation into sheltered ditches. Under such circumstances, they become isolated populations. If one of these populations dies out, recolonisation from another population is often impossible due to the presence of weirs and the fact that habitats are no longer flooded in the spring. Genetic exchange is not possible either. In other words, once the species has disappeared in such an area, one can easily speak of a local extinction (BIJ12, 2021).

3. Methodology

3.1 Literature research design

During the research, both qualitative and quantitative data are considered. Quantitative data acquired from the databases give an indication of where *M. fossilis* is currently found. By carrying out a qualitative study it can be determined whether these data are still correct. It was decided to select 12 known research locations where a determination of *M. fossilis* is known, thus the given data can be checked with the new obtained data. In addition, the decision made by reason of the reliability and likelihood of the sources must be observed before all locations can be researched.

3.2 National Database of Flora and Fauna

The quantitative data came from the National Database of Flora and Fauna. In this database all the observations are compiled and displayed on a map. Also described is who has put the observation in the database and in which year the observation was. Tributaries to the NDFF database are Waarneming.nl; Telmee, RAVON, Natuurhistorisch Genootschap in Limburg (NHGL) and Waterschap Peel en Maasvallei (predecessor of Water Limburg). These organisations are nature organisations and government bodies. The data include the location and abundance in which *M. fossilis* has been observed, the water types, the coordinates, year and occasionally stage (RAVON, 2022).

This data is completely checked if the sources are reliable and if there is a possibility that *M. fossilis* is in the area. Differences in observations were not clear, so extra information was requested from the original source. By contacting the original source, more data about the observations came forward.

3.3 Research locations

Following the reliability of the previous observations (from the NDFF), 12 research locations were selected. These locations have a suitable biotope where *M. fossilis* could live. The locations are as follows: Boekend, Boukoul, Broekhuizen, Hunsel, Herkenbosch (containing 3 locations), Grathem, Sint Odiliënberg and Weert (containing 3 locations). The unsuitable locations have also been named to explain why these locations were not chosen for investigation. These sites were not chosen because the reliability and likelihood of the sources were negative. For example, it is considered unlikely that *M. fossilis* is still present in waters where one individual was observed before 1950 and not since. The locations are: Linne, Maastricht, Meerlo, Neer, Venlo Trade Port North and Ven-Zelderheide.

3.4 Research method

The methodology was written to answer the main and sub question posed in this report. The literature review shows that there are four methods for finding *M. fossilis*. Three out of the four methods are performed during field research and are listed below.
One of the four methods to search for *M. fossilis* was by means of landing nets, this method was not chosen because of the dense vegetation in the stream. It was not possible to go through the vegetation and catch *M. fossilis*. In addition, steep banks, closed reed beds and dense vegetation make it difficult to catch or observe with a net. When catching with landing nets, larger *M. fossilis* may be missed because they flee into the vegetation or to the bottom (BIJ12, 2021; de Bruin & Kranenbarg, 2017; Jansen, 2011).

Electro-fishing

Researching by electro-fishing (Figure 3) can be done with devices that use continuous direct current (generator or portable direct current device) or by using portable devices with (pulsed) direct current. With direct current fishing is done with the device at a low current (depending on the type of device). Pulsed direct current sends short pulses of electricity through the water. Both methods stun *M. fossilis*,

which causes spasms and forces them to the surface where the movements give away their location. Polarised glasses often allow the species to be seen better in the stream. In dense waters you should also fish in open places (Viridis, sd; de Bruin & Kranenbarg, 2017; BIJ12, 2021). However, with electro-fishing, the soil is disturbed by having to walk in the watercourse due to the use of conductive current. Walking in the stream can damage flora by standing on it and sediment can come loose and spread throughout the stream. During electrofishing, trails of 250m were walked, the number of trails is different per area because each area has a different surface.

Figure 3 Example electro fishing

Fykes

A fishing fyke (Figure 4) is a circular knitted fishing net that is stretched on several hoops of smaller diameter and ends in a tightly woven conical section. Inside the fyke are funnel-shaped nets that prevent the fish from swimming back.

The principle of a fyke is the same everywhere, however depending on the species and size of the fish to be caught, appropriate sizes of hoops and meshes are used. Selective fishing is possible by placing a net in front of the entrance to the fyke with a mesh size larger than that of the fyke itself. In this way, large fish and large wolverine crabs are stopped and birds and seals can no longer accidentally enter a fyke. Fish that are too small can leave the fyke by installing an escape window at the back of the fyke. This is a knitted-in net with a larger mesh than the fyke itself (Crossland, 1976; Jansen, 2011; BIJ12, 2021).

The effectiveness of a fyke depends on the size. Research has shown that large fykes have an average catch rate were significantly different depending on volume. When all other factors are equal (i.e., area, depth, season), the difference in catch rates may be due to different escape rates of the trapped fish. The greater the enclosed volume of the fyke, the less likely a fish is to find a way out (Crossland, 1976; Jansen, 2011; BIJ12, 2021).

The traps were placed in the waters where it was possible, where it was physically possible to stand and where the waters had a suitable habitat for *M. fossilis*.

Figure 4 Example of a fyke

Figure 5 Example of an eDNA kit

eDNA

Environmental DNA (eDNA) is a new method to determine the presence of species in a water body. The method is based on aquatic organisms leaving DNA behind in the water via faeces, skin cells and urine. Due to the fact the DNA in the water can move easily between areas, means it can spread easily over a larger surface. By taking water samples and extracting the DNA from the water by filtering water and collecting it in a jar, after which it is extracted by an external company. The presence of a species in the water can be demonstrated without having to catch the species itself (Figure 5). However, eDNA cannot determine densities (RAVON, 2022; de Bruin & Kranenbarg, 2017; BIJ12, 2021; Herder, et al., 2014).

eDNA is a convenient way of finding DNA particles in water bodies, so that there is certainty whether a species is present or not without having to carry out additional field research. During the field research, 12 samples were taken from 8 locations. At some locations 2 samples were taken due to the size of the area, such as Sint Odiliënberg.

Collected parameters during field research

At each location, a field form with various parameters was filled in (Appendix III). The subjects contain visible features and morphological characteristics. The visible features include colour, visible pollution, turbidity, shading, odour, natural longitudinal profile, cross-sectional profile, bank angle, nature of the banks, flow variation, meandering, substrate condition, biotope and clean-up indication.

The morphological characteristics of the streams consist of the depth (cm), width (m), sapropel layer (cm) and flow velocity (m/s) of the water. The coverage of vegetation (emergent, floating, submerged, mosses and algae/threading algae) (%) is also assessed. Furthermore, the substrate is described in different soil types (%) (sand, fine and coarse gravel, stone, concrete, iron ochre, clay/loam, peat, sapropel without hydrogen sulphide (H2S), sapropel with H2S, fine and coarse detritus, wood, tree roots and unnatural substrates).

3.5 Data comparison

To answer the main and sub questions, the results are compared with previous data from the National Database Flora and Fauna (NDFF), for example the dispersal of *M. fossilis* in Limburg. In addition, the results are compared with each other, for example the location were *M. fossilis* was observed, here the biotopes characteristics are compared with each other. By making a comparison with previous data and a comparison with current locations, a conclusion and advice can be given.

4. Results

The current distribution is shown in Figure 6 (Stichting NDFF, sd). It can be seen that the current distribution of *M. fossilis* is mainly in central Limburg with some exceptions in the North and South. There are in total 68 observations, 54 observations within the borders of the province Limburg and 14 at the border with Belgium, Germany and the province North Brabant (NL). Most observations of *M. fossilis* were reported around Herkenbosch.

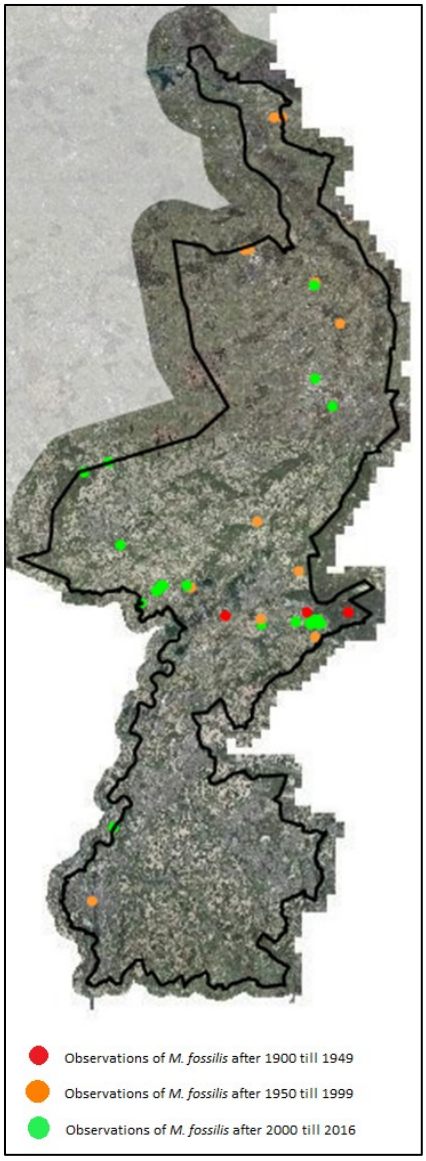


Figure 6 Previous observations of M. fossilis

The results accumulated during the fieldwork from March to April 2022 were collected according to the methodology described above. In total, 12 locations were sampled (Table 1). An overview of the collected results is provided in this chapter. In addition, a figure of each location is attached. The Figure shows marks of whether electrofishing (red) was done or fykes (blue) were placed. In the figures it is also noted when sampling of the location was not possible (green). Reasons for not sampling are, for example, that the stream has run dry, or the water is too deep. The locations where eDNA research was carried out are shown with a black arrow and the text “eDNA research”.

Table 1 Number of sampling points and methodology used per research area

Area	Electro fishing	Fykes	eDNA
Boekend (Boek)	-	3	1
Boukoul (Bouk)	2	-	1
Broekhuizen (Broek)	-	5	-
Grathem (Uffel)	-	8	-
Herkenbosch – Vogterbeek (Vogt)	4	6	1
Herkenbosch – Steinbroeklossing (Stein)	3	7	2
Herkenbosch – Postbeek (Post)	4	-	1
Hunsel (Uffel)	-	8	-
Sint-Odiliënberg (Odil)	-	-	1
Weert – Vloedlossing (Vloed)	2	-	2
Weert – Kievitsbeek (Kiev)	6	4	2
Weert – Kuppenlossing (Moes)	1	3	1
Total	**22**	**44**	**12**

4.1 Boekend – Overloop Everlosebeek

In the Overloop Everlosebeek *M. fossilis* was sighted once in 1929. On behalf of Ravon, Mr. Spikmans, logged the data from the Red List Fishes Historical Data into the NDFF database, which has various sources (RAVON, 2022). The area itself is a small wetland, which flows through a culvert to the Everlosebeek (Figure 7). The location has a total vegetation cover (emergence, floating and submerse) of 60% - 80%. The substrate consists mainly of sapropel without H2S (50%) and clay (30%) (Table 2 and 3).

Table 2 Dimensions sapropel layer and velocity of the Overloop Everlosebeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Boek01, Boek02 and Boek03	80	4	20	0,05

Table 3 Vegetation and substrate coverage (%) of the Overloop Everlosebeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Coarse gravel	Clay/ loam	Sapropel without H2S	Coarse detritus	Wood
Boek01	40	5	5	50	5	2	30	50	13	5
Boek02	20	5	5	30	5	2	30	50	13	5
Boek03	60	5	5	70	5	2	30	50	13	5

Two sampling locations in the stream were unsuitable for the placement of the fykes (Boek04 and Boek05), due to drought and the water depth. In one part of the stream three fykes (Boek01, Boek02 and Boek03) were placed. However, within the sampling period *M. fossilis* was not found despite the dense vegetation, forming a suitable habitat. Yet, a total of 7 individuals were observed, including *Esox Lucius, Tinca tinca* and *Rutilus rutilus* inside the fykes. It was decided to sample via eDNA at locations

Boek01 through Boek03, thus there is a control measure whether *M. fossilis* does or does not reside in the Overloop Everlosebeek.

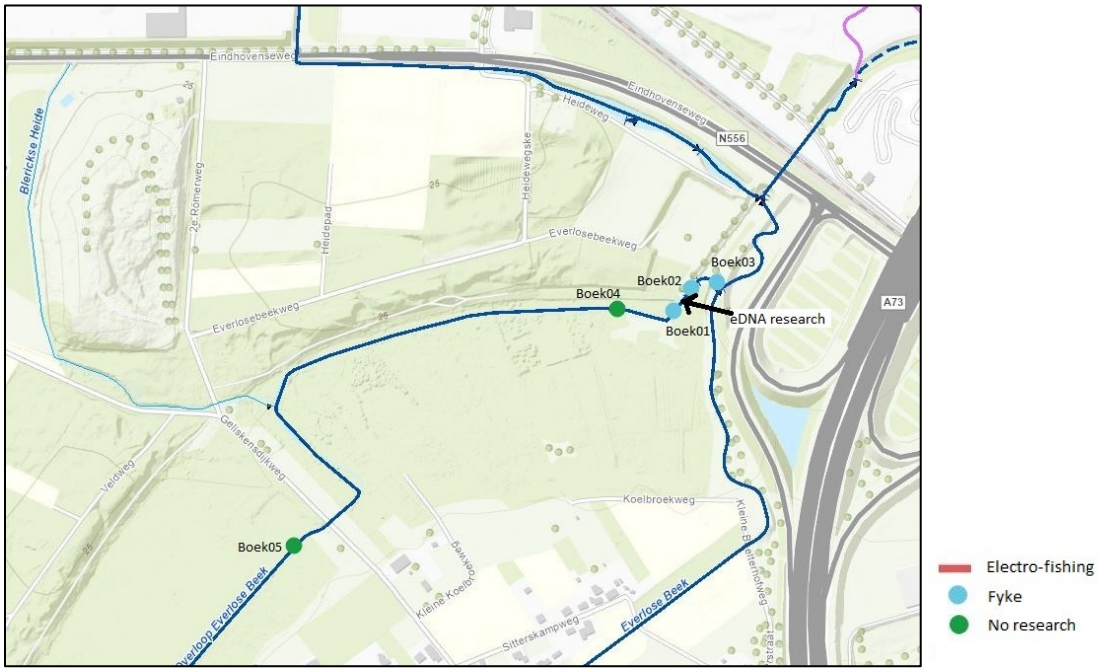


Figure 7 Overview map of sampling locations in the Overloop Everlosebeek

Figure 8 Impression of the Overloop Everlosebeek

4.2 Boukoul - Blankwaterlossing

In the area of Boukoul one sighting was noted in 1984 by Hendrik de Nie and placed into the Atlas of Dutch freshwater fish (RAVON, 2022), however at the coordinates of this sighting (Bouk03) no water was found (Figure 9). Close to the sighting area the Blankwaterlossing is located. It was decided to do research in the Blankwaterlossing by means of electro fishing due to its close proximity and observed suitable habitat (Bouk01 and Bouk02). During the electro fishing *M. fossilis* was not observed, though a total of 74 individuals of other species were found, including *Pungitius pungitius* and *Barbatula barbatula*. It was decided to sample via eDNA at locations Bouk2 and Bouk02, thus there is a control measure whether *M. fossilis* does or does not reside in the Blankwaterlossing.

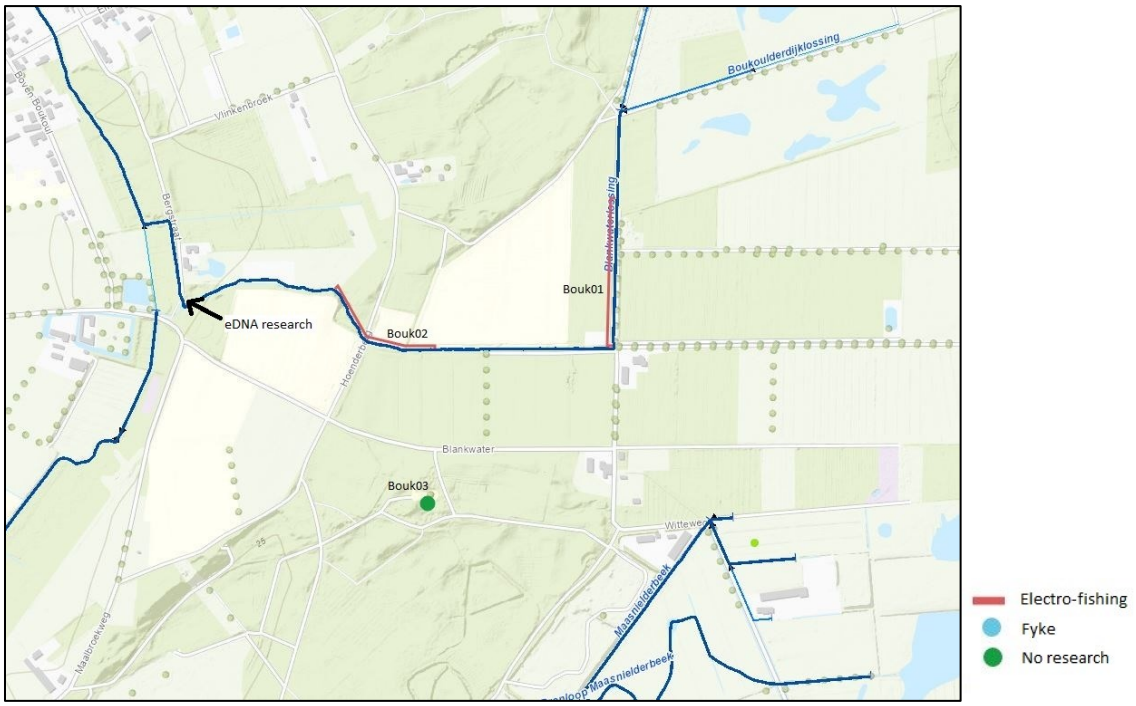


Figure 9 Overview map of sampling locations in the Blankwaterlossing

Figure 10 Impression of the Blankwaterlossing

Figure 11 Impression of the Blankwaterlossing

Several physical features were observed during electro fishing, such as an elevation difference and a coverage of vegetation. Bouk01 has no height difference during the trajectory, while Bouk02 has a height difference of 1.5 – 2m from the beginning to the end of the trajectory (Actueel Hoogtebestand Nederland, 2022). The substrate of Bouk01 consist mainly of fine and coarse detritus (together 49%), while Bouk02 mainly consist of sand (60%) (Table 4). Furthermore, Bouk01 has a vegetation cover of 5% while Bouk02 has no vegetation coverage (Table 5).

Table 4 Dimensions sapropel layer and velocity of the Blankwaterlossing

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Bouk01	20	1	5	0,08
Bouk02	70	2	15	0,2

Table 5 Vegetation and substrate coverage (%) of the Blankwaterlossing

Measurement point	Vegetation: Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Sand	Stone	Concrete	Clay/ loam	Sapropel without H2S	Fine detritus	Coarse detritus	Wood	Tree roots
Bouk01	2	3	5	10	20	-	-	20	10	24	25	1	-
Bouk02	-	-	-	-	60	1	5	20	-	5	5	2	2

4.3 Broekhuizen – Broekhuizer Molenbeek

In the area of the Broekhuizer Molenbeek one sighting has occurred in 2001, conducted by Piet van den Munckhof (RAVON, 2022). The area consists of a wetland (location Broek01 and Broek02) and stream surrounded by an extensively managed grassland (Broek03 through Broek05). In the area of the Broekhuizer Molenbeek five fykes were placed, however three fykes could not be placed due to the presence of beavers and depth of the water (Figure 14).

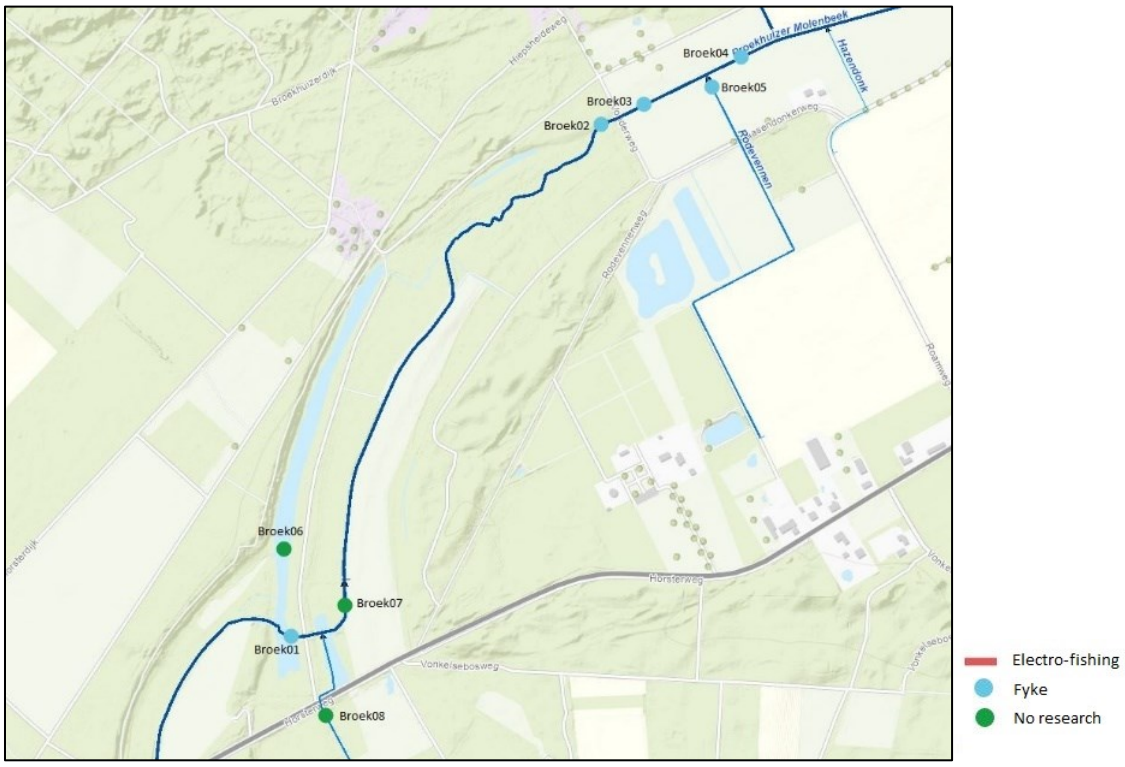


Figure 14 Overview map of sampling locations in the Broekhuizer Molenbeek

Figure 13 Impression of the Broekhuizer Molenbeek

Figure 12 Impression of the Broekhuizer Molenbeek

It is notable that the locations Broek01 and Broek02 are totally different from the rest of the research area. Broek01 and Broek02 have a coverage vegetation between 5 - 7%, with a substrate cover of sapropel without H2S (35 - 50%) and sapropel with H2S (30%). The sapropel layer lays between the 20 - 70cm and 50 – 120cm, while the locations have a depth of 80cm and 150cm (Table 6). During the 72-hour timeframe a total of 8 individuals were observed, including *Esox Lucius, Tinca tinca, Rutilus rutilus, Gobio gobio* and *Scardinius erythrophthalmus* were found inside the fykes.

Broek03 and Broek04 have a vegetation coverage of 5 – 8%, with a substrate cover of clay (55%) and sapropel without H2S (40 - 45%). The sapropel layers are 40cm, while the locations have a depth between 80 - 90cm. Broek05 has a coverage vegetation of 2%, with a substrate coverage of sapropel without H2S (65%) and has a depth of 20cm (Table 7).
In the first 24 hours one *M. fossilis* of 20cm (male) was found inside the fyke of Broek03 (Figure 15). Furthermore, a total of 15 individuals were observed, including *Gasterosteus aculeatus, Lepomis gibbosus, Perca fluviatilis, Tinca tinca, Pseudorasbora parva, Gobio gobio, Rutilus rutilus* and *Pungitius pungitius.* A total of 23 individuals were observed by means of fykes.

Table 6 Dimensions sapropel layer and velocity of the Broekhuizer Molenbeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Broek01	140	4	120	0,01
Broek02	80	4	70	0,02
Broek03	90	3	40	0,02
Broek04	80	4	40	0,02
Broek05	20	0,5	0	0

Table 7 Vegetation and substrate coverage (%) of the Broekhuizer Molenbeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Clay/ loam	Sapropel without H2S	Sapropel with H2S	Fine detritus	Coarse detritus	Wood
Broek01	5	-	2	7	-	8	50	30	-	10	2
Broek02	2	1	2	5	2	10	35	30	10	10	5
Broek03	5	1	2	8	-	55	40	-	-	-	5
Broek04	2	-	3	5	-	54	45	-	-	-	1
Broek05	1	-	1	2	-	10	65	24	-	-	1

Figure 15 Caught M. fossilis at Broekhuizer Molenbeek

4.4 Grathem- Uffelsebeek

In Grathem there have been two sightings of *M. fossilis* in 1990 and 1997 conducted by the NHGL (Stichting NDFF, 2019). In the area, the Uffelsebeek flows from Belgium through Grathem (Figure 16). The Uffelsebeek flows through an agricultural area, some small forest plots and the village centre (Gemeente Leudal, 2014). Eight fykes were placed in this area.

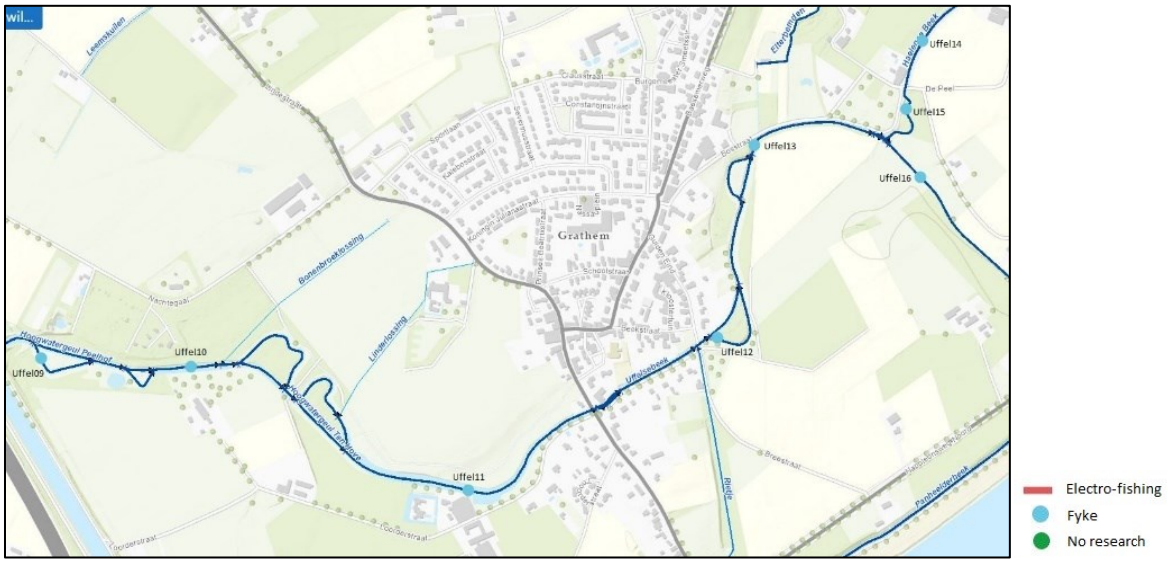


Figure 16 Overview map of sampling locations in the Uffelsebeek

Figure 17 Impression of the Uffelsebeek

Figure 18 Impression of the Uffelsebeek

Uffel09, Uffel10 and Uffel11 are similar in comparison, the maximum depth sits between 80 - 110cm and has a sapropel layer between 30 – 50cm. In addition, the vegetation coverage at Uffel09 and Uffel11 are close to each other (2 – 5%), while the vegetation coverage at Uffel10 is 15%. The substrate is covered by clay (30 – 70%) and sapropel without H2S (15 - 70%) at all locations.

Uffel12 and Uffel13 have a maximum depth of 90 - 120cm and have a sapropel layer of 30cm. In addition, the vegetation coverage sits between 2 - 6% and the substrate is covered by clay (20 - 60%) and sapropel without H2S (34 - 70%).

The locations Uffel14, Uffel15 and Uffel16 have a maximum depth of 80 to 90cm, with a sapropel layer of maximum 20 – 50cm. The vegetation coverage sits between 5 - 11% and the substrate is covered by clay (30 - 70%) and sapropel without H2S (21 - 54%). Uffel16 has been placed at a distance of 10 meters of a weir (Table 8 and 9).

Table 8 Dimensions sapropel layer and velocity of the Uffelsebeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Uffel09	110	7	50	0,08
Uffel10	80	15	30	0,08
Uffel11	100	15	40	0,2
Uffel12	90	5	30	0,1
Uffel13	120	7	30	0,1
Uffel14	90	4	50	0,08
Uffel15	80	4	20	0,1
Uffel16	80	5	50	0,15

Table 9 Vegetation and substrate coverage (%) of the Uffelsebeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Substrate: Sand	Stone	Concrete	Clay/ loam	Sapropel without H2S	Fine detritus	Coarse detritus	Wood	Tree roots
Uffel09	5	-	-	5	-	-	-	30	70	-	-	-	-
Uffel10	10	-	5	15	-	-	-	60	20	10	10	-	-
Uffel11	2	-	-	2	5	-	-	70	15	-	5	5	-
Uffel12	2	-	-	2	-	-	-	20	70	-	10	-	-
Uffel13	5	-	1	6	5	-	-	60	34	-	-	1	-
Uffel14	5	-	-	5	-	-	-	70	24	-	5	1	-
Uffel15	5	1	5	11	-	-	-	30	54	-	10	5	1
Uffel16	2	-	5	7	-	2	2	60	21	-	10	5	-

No fishes were found inside fyke Uffel09. Uffel12 was taken out after 48 hours by a person, which causes data to be missing. Furthermore, Uffel16 was placed for 24 hours so it can be researched whether *M. fossilis* is residing in the Panheelderbeek after the junction of the Uffelsebeek.
M. fossilis was not observed in the area. However, a total of 120 individuals were observed, including *Barbatula barbatula, Rhodeus amarus, Rutilus rutilus, Gasterosteus aculeatus, Esox Lucius, Pungitius pungitius, Gobio gobio* and *Pseudorasbora parva*.

4.5 Herkenbosch – Vogterbeek

In the West of Herkenbosch flows the Vogterbeek and the Herkenbosscher Leigraaf, these streams flow into the Roer (to the West). Between both streams was one sighting of *M. fossilis* in 1987 by Willem Vergoossen and Waterschap Roer en Overmaas using a fishnet (Vergoossen, 1987; Waterschap Roer en Overmaas, 1987). Three sections were researched by electro fishing and five fykes were placed in the Vogterbeek. The Herkenbosscher Leigraaf was also researched by electro fishing and one fyke was placed into the stream (Figure 19). The streams are located in an agricultural and nature area. During the field visit it was discovered Vogt11 had dried up, which means it could not be researched.

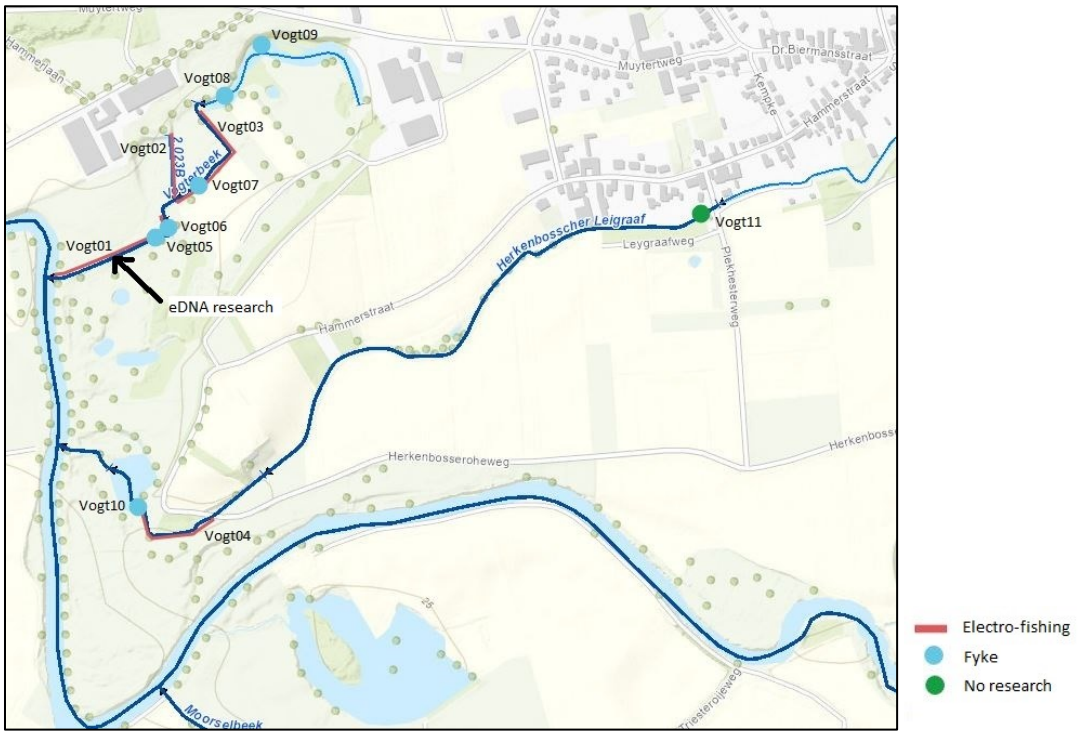


Figure 19 Overview map of sampling locations in the Vogterbeek

Figure 20 Impression of the Vogterbeek

Figure 21 Impression of the Vogterbeek

The Vogterbeek (Vogt01, Vogt02, Vogt03, Vogt08 and Vogt09) has a substrate coverage of clay (30 – 60%) and sapropel without H2S (14 – 35%) with a vegetation coverage till 20% and depth between 50 – 90 cm. The vegetation coverage in the Herkenbosscher Leigraaf (Vogt04) is 32% and the substrate mainly consist of clay (88%). There is a depth of 20cm, containing a 5cm layer of sapropel (Table 10 and 11).

Table 10 Dimensions sapropel layer and velocity of the Vogterbeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Vogt01	90	1	20	0,04
Vogt02	70	2	25	0,02
Vogt03	70	1	10	0,04
Vogt04	20	1	5	0,04
Vogt08	50	16	10	0,02
Vogt09	90	25,5	10	0,02

Table 11 Vegetation and substrate coverage (%) of the Vogterbeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Coarse gravel	Clay/ loam	Sapropel without H2S	Fine detritus	Coarse detritus	Wood
Vogt01	-	-	-	-	-	-	65	35	-	-	-
Vogt02	5	-	-	5	1	-	50	35	5	10	-
Vogt03	1	-	1	2	30	-	50	14	15	10	1
Vogt04	30	2	-	32	30	-	88	10	-	-	2
Vogt08	10	5	5	20	15	5	30	30	-	25	10
Vogt09	10	5	5	20	15	5	30	30	-	25	10

Upon inspecting of the fykes after 48 hours, a dead Muskrat was found in fyke Vogt07 and a dead Beaver rat was found in fyke Vogt06. These fykes were left in place in consultation with the pest control operators. However, when inspecting the fykes after 72 hours a dead Beaver was found in fyke Vogt07. Because all the fykes were removed after 72 hours, no further measures were taken.
M. fossilis was not observed in the area. However, a total of 49 individuals were observed, including *Tinca tinca*, *Cyprinus carpio*, *Gasterosteus aculeatus, Pseudorasbora parva, Rhodeus amarus, Pungitius pungitius* and *Carassius gibelio*. It was decided to sample via eDNA, thus there is a control measure whether *M. fossilis* does or does not reside in the Vogterbeek. The Herkenbosscher Leigraaf had dried up before eDNA research was carried out.

4.6 Herkenbosch – Steinbroeklossing

In the South of Herkenbosch flows the Steinbroeklossing, Riemer and Bosbeek. Both streams are connected to the Bosbeek and flow through a nature area. There have been four sightings of *M. fossilis* in 2008 by Waterschap Roer and Overmaas (Waterschap Roer en Overmaas, 2008). Two sections were researched by electro fishing and four fykes were placed in the Steinbroeklossing. The Riemer was also researched by electro fishing and three fyke were placed. In addition, one fyke was placed in the Bosbeek (Figure 22).

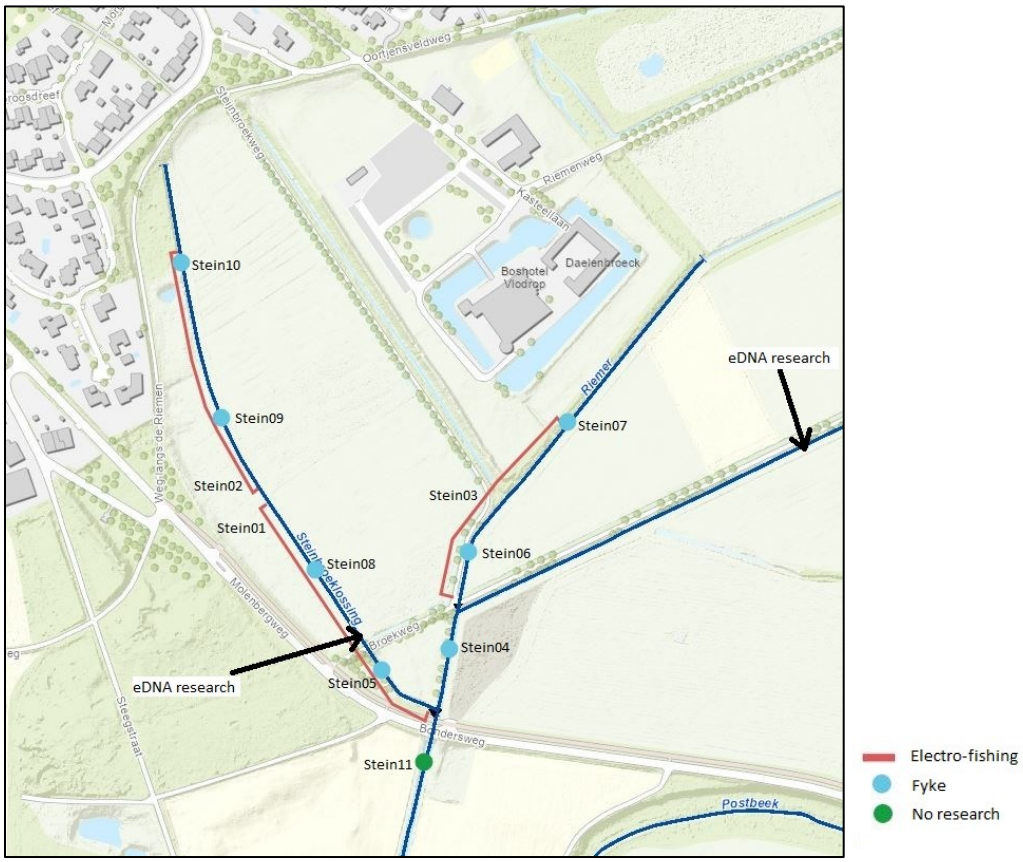


Figure 22 Overview map of sampling locations in the Steinbroeklossing

Figure 23 Impression of the Steinbroeklossing

There is no significant difference in depth between the streams (ranking from 70cm to 80cm) and vegetation coverage (3 – 4%). The sapropel layer in the three stream lies between 40 – 50cm. Stein03 has a high substrate coverage of 78% (sapropel without H2S), while the substrate coverages at Stein01, Stein02 and Stein04 mainly consists of sapropel with H2S (60 – 70%) (Table 12 and 13).

Table 12 Dimensions sapropel layer and velocity of the Steinbroeklossing

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Stein01	80	3	40	0,05
Stein02	80	2	50	0,05
Stein03	70	3	50	0,08
Stein04	80	3	50	0,05

Table 13 Vegetation and substrate coverage (%) of the Steinbroeklossing

Measurement point	Vegetation: Emergent	Submerged	Total aquatic vegetation	Substrate: Clay/ loam	Sapropel without H2S	Sapropel with H2S	Coarse detritus	Wood
Stein01	2	1	3	20	19	60	-	1
Stein02	2	1	3	10	9	70	10	1
Stein03	2	2	4	20	78	-	-	2
Stein04	2	1	3	20	19	60	-	1

During the inspecting of the fykes after the first 24 hours, a dead beaver was found in fyke Stein04. All the fykes in the area were removed in consultation with the pest control operators. The obtained field data is from the first 24 hours the fykes were in place. *M. fossilis* was not observed in the area. However, a total of 61 individuals were observed, including *Leucaspius delineates*, *Scardinius erythrophthalmus*, *Tinca tinca*, *Carassius gibelio*, *Ambramis brama* and *Leuciscus leuciscus*. It was decided to sample via eDNA, thus there is a control measure whether *M. fossilis* does or does not reside in the Steinbroeklossing and Bosbeek.

4.7 Herkenbosch – Postbeek

In the East of Herkenbosch flows the Postbeek, Broekbeek and Bosbeek. Both streams are connected to the Bosbeek (which is connected to the Roer) and flow in a nature area (Turfkoelen). There have been four sightings of *M. fossilis* in 2008 by the Waterschap Roer and Overmaas (Waterschap Roer en Overmaas, 2008). Three sections were research by electro fishing in the Postbeek. The Broekbeek was researched in one section by means of electro fishing. The locations Post05, Post07 and Post08 could not be researched due to the fact the streams had dried up. The location Post06 could not be research due to the depth of the stream (Figure 24).

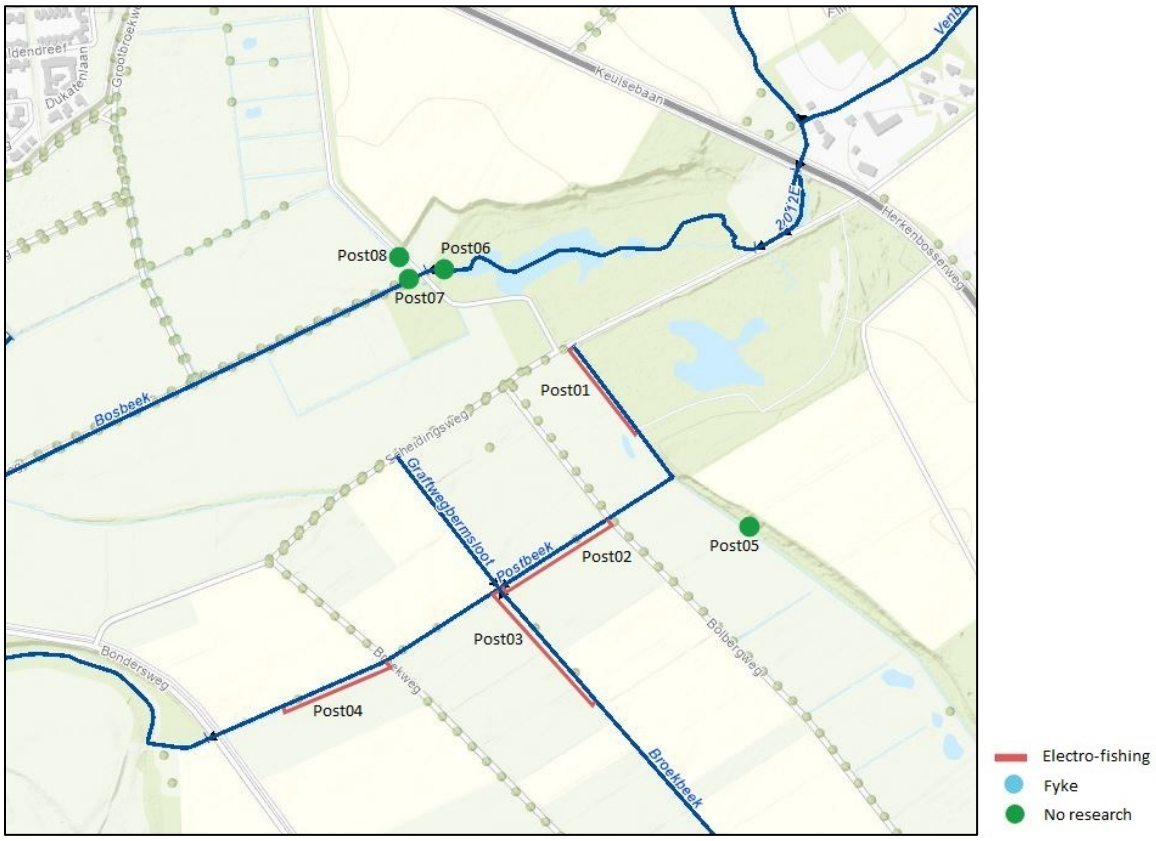


Figure 24 Overview map of sampling locations in the Postbeek

Figure 25 Impression of the Postbeek

Figure 26 Impression of the Postbeek

Post04 has the highest vegetation coverage of 61%, while the rest has a vegetation coverage between 9 – 22%. There is no significant difference in depth between the streams (ranking from 70 to 90cm). The sapropel layer in the three stream lays between 20 – 50cm and the substrate is covered by sapropel without H2S (39 – 68%). Post04 is the only location with a substrate coverage of 40% sapropel with H2S (Table 14 and 15).

Table 14 Dimensions sapropel layer and velocity of the Postbeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Post01	90	4	50	0,05
Post02	70	2	20	0,05
Post03	70	1	30	0,09
Post04	80	4	50	0,15

Table 15 Vegetation and substrate coverage (%) of the Postbeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Coarse gravel	Stone	Clay/ loam	Sapropel without H2S	Sapropel with H2S	Fine detritus	Coarse detritus	Wood
Post01	5	7	10	22	10	-	1	10	68	-	10	10	1
Post02	2	1	7	10		-	-	9	50	-	20	20	1
Post03	5	2	2	9	-	-	-	20	60	-	10	10	-
Post04	1	10	50	61	20	1	-	20	39	40	-	-	-

M. fossilis was observed six times (Figures 26 and 27). Two males of 16 and 15cm, two females of 9 and 6cm and one unknown genus of 6cm was observed in the Postbeek. Including one female of 8cm, which was observed in the Broekbeek. In addition, a total of 41 individuals were observed, including *Esox lucius, Tinca tinca, Carassius gibelio, Pungitius pungitius, Lampetra planeri* and *Scardinius erythrophthalmus*. A total of 50 individuals were observed by means of electro fishing.

Figure 27 Caught M. fossilis at the Postbeek

Figure 28 Caught M. fossilis at the Postbeek

4.8 Hunsel - Uffelsebeek

In the town of Hunsel flows the Uffelsebeek, which flows from Belgium into the Netherlands. The stream flows through an agriculture and nature area and the village centre (Maes, 2013) (Figure 29). By means of eDNA research, DNA of *M. fossilis* has been detected in the Uffelsebeek by the observer Jöran Janse in 2013 (RAVON, 2022), whom was commissioned by Waterschap Peel and Maasvallei. Including four sightings of *M. fossilis* by Natuurbank Limburg in 2013 (Stichting NDFF, 2019). As well as two more sightings of *M. fossilis* by Waterschap Peel and Maasvallei in 2015 (Stichting NDFF, 2019).

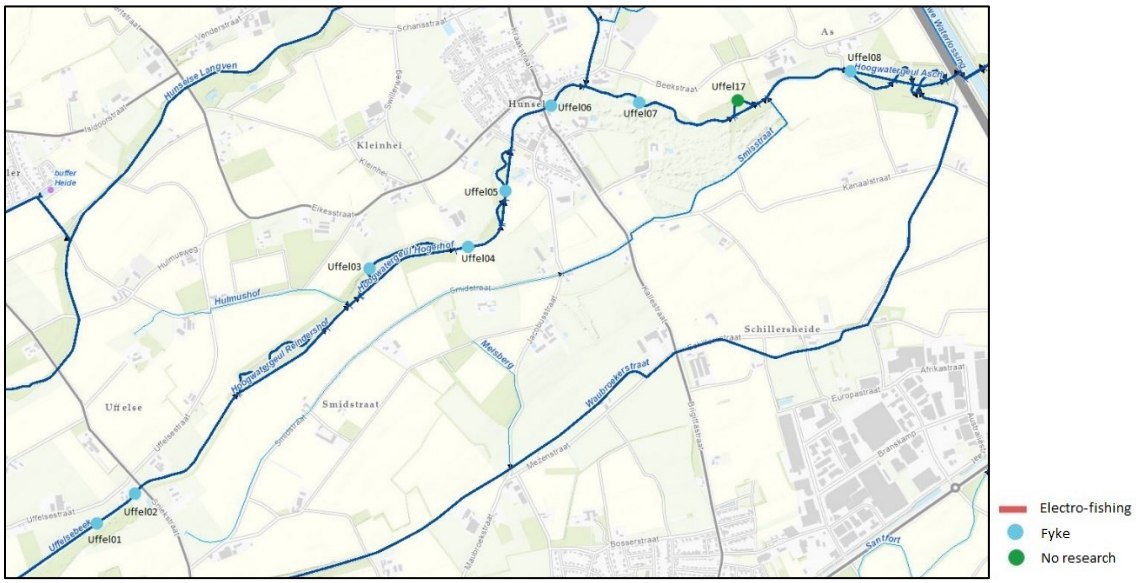


Figure 29 Overview map of sampling locations in the Uffelsebeek

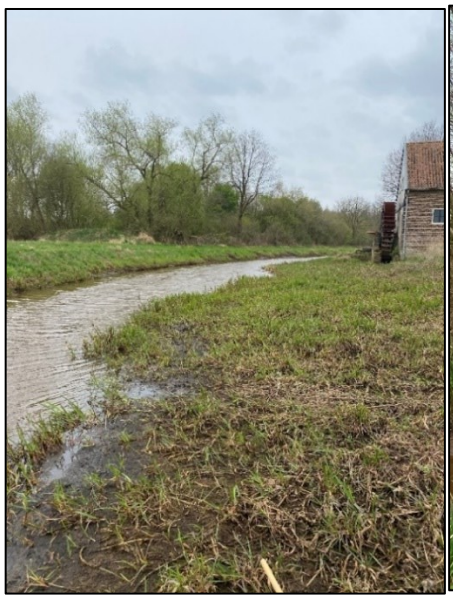


Figure 30 Impression of the Uffelsebeek

Figure 31 Impression of the Uffelsebeek

Eight fykes were placed in the stream, however one fyke could not be placed due to the depth (Uffel17). Most of the locations have a depth of 110 – 140cm with the exception of Uffel03 (70cm) and Uffel06 (60cm). The stream itself has a moderate curve, with a moderate flow velocity (Table 16) and the sapropel layer sits between 30 – 60cm. The substrate is mostly covered with clay (20 – 70%) and sapropel without H2S (15 – 70%) (Table 17).

Table 16 Dimensions sapropel layer and velocity of the Uffelsebeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Uffel01	140	4	50	0,2
Uffel02	130	4	40	0,2
Uffel03	70	4	30	0,15
Uffel04	120	4	50	0,05
Uffel05	120	3	60	0,1
Uffel06	60	5	30	0,2
Uffel07	110	4	60	0,1
Uffel08	140	7	60	0,1

Table 17 Vegetation and substrate coverage (%) of the Uffelsebeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Substrate: Sand	Stone	Concrete	Clay/ loam	Sapropel without H2S	Fine detritus	Coarse detritus	Wood	Tree roots
Uffel01	5	-	-	5	-	-	-	30	70	-	-	-	-
Uffel02	10	-	5	15	-	-	-	60	20	10	10	-	-
Uffel03	2	-	-	2	5	-	-	70	15	-	5	5	-
Uffel04	2	-	-	2	-	-	-	20	70	-	10	-	-
Uffel05	5	-	1	6	5	-	-	60	34	-	-	1	-
Uffel06	5	-	-	5	-	-	-	70	24	-	5	1	-
Uffel07	5	1	5	11	-	-	-	30	54	-	10	5	1
Uffel08	2	-	5	7	-	2	2	60	21	-	10	5	-

M. fossilis was not observed in the area. However, a total of 54 individuals were observed, including *Lepomis gibbosus*, *Gobio gobio, Barbatula barbatula, Tinca tinca, Gasterosteus aculeatus, Rutilus rutilus, Rhodeus amarus* and *Pungitius pungitius*.

4.9 Linne – Vlootbeek

In 1990 one individual of *M. fossilis* was observed in the stream Vlootbeek by Ravon (2022) (Figure 32). On behalf of Ravon, Mr. Spikmans, logged the data from the Red List Fishes Historical Data into the NDFF database, which has various sources. However*, M. fossilis* has not been observed since the last sighting in 1947. Therefore, the probability of *M. fossilis* still being in the Vlootbeek will be almost nil. For this reason, no research was done in the Vlootbeek.

Figure 32 Overview map of sampling locations in the Vlootbeek

4.10 Maastricht – Noordelijke Jekertak

In 1947 one individual of *M. fossilis* was observed nearby the stream Noordelijke Jekertak by the NHGL (Stichting NDFF, 2019) (Figure 33). However, the exact location where *M. fossilis* was observed has no water. It is possible that the coordinates of the exact location (where the sighting was), were entered wrong into the database. The nearest stream is the Noordelijke Jekertak, as it is the closest stream, it is thought that *M. fossilis* was observed in this stream. However, the possibility of *M. fossilis* living in the Noordelijke Jekertak is slim, as the biotope is not typical where *M. fossilis* would survive. For example, the velocity of the stream will likely be fast due to the hills. For this reason, no research was done in the Noordelijke Jekertak.

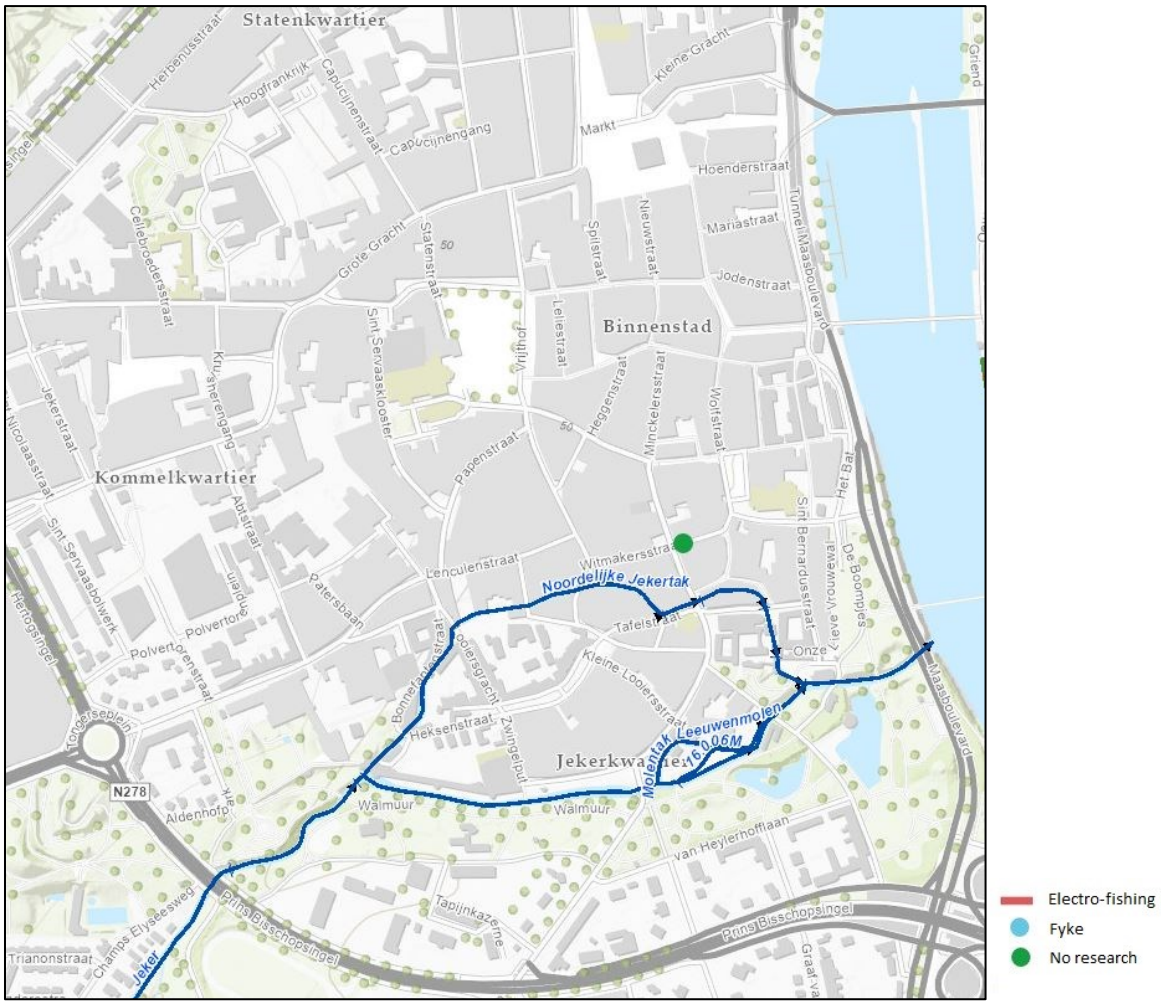


Figure 33 Overview map of sampling locations in the Noordelijke Jekertak

4.11 Meerlo – Groote Molenbeek

In 1990 and 1997 one individual of *M. fossilis* was observed in the stream Groote Molenbeek and nearby the Van Smallenbroek (Figure 34) by the NHGL and Waterschap Peel and Maasvallei (Stichting NDFF, 2019). *M. fossilis* was searched for frequently over the past 15 years, though it was not observed again during that time. The probability of finding *M. fossilis* in the streams is low. For this reason, no research was done in the Groote Molenbeek and Van Smallenbroek.

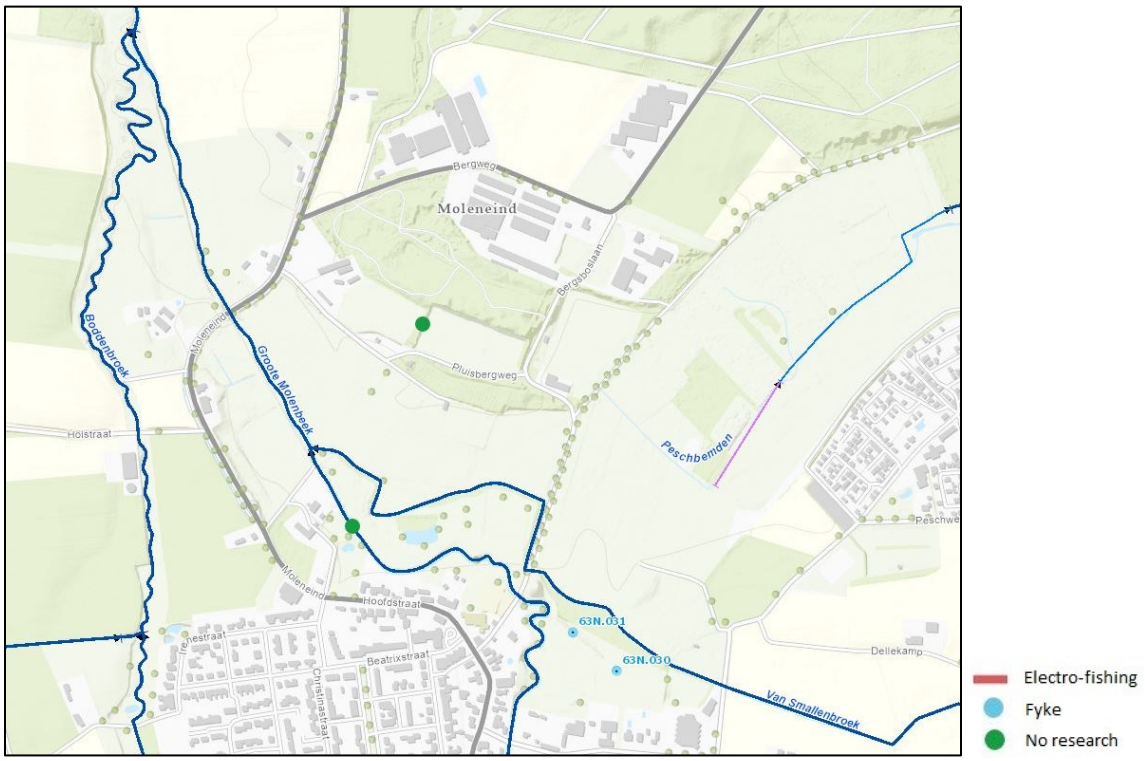


Figure 34 Overview map of sampling locations in the Groote Molenbeek

4.12 Neer - Ophovenlossing

In the area of Neer flows the Ophovenlossing, where in 1980 one *M. fossilis* was observed by Hendrik de Nie and placed into the Atlas of Dutch freshwater fish (RAVON, 2022) (Figure 35). The stream is surrounded by agricultural and nature areas. The Ophovenlossing flows into the Keizersloop by means of a culvert. However, the stream could not be sampled because it had dried up.

Figure 35 Overview map of sampling locations in the Ophovenlossing

Figure 36 Impression of the Ophovenlossing

Figure 37 Impression of the Ophovenlossing

4.13 Sint-Odiliënberg - Overenlossing

In the area of Sint-Odiliënberg flows the Overenlossing into the 1e, 2e and 3e Zijtak Overenlossing, where in 2005 (five) and 2010 (six) a total of eleven *M. fossilis* were observed by Willem Vergoossen (2009; 2010) and Waterschap Roer en Overmaas (2005; 2010) by using the research method of electro fishing and fishnets. The streams are surrounded by a nature area called Estate Hoosden (Figure 38).

During the visitation to the area, it was discovered that the locations Odil05 and Odil06 had dried up. Locations Odil01, Odil02 and Odil03 could not be researched due to the depth of the streams. It was decided to sample via eDNA at locations Odil01 through Odil04, thus there is a control measure whether *M. fossilis* does or does not reside at Estate Hoosden.

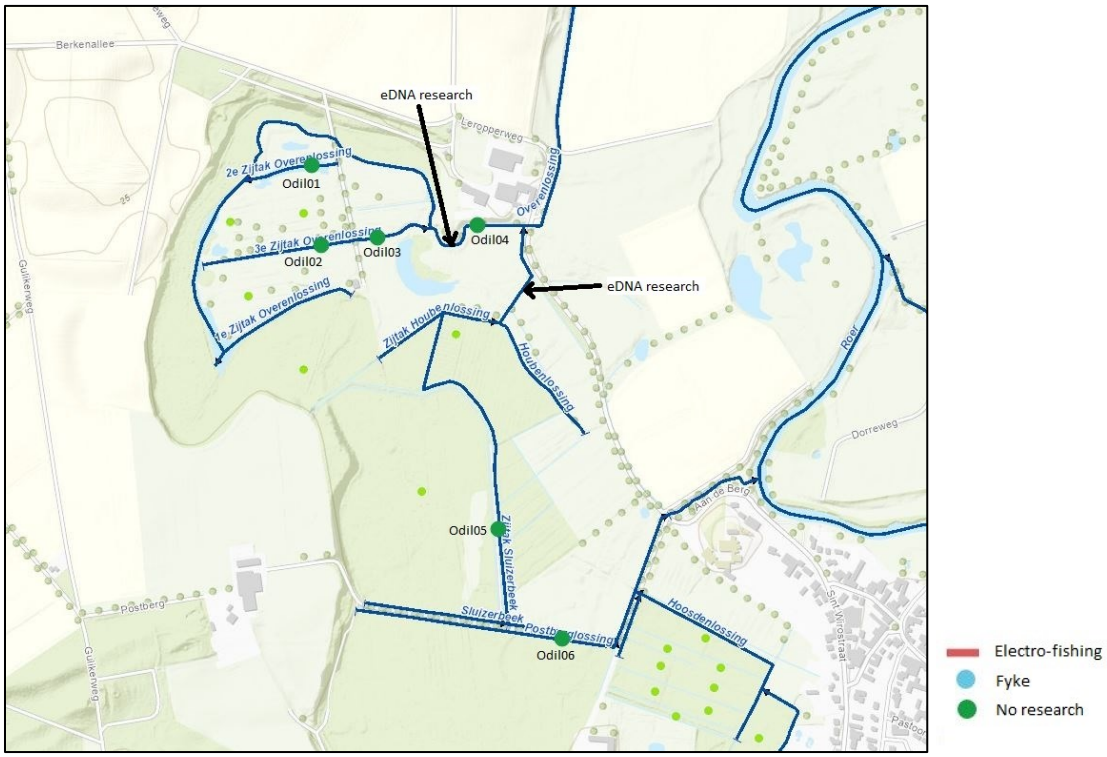


Figure 38 Overview map of sampling locations in the Overenlossing

Figure 39 Impression of the Overenlossing

4.14 Venlo Trade Port North - Gekkengraaf

In 2000 one individual of *M. fossilis* was observed in the stream Gekkengraaf (Venlo) by NHGL (Stichting NDFF, 2019) (Figure 40). However, the Gekkengraaf needed to be rerouted in such manner it did not meet with another stream used for facility treatment and infiltration at the time Trade Port North was developed in 2011. (Adviesbureau RBOI, 2011). Adviesbureau RBOI (2011) has mentioned the existing natural values of the area will be limited and no space will be taken from the natural areas and the connecting zones. The report mentioned the development of the area may affect some protected species, although *M. fossilis* is not mentioned. Ultimately, it was decided to not do research in this area because it does not have a suitable habitat where *M. fossilis* would occur.

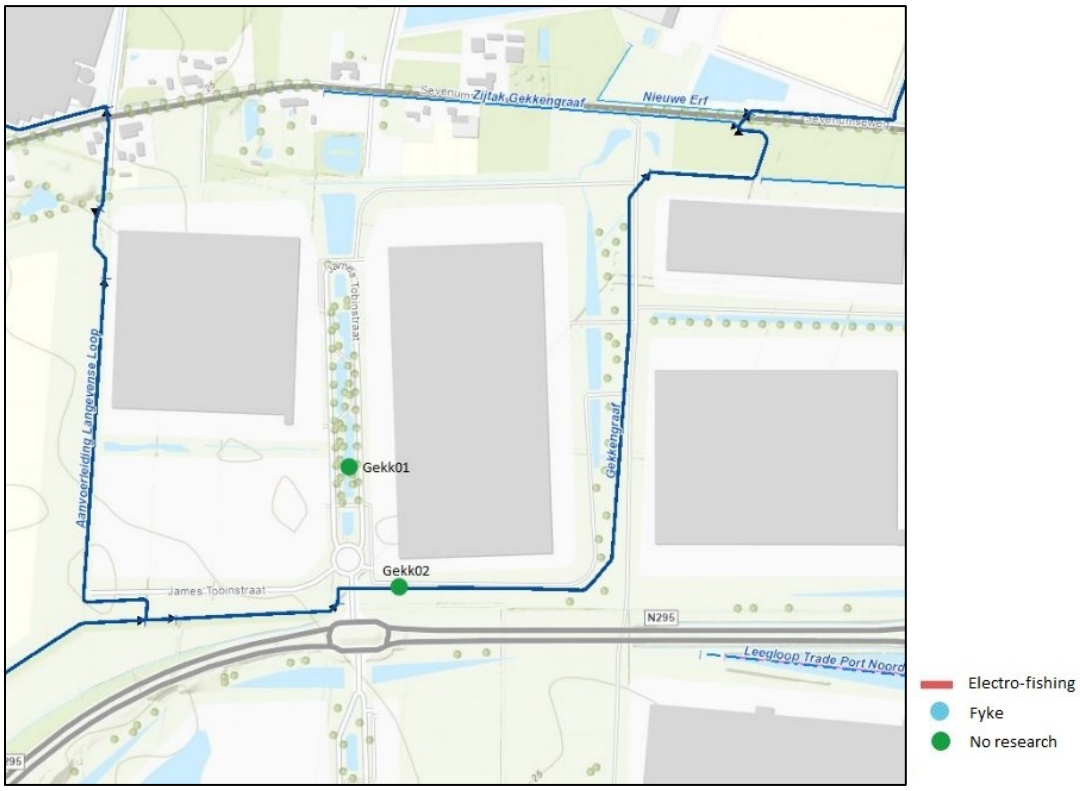


Figure 40 Overview map of sampling locations in the Gekkengraaf

4.15 Ven-Zelderheide - Niers

In the area of Ven-Zelderheide (hamlet Zelder) flows the Niers, where in 1990 one *M. fossilis* was observed by NHGL (Stichting NDFF, 2019) (Figure 41). The Niers flows from Germany into the Meuse and is surrounded by agricultural and nature area. *M. fossilis* was not seen since the last sighting in 1990. The probability of finding *M. fossilis* in the streams is low. For this reason, no research was done in the Niers.

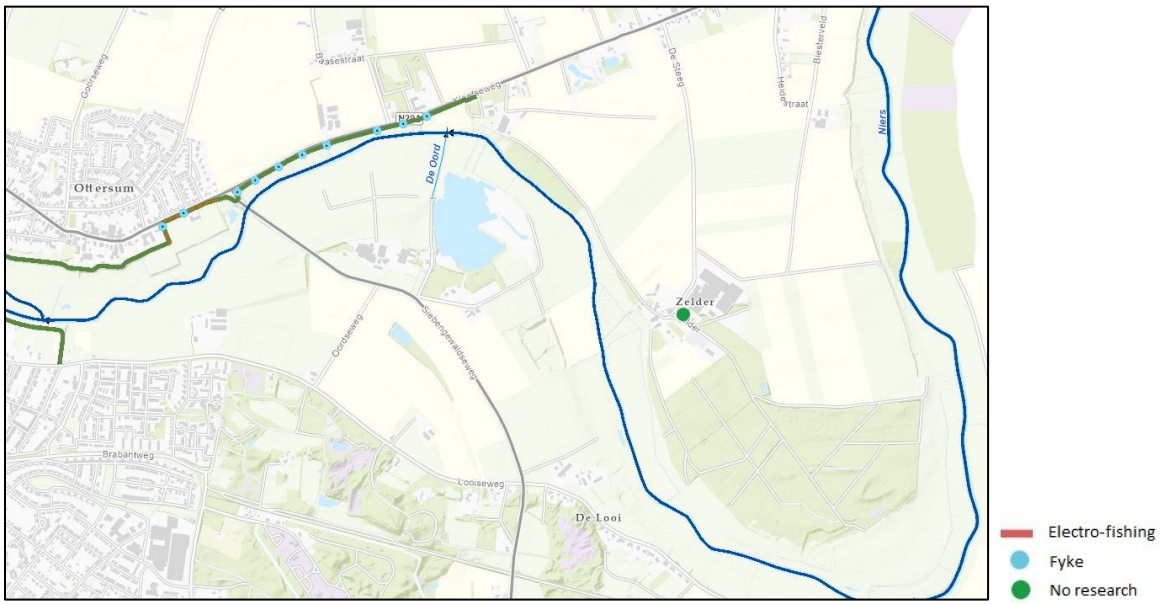


Figure 41 Overview map of sampling locations in the Niers

4.16 Weert – Vloedlossing

By means of eDNA research, DNA of *M. fossilis* was detected in the Vloedlossing in 2013 (RAVON, 2022) by the observer Jöran Janse, whom was commissioned by Waterschap Peel en Maasvallei. The Vloedlossing flows through a nature area called Weerterbos (Figure 42). *M. fossilis* was not observed by using electro fishing in the area. However, a total of 71 individuals were observed, including *Gasterosteus aculeatus, Pungitius pungitius* and *Esox Lucius*. It was decided to sample via eDNA, thus there is a control measure whether *M. fossilis* does or does not reside in the Vloedlossing.

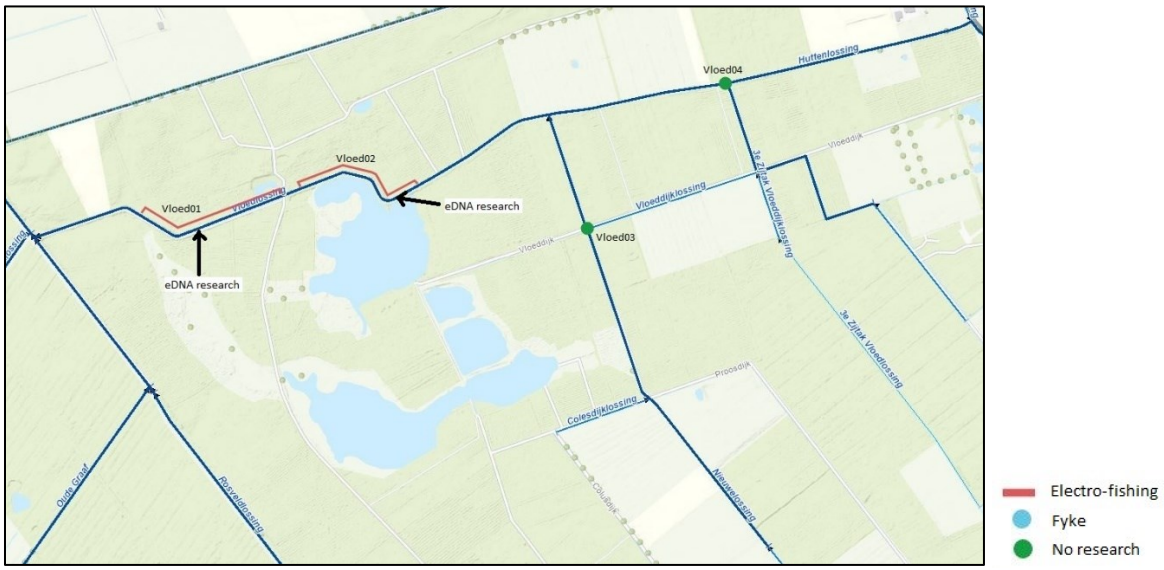


Figure 42 Overview map of sampling locations in the Vloedlossing

Figure 43 Impression of the Vloedlossing

Figure 44 Impression of the Vloedlossing

During the visitation to the area, it was discovered that the locations Vloed03 and Vloed04 had dried up. Vloed01 and Vloed02 are different despite the distance between them. The current water level is 20 cm and there is a lot of leaf litter on the bottom and little vegetation (2%), due to the shallow depth no fykes were placed. The depth of Vloed02 is 40cm, there is a lot of leaf litter and duckweed (total vegetation of 27%) (Tables 18 and 19). Due to the shallow depth no fykes were placed.

Table 18 Dimensions sapropel layer and velocity of the Vloedlossing

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Vloed01	20	1,5	10	0,07
Vloed02	40	1,5	5	0,07

Table 19 Vegetation and substrate coverage (%) of the Vloedlossing

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Substrate: Sand	Clay/ loam	Sapropel without H2S	Fine detritus	Coarse detritus
Vloed01	0	1	1	2	10	10	20	-	60
Vloed02	2	10	15	27	-	30	10	20	40

4.17 Weert – Kievitsbeek

By means of eDNA research, DNA of *M. fossilis* has been detected in the Kievitsbeek in 2013 (RAVON, 2022) by Jöran Janse, whom was commissioned by Waterschap Peel and Maasvallei. The Kievitsbeek flows through an agriculture and nature area (Figure 45). Six sections were researched by electro fishing and four fykes were placed in the Kievitsbeek. Two spots (Kiev11 and Kiev12) were unsuitable for the placement of the fykes due to drought and the depth.

Figure 45 Overview map of sampling locations in the Kievitsbeek

Figure 46 Impression of the Kievitsbeek

Figure 47 Impression of the Kievitsbeek

Kiev01 is not entirely suitable for *M. fossilis* in terms of habitat. Kiev01 has little to no vegetation with little sapropel (15cm) and a depth of 40cm. Kiev02 is shallow (20cm) and has a high vegetation cover of 40% and of which 80% was covered with algae/threading algae. The adjacent ditch (Kievitsdijklossing) dried up completely. Kiev04 has a lot of algae growth, they have a coverage of 60%, with a sapropel layer of 25cm and a total depth of 50cm. Kiev05 has a lot of H2S present, and the substrate is covered with sapropel without H2S (80%). The water has a maximum depth of 60cm with a 10cm sapropel layer. Due to the presence of H2S there is less oxygen in the water, which can lead to less fauna in the water.

Kiev03 and Kiev06 have a depth of 80 - 100cm. The sapropel layer sits between 20 - 30cm and the vegetation coverage between 12 - 40%. There is a little velocity (0,02m/s) (Tables 20 and 21). *M. fossilis* was not observed in the area. However, a total of 168 individuals were observed, including *Gasterosteus aculeatus, Pungitius pungitius, Umbra pygmaea, Carassius gibelio, Scardinius erythrophthalmus, Tinca tinca, Proterorinus semilunaris* and *Gobio gobio*. It was decided to sample via eDNA, thus there is a control measure whether *M. fossilis* does or does not reside in the Kievitsbeek.

Table 20 Dimensions sapropel layer and velocity of the Kievitsbeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Kiev01	40	3	15	0,2
Kiev02	20	0,5	5	0,02
Kiev03	60	3	25	0,1
Kiev04	45	1	10	0,01
Kiev05	60	2	10	0,01
Kiev06	100	2	20	0,03

Table 21 Vegetation and substrate coverage (%) of the Kievitsbeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Sand	Clay/ loam	Sapropel without H2S	Sapropel with H2S	Fine detritus
Kiev01	2	-	5	7	15	15	5	80	-	-
Kiev02	15	5	10	40	80	-	25	65	-	10
Kiev03	2	-	10	12	90	-	15	70	-	15
Kiev04	2	-	10	12	60	-	15	70	-	15
Kiev05	1	-	5	6	60	-	10	10	80	-
Kiev06	2	-	10	12	40	-	10	60	20	10

4.18 Weert – Kuppenlossing

By means of eDNA research, DNA of *M. fossilis* was detected in the Kuppenlossing in 2013 (RAVON, 2022) by Jöran Janse, whom was commissioned by Waterschap Peel and Maasvallei. The Kuppenlossing flows through an agriculture and nature area, named the Moeselpeel (Figure 48). Two sections were researched by electro fishing and three fykes were placed in the Kuppenlossing and Moeselpeel. One spot (Moes05) was unsuitable for the placement of a fyke and research by electro fishing, due to drought and depth.

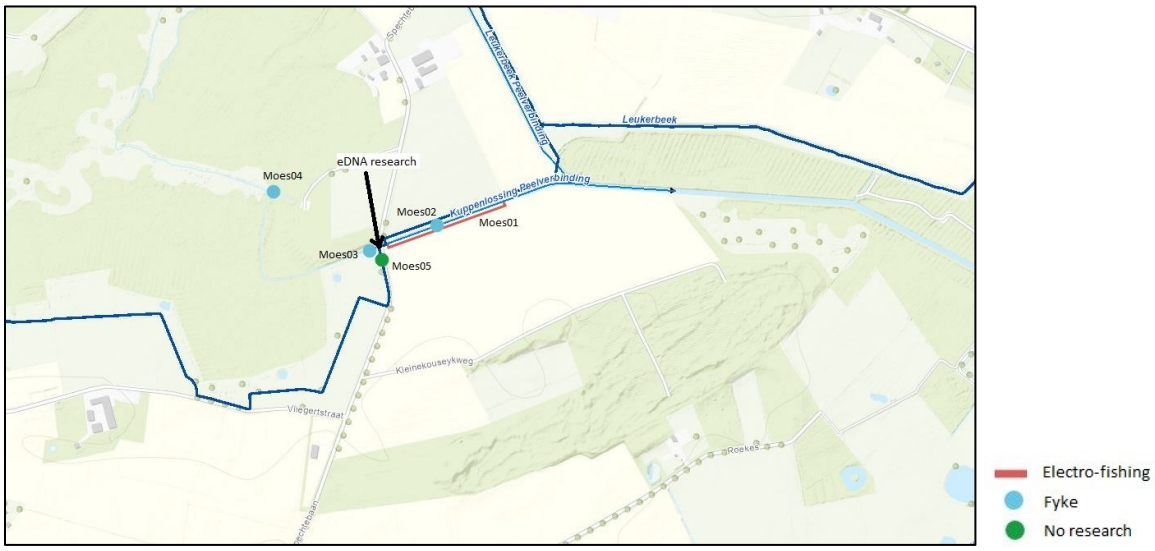


Figure 48 Overview map of sampling locations in the Kuppenlossing

Figure 49 Impression of the Kuppenlossing

Figure 50 Impression of the Kuppenlossing

The average depth is around 60cm with a maximum sapropel layer of 10cm at Moes01 and Moes02. While the average depth is about 120cm in the Moeselpeel (Moes03 and Moes04), with a maximum sapropel layer of 40cm. The vegetation coverage sits between 16% and 32%. There is a little velocity (0,01 - 0,02m/s) in the Moeselpeel, while the Kuppenlossing (Moes01 and Moes02) has a velocity of 0,2m/s (Tables 22 and 23).
M. fossilis was not observed in the area. However, a total of 61 individuals were observed, including large numbers of *Gasterosteus aculeatus, Umbra pygmaea* and *Tinca tinca*. It was decided to sample via eDNA, thus there is a control measure whether *M. fossilis* does or does not reside in the Kuppenlossing.

Table 22 Dimensions sapropel layer and velocity of the Kuppenlossing

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Moes01	25	4	10	0,1
Moes03	120	3	30	0,05
Moes04	60	4	40	0,01

Table 23 Vegetation and substrate coverage (%) of the Kuppenlossing

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Concrete	Clay/ loam	Sapropel without H2S	Sapropel with H2S	Fine detritus	Coarse detritus
Moes01	15	1	0	16	80	-	10	20	40	10	20
Moes03	8	5	2	15	-	5	35	60	-	-	-
Moes04	25	2	5	32	-	-	10	60	-	10	20

4.19 Comparison Broekhuizen and Herkenbosch – Postbeek

Since *M. fossilis* was observed at the Broekhuizen and Herkenbosch (Postbeek) (Figure 51), it is important to conduct research about the habitat. Due to the field observations, it was possible to determine if the locations are similar or different. These two locations have similar morphological characteristics (Table 24). They both have an average depth of 70 to 90cm, with a sapropel layer of 20 to 50cm. In both locations there is a mild flow velocity, which means that the water does not flow too fast neither is stagnant. Yet, Broek03 has the lowest velocity (0,02 m/s) which occurs due to the stream being fed by a wetland. Post03 has the highest flowing (0,09 m/s) stream which is caused by either a higher amount of water flowing into the system or a higher gradient (downstream).

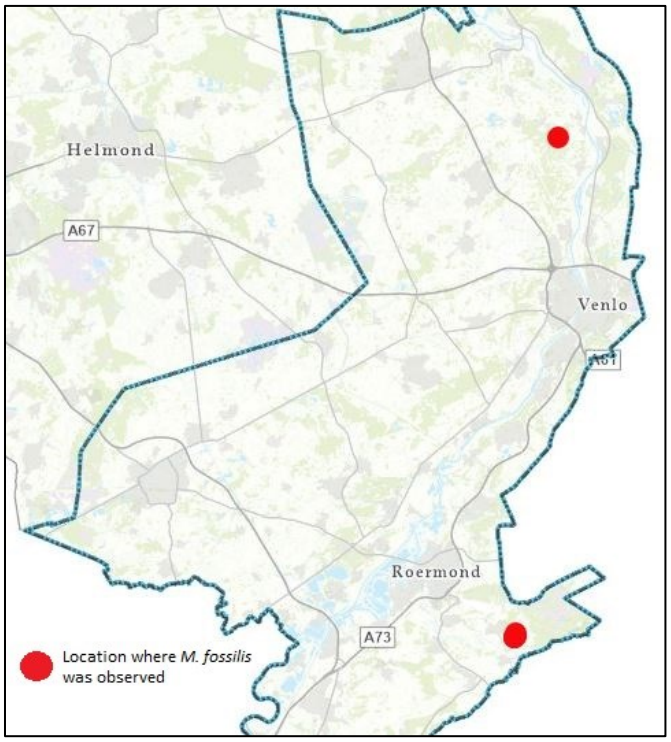


Figure 51 Overview map of the area M. fossilis was observed

Table 24 Dimensions sapropel layer and velocity of the Broekhuizer Molenbeek and the Postbeek

Measurement point	Max. depth (cm)	Width (cm)	Max. sapropel layer (cm)	Current velocity (m/S)
Broek03	90	3	40	0,02
Post01	90	4	50	0,05
Post02	70	2	20	0,05
Post03	70	1	30	0,09

Post01 surpasses the other locations at Herkenbosch due to higher percentages in morphological characteristics, for example the total aquatic vegetation is 22% with 10% of algae/ filamentous algae. The other locations (Post02 and Post03) only have a total aquatic vegetation percentage of 9 – 10% (Table 25 and Figure 50). Broek03 is notable different hence the 8% of total aquatic vegetation coverage, which is the lowest percentages of the areas combined.

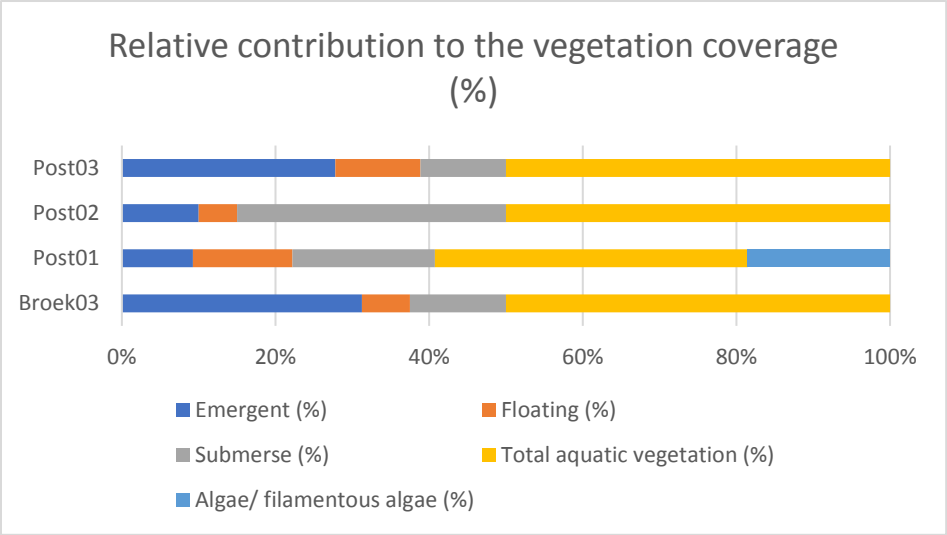


Figure 52 Relative contribution to the vegetation coverage at the Broekhuizer Molenbeek and Postbeek

Table 25 Vegetation and substrate coverage (%) of the Broekhuizer Molenbeek and Postbeek

Measurement point	Vegetation: Emergent	Floating	Submerged	Total aquatic vegetation	Algae/ filamentous algae	Substrate: Stone	Clay/ loam	Sapropel without H2S	Fine detritus	Coarse detritus	Wood
Broek03	5	1	2	8	-	-	55	40	-	-	5
Post01	5	7	10	22	10	1	10	68	10	10	1
Post02	2	1	7	10		-	9	50	20	20	1
Post03	5	2	2	9	-	-	20	60	10	10	-

Looking at Figure 51, it is immediately obvious that sapropel without H2S (orange) stands out because it is present in every stream in large percentages (40 – 68%) at all locations. Although the other streams have a lower percentage of clay/loam (9 – 20%), the substrate in Broek03 consists of 55% of clay/loam. It can be seen that fine and coarse detritus is present in Post01 to Post03 but not in Broek03.

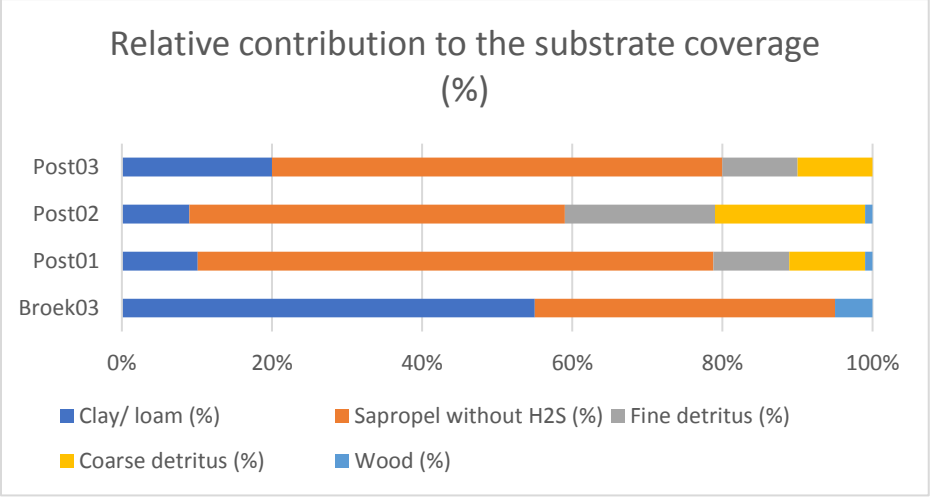


Figure 53 Relative contribution to the substrate coverage at the Broekhuizer Molenbeek and Postbeek

During the 72-hour examination of the fykes, a total of 48 fish were observed (Figure 52). Seven out of 48 fish were observed in Broek03 and 41 out of 48 fish were observed in Post01 to Post03.
During electro-fishing, most fish (17 total) were observed at Post02, as well as most *M. fossilis* (4 total) were observed. In total 7 *M. fossilis* were observed in the locations combined.

In Broek03, Post01, Post02 and Post03 the species *Perca fluviatilis, Lepornis gibbosus, Gasterosteus aculeatus, Tinca tinca, Carassius gibelio, Pungitius pungitius* and *Esox lucius* can be found. The natural habitat of these fish is stagnant to slow-flowing plant-rich waters with muddy bottoms. All species are also sight hunters, which means that the water must be clear to hunt and ultimately survive (RAVON, sd). These characteristic habitats are similar to the natural habitat of *M. fossilis*.
A total of 721 fish were observed in all research areas by means of electro-fishing and fykes.

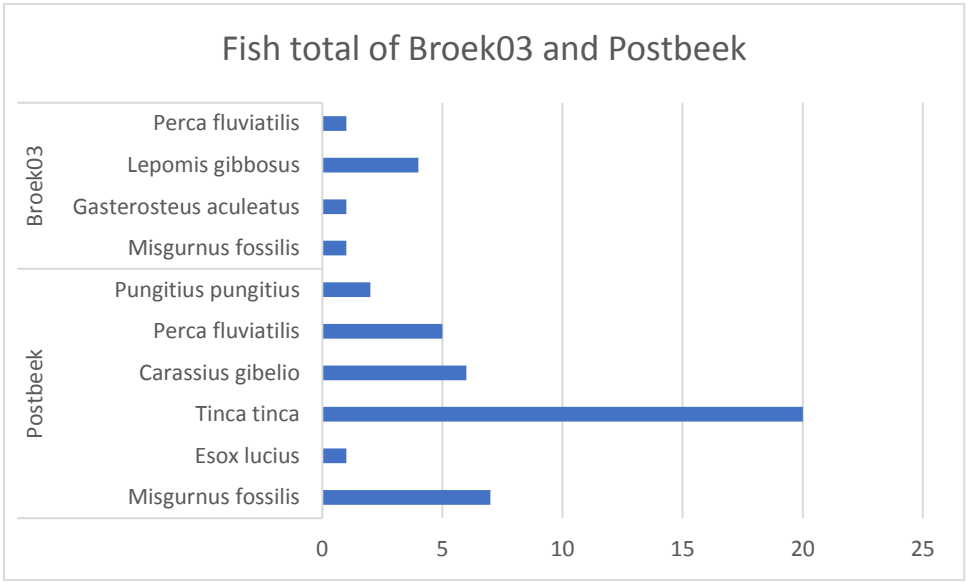


Figure 54 Fish total at the Broekhuizer Molenbeek and Postbeek

5. Discussion

While examining the NDFF data, it appeared that several locations were suitable for field research. However, during the field visit it became apparent that some locations were not suitable due to the drying up of the stream or the total absence of water in the area. This was the case at namely Boukoul, Herkenbosch – Vogterbeek, Herkenbosch – Postbeek, Neer and Weert – Vloedlossing.
Despite the absence of water, we checked whether there was any water flowing in the vicinity, so research could be carried out in the nearby stream if Conditions met the habitat requirements of *M. fossilis*. This was for example the case in Boukoul where the original NDFF data indicated a sighting in the middle of a nature area without water. It was then decided to research the Blankwaterlossing because it was closest to the original area. During the field research at Weert - Vloedlossing it was observed that two locations had dried up and one out of the two researched streams had a chance to dry up due to the low water level (20cm).

Three different methods were used to carry out field research in this study, namely electrofishing, the placement of fykes and eDNA research. For each method, there are a number of discussion points because an error remains. Electro-fishing became heavier and heavier as the duration of the field research increased, due to the physical effort required to carry out the study. As a result, not all areas could be fully sampled using electrofishing. Furthermore, not all fish were observed because they were not all within the range of the net. Moreover, there is a chance that some of the fish are hiding in deeper parts of the stream and were therefore not found while being present.

When trying to place the fykes, there were problems with the range at some locations. Some waters were too deep or too shallow for the fykes to be set. If these fykes were placed in shallow waters, there is a chance that other fauna, such as birds, would get stuck in them. At the locations Herkenbosch - Vogterbeek and Steinbroeklossing dead beavers were found in the fykes. In consultation with the pest control operators, the fykes were removed so no more beavers could be accidentally caught.
In addition, the fyke may be incorrectly positioned in the current, for example the entrance was located too deep in the water, or the current did not flow towards the fyke entrance. When the entrance of the fyke is against the current, there is a greater chance of fish swimming in. Furthermore, a total of 61 *Umbra pygmaea* have been observed at the Moeselpeel, which is very high even for an invasive species. Especially due to the high number of predatory birds in the area.

When no individual of *M. fossilis* were found in locations which provided suitable habitat and had previous observations, additional eDNA analysis can conclusively determine if *M. fossilis* is present (Kranenberg, et al., 2014). This is important as electro fishing and placement of fykes does not have a 100% success rate.

In the Uffelsebeek a number of fish observations were made during field research. Most fish were observed after 48 hours. While at other locations (outside Grathem and Hunsel) fish were mostly found directly after the first 24 hours. It is also striking that 115 individuals were observed downstream in Uffel13 to Uffel16 and a total of 5 individuals were found upstream in Uffel09 to Uffel12. However, it should be taken into account that fyke Uffel12 was removed by a person after 48 hours, which causes data to be missing. Furthermore, Uffel16 has been placed for 24 hours so it can be excluded whether *M. fossilis* is in the Panheelderbeek after the junction of the Uffelsebeek.

It is noticeable, that in the area of the Kievitsbeek several problems were present. For example, part of Kiev02 was dried up and the rest of the ditch also tended to dry up (E. Binnendijk, personal communication, March 22, 2022). Furthermore, there was a strong presence of H2S in Kiev05, which causes less oxygen in the water. If the oxygen content remains low for prolonged periods, this may

result in less fauna in the water (Vriese, de Laak, & Jansen, 1994). Yet, more than 30 frogs were observed in the fykes.

The current observations have dropped considerably compared to previous observations (7 out of 54 previous observations). However, eDNA research was carried out, the results of which are not yet known. There is a chance the eDNA research revealed DNA from *M. fossilis,* which were found at the locations. This would mean the presents of *M. fossilis* in the area can increase of stay the same. However, the observations will not be higher than 12 observations because only 12 extra locations were sampled.

6. Conclusion and recommendation

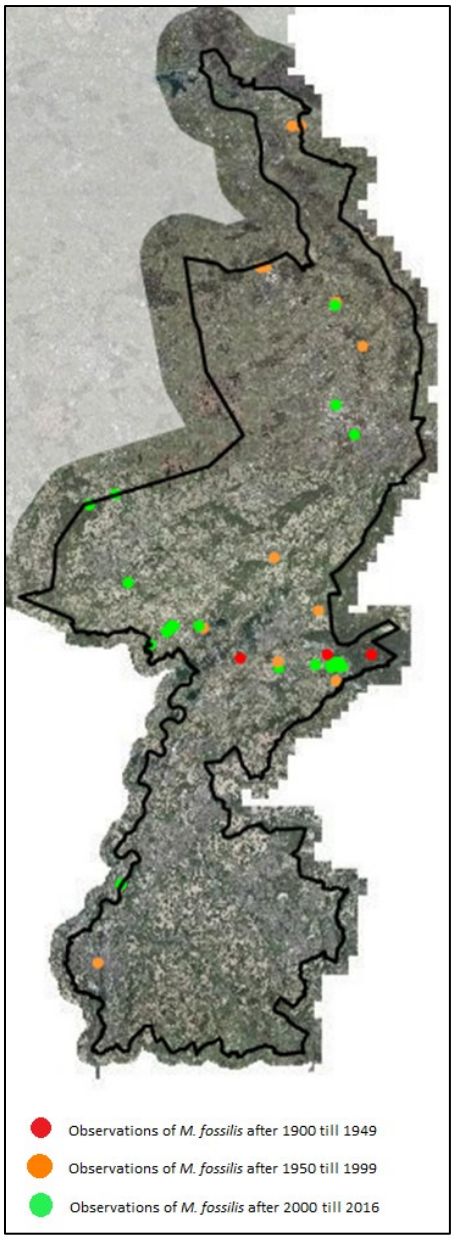
The aim of the study of *M. fossilis* was to find out where and in what abundance the species is present in the Province of Limburg. To obtain this data, sub-questions were formulated to answer the main question. Through a literature study and fieldwork, the sub-questions are answered.

At the beginning of the research data was obtained from the NDFF database where the collected observations are listed. These data with observations were checked if they are still up to date by field visit and checking the sources. By investigating the source (by whom, year and method), it can be determined whether the data is reliable. From the research, 12 out of 18 locations were found to be reliable and field research was carried out. The 12 locations are Boekend, Boukoul, Broekhuizen, Grathem, Herkenbosch (Vogterbeek, Steinbroeklossing and Postbeek), Hunsel, Sint Odiliënberg and Weert (Vloedlossing, Kuppenlossing and Kievitsbeek).

From the results it can be concluded that *M. fossilis* has been observed on two of the eighteen locations (Broekhuizen and Herkenbosch). One individual (male) of 20 cm was found by means of a fyke in Broekhuizen (Broek03). In Herkenbosch (Post01, Post02 and Post03) a total of 6 individuals have been observed by means of electro fishing. In Post01, one individual (male) of 16cm was found. At Post02, four individuals were found, one individual (male) of 15cm, one individual (female) of 9cm and two individuals (female and unknown) of 6cm. At Post03 one individual (female) found of 8 cm.

In the whole area Broekhuizen a total of 23 individuals fish were observed, of which 1 individual proved to be *M. fossilis*. In the entire area Herkenbosch - Postbeek a total of 50 individuals have been observed, of which 6 individuals have proven to be *M. fossilis*. The number of *M. fossilis* is not large compared to other fish species present. However, it can be seen that several individuals have been identified over a large area in Herkenbosch - Postbeek.

Previous research (Stichting NDFF, sd) has shown a total of 54 sightings of *M. fossilis*. The current research has observed 7 sightings of *M. fossilis* in Limburg. This means that the current observations are only 12,96% (7/54*100%) of the previous observations. The decrease in the number of sightings may be due to the strong decrease in sedimentary habitat caused by human intervention. As well as the disappearance of the low dynamic floodplain due to the intensification of agriculture (RAVON, sd). In the Figures 55 and 56 below, the difference between the previous and current observations of *M. fossilis* in Limburg can be clearly seen.



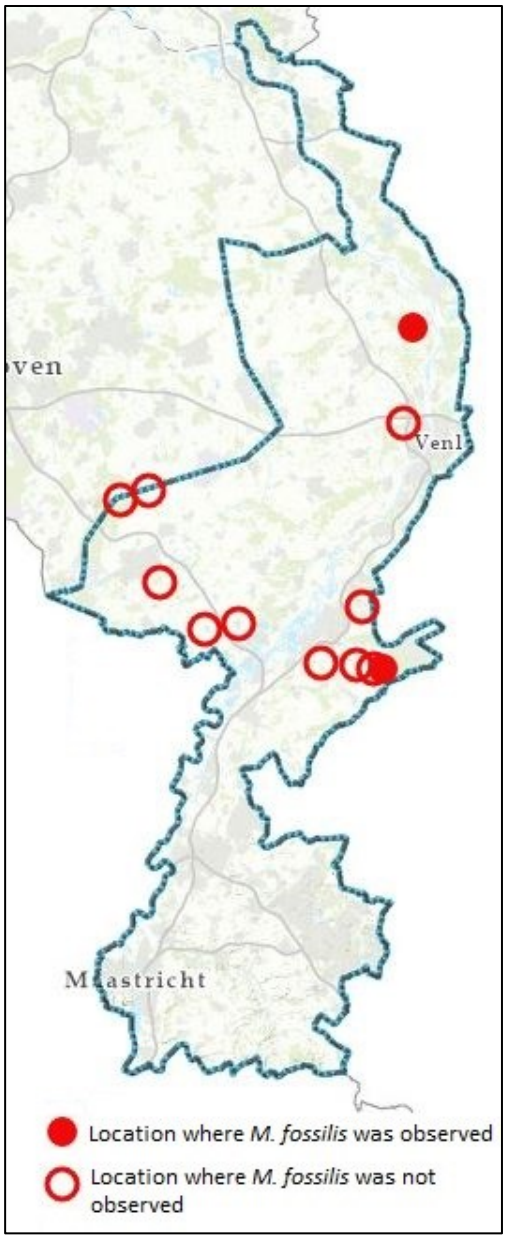


Figure 55 Previous observations of M. fossilis *Figure 56 Overview map of observed M. fossilis 2022*

6.1 Recommendation

The general management strategies described for *M. fossilis* by Belpaire & Coeck (2016) were not found in the waters of Limburg. It is therefore recommended to implement the strategies of Belpaire & Coeck (2016). Namely to secure the population by removing (potential) threats, and strengthening, connecting and expanding the habitat to improve the dispersal and spawning opportunities.

When these strategies have become reality, a plan for habitat maintenance should be put in place. As a start, maintenance work should be carried out outside vulnerable periods. This means not carrying out any work during the breeding season, winter dormancy and drought. The breeding season begins in early April and ends in late August. The legislation already states that no work may be carried out during these periods. The winter rest period starts at the beginning of November and ends at the end of March. The months of September and October remain to carry out this maintenance work. By working in phases, it is possible to carry out maintenance work while the species is present.
Suppose that maintenance work is carried out, such as mowing the bank or dredging the ditch, would mean vegetation and mud would be removed. The complete removal of vegetation and mud would

leave *M. fossilis* with no place to hide or breed, which would increase the likelihood of predation and ultimately lead to its extinction (BIJ12, 2021; Binnendijk & Tielen, 2021).

In the habitats where *M. fossilis* has been found, research can be carried out into the oxygen content, drought (current and future), water level control and the presence or absence of variables that are desirable in the habitat of *M. fossilis*. This research may provide an explanation as to why *M. fossilis* is or is not present in the area and what measures should be taken to attain a desirable habitat (de Bruin & Kranenbarg, 2017).

M. fossilis is dependent on the presence of sludge and dense submerged vegetation. Restoration or creation of wetlands allows vegetation to grow and provide a gradual transition between land and water zones. Widened banks provide a higher biodiversity of riparian and aquatic plants, where juveniles, for example, can stay (Belpaire & Coeck, 2016).

To summarise, existing habitats should be improved through an improved maintenance plan and more research about the best way to improve the habitat of *M. fossilis*. Here it is useful to look at where you want to improve the area. After the results of the eDNA survey are published, conduct more field research in the waters to try and find *M. fossilis*.

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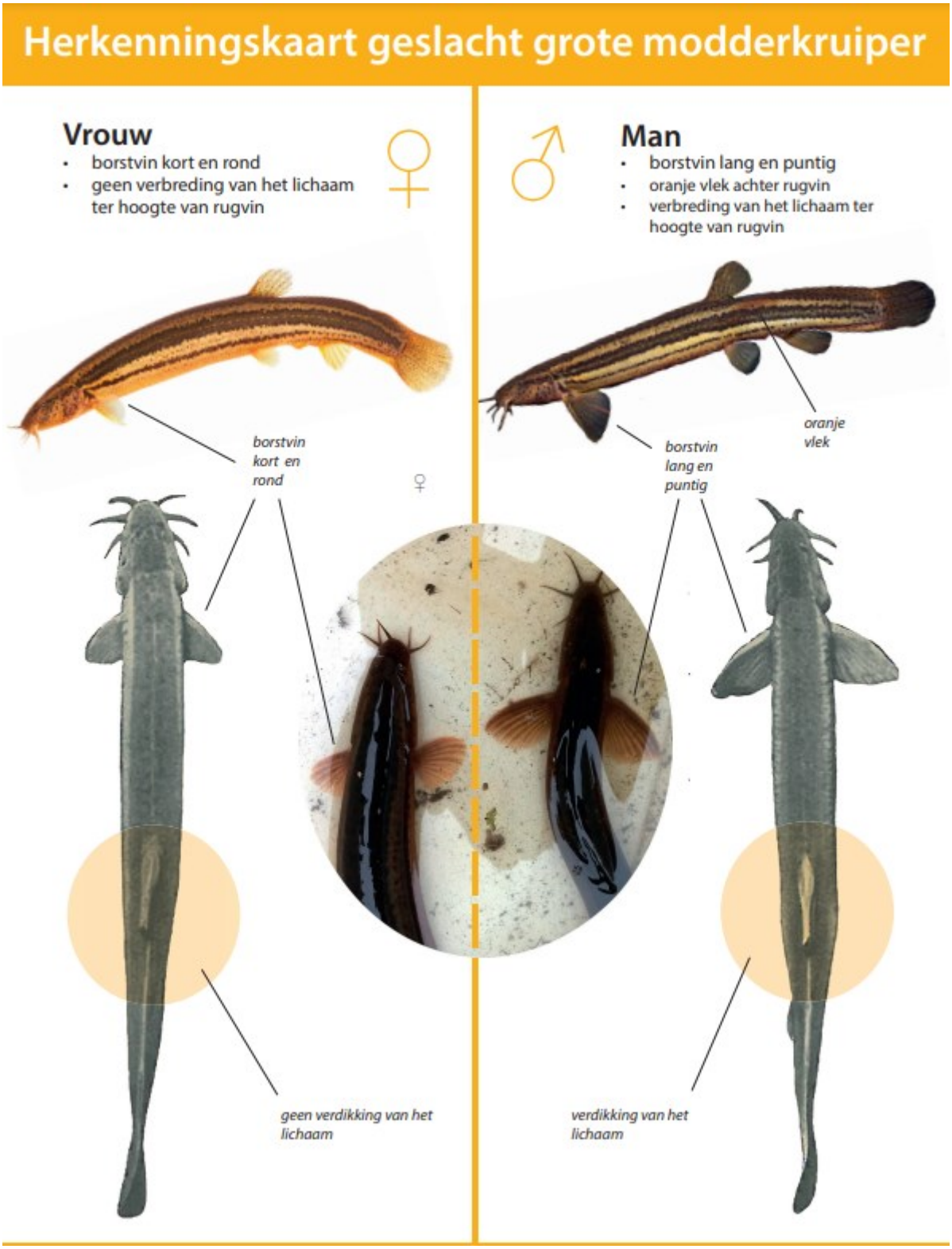
Appendices

Appendix I – Recognition card *Misgurnus fossilis* (Bruin, de, Herder, & Hartmant, sd)



Appendix II – National Database Flora and Fauna: dataset containing previous observations and locations of Misgurnus fossilis

Original number	Centrum X	Centrum Y	Place	Year	Name stream	Flow direction	Data manager	Reliable and why
3	196911	351657	Sint-Odiliënberg	2010	3e Zijtak Overenlossing	Oosten	Waarneming.nl	Ja, nakijken data eigenaar, wie?
1	196911	351657	Sint-Odiliënberg	2010	3e Zijtak Overenlossing	Oosten	Waarneming.nl	Ja, nakijken data eigenaar, wie?
2	196911	351657	Sint-Odiliënberg	2010	3e Zijtak Overenlossing	Oosten	Waarneming.nl	Ja, nakijken data eigenaar, wie?
1	202960	351084,5	Herkenbosch	2008	Bosbeek	Zuiden	RAVON	Ja, nakijken wie dit heeft gedaan
1	202980,5	351140,3	Herkenbosch	2008	Bosbeek	Zuiden	RAVON	Ja, nakijken wie dit heeft gedaan
1	202961	351080	Herkenbosch	2008	Bosbeek	Zuiden	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	202977	351142	Herkenbosch	2008	Bosbeek	Zuiden	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203735	351533	Herkenbosch	1980	Bosbeek (ten oosten)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	188500	355500	Herkenbosch	1990	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203690,3	351558,7	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203683,2	351569,7	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203676,2	351569,7	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203647,9	351602,8	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203669,5	351536,2	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203690,5	351536,4	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	RAVON	Ja, nakijken wie dit heeft gedaan
1	203645	351603	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203671	351574	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203673	351532	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203675	351572	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203683	351565	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203687	351540	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
1	203691	351557	Herkenbosch	2008	Bosbeek (ten zuiden)	Westen	Waarneming.nl	Ja, nakijken wie dit heeft gedaan
12	203843,4	351101,3	Herkenbosch	2008	Broekbeek	Noorden	RAVON	Ja, Betrouwbaar
1	206500	387500	Broekhuizen	2001	Broekhuizer Molenbeek	Noorden	RAVON	Ja, bron? Ravon mailen
1	203473	380831	Trade Port	2000	Gekkengraaf (ten zuiden)	Noordoosten	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, waarneming Vissenwerkgroep. Op een kaart plotten en nagaan
1	203370	392150	Meerlo	1997	Groote Molenbeek	Noordwesten	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, waarneming Vissenwerkgroep. Op een kaart plotten en nagaan

1	179930	360652	Weert	2013	Kuppenlossing	Oosten	RAVON	Ja, in opdracht van WMP (eDNA onderzoek); Nakijken
1	198500	412500	Ven-Zelderheide	1990	Niers	Noorden	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, waarneming Vissenwerkgroep. Op een kaart plotten en nagaan; Veldbezoek (sloten); Schepnet
1	176500	317500	Maastricht	1990	Noordelijke Jekertak (ten zuiden)	Oosten	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, waarneming Vissenwerkgroep. Op een kaart plotten en nagaan
1	196500	363500	Neer	1980	Ophovenlossing (ten noorden)	Noordoosten	RAVON	Nee, navragen
1	188500	355500	Grathem	1990	Panheelderbeek	Zuidwesten	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, waarneming Vissenwerkgroep. Op een kaart plotten en nagaan
1	203937	351402	Herkenbosch	2008	Postbeek	Zuidwesten	Waarneming.nl	Betrouwbaar
23	204201,6	351157,7	Herkenbosch	2016	Postbeek (ten noorden)	Zuidwesten	Peel en Maasvallei (waterschap)	Betrouwbaar
3	197000	351000	Sint-Odiliënberg	2005	Postberglossing of Sluizerbeek	Oosten	Waarneming.nl	Waarschijnlijk betrouwbaar
1	203005	351265	Herkenbosch	2008	Riemer	Zuiden	Waarneming.nl	Betrouwbaar
1	201158	351347	Herkenbosch	1987	Roer (ten westen) en Vogterbeek (ten noorden)	Roer ten Noorden en Vogterbeek ten westen	Waarneming.nl	Waarschijnlijk betrouwbaar; wel kijken door wie het is waargenomen
1	184287	355111,9	Hunsel	2013	Splitsing Uffelsebeek en Hoogwatergeul Hogerhof	Noordoosten	Telmee.nl	Natuurbank Limburg; Goedgekeurd
1	202860	351248	Herkenbosch	2008	Steinbroeklossing	Zuiden	Waarneming.nl	Betrouwbaar
1	205570,6	377471,2	Boekend	1929	Stroom Blerickse heide, richting de Everlose beek	Oosten	RAVON	Nee, nabellen
1	201500	357500	Boukoul	1984	Ten noorden ligt de Blankwaterlossing	Noordoosten	RAVON	Nee, navragen, mogelijk veldbezoek

2	185110	355750	Hunsel	2015	Uffelsebeek	Oosten	Peel en Maasvallei (waterschap)	Ja, waarneming waterschap tijdens vistrap bemonstering
1	184565,3	355302,4	Hunsel	2013	Uffelsebeek	Noordoosten	Telmee.nl	Ja, betrouwbaar
2	184326,9	355112	Hunsel	2013	Uffelsebeek	Noordoosten	Telmee.nl	Ja, betrouwbaar
1	187950	355750	Grathem	1997	Uffelsebeek	Noordoosten	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, waarneming Vissenwerkgroep. Op een kaart plotten en nagaan
1	184795	355752	Hunsel	2013	Uffelsebeek	Oosten	RAVON	Ja, in opdracht van WMP (eDNA onderzoek); Nakijken; In een kaart plotten (met fuiken nakijken)
1	203500	392500	Meerlo	1990	Van Smallenbroek	Westen	Natuurhistorisch Genootschap in Limburg (NHGL)	Betrouwbaar, vis niet meer waargenomen. Dus hij zit er waarschijnlijk niet meer (vaak nagezocht in de afgelopen 15 jaar) Niet nazoeken!
1	175505	369491	Grens Limburg en Noord-Brabant	2013	Vloedlossing	Westen	RAVON	Ja, in opdracht van WMP (eDNA onderzoek); Nakijken
1	192631,7	352074,4	Linnen - Weerd	1947	Vlootbeek	Oosten	RAVON	Nee, nabellen

Appendix III: Field Forms and maps

Attachments field forms and maps are displayed in an additional document. See “additional products or attachments” on Onstage.

Appendix IV – Observations of fish during field research

Measurement point	Scientific name	Species	Length (cm)	Number
Boek01	Esox lucius	Northern pike	12	1
Boek02	Tinca tinca	Tench	25	1
Boek03	Esox lucius	Northern pike	50	1
Boek03	Esox lucius	Northern pike	40	2
Boek03	Rutilus rutilus	Common roach	15	1
Boek03	Tinca tinca	Tench	7	1
Bouk01	Pungitius pungitius	Ninespine stickleback	6	8
Bouk01	Pungitius pungitius	Ninespine stickleback	5	18
Bouk01	Pungitius pungitius	Ninespine stickleback	4	18
Bouk01	Pungitius pungitius	Ninespine stickleback	3	12
Bouk02	Barbatula barbatula	Stone loach	13	1
Bouk02	Barbatula barbatula	Stone loach	12	3
Bouk02	Barbatula barbatula	Stone loach	11	9
Bouk02	Barbatula barbatula	Stone loach	10	1
Bouk02	Barbatula barbatula	Stone loach	9	3
Bouk02	Barbatula barbatula	Stone loach	8	1
Broek01	Tinca tinca	Tench	15	1
Broek01	Rutilus rutilus	Common roach	12	1
Broek01	Rutilus rutilus	Common roach	8	1
Broek01	Gobio gobio	Gudgeon	9	1
Broek01	Esox lucius	Northern pike	50	1
Broek01	Scardinius erythrophthalmus	Common rudd	9	1
Broek01	Tinca tinca	Tench	35	1
Broek02	Tinca tinca	Tench	15	1
Broek03	Misgurnus fossilis	Weather loach	20	1
Broek03	Gasterosteus aculeatus	Three-spined stickleback	5	1
Broek03	Lepomis gibbosus	Pumpkinseed	9	1
Broek03	Lepomis gibbosus	Pumpkinseed	8	1
Broek03	Lepomis gibbosus	Pumpkinseed	7	2
Broek03	Perca fluviatilis	European perch	15	1
Broek04	Tinca tinca	Tench	15	1
Broek04	Pseudorasbora parva	Topmouth gudgeon	7	1
Broek04	Gasterosteus aculeatus	Three-spined stickleback	6	1
Broek04	Gobio gobio	Gudgeon	7	1
Broek04	Gasterosteus aculeatus	Three-spined stickleback	6	1
Broek04	Rutilus rutilus	Common roach	7	1
Broek04	Tinca tinca	Tench	12	1
Broek05	Pungitius pungitius	Ninespine stickleback	5	1
Kiev01	Gasterosteus aculeatus	Three-spined stickleback	6	2
Kiev01	Gasterosteus aculeatus	Three-spined stickleback	5	1
Kiev01	Gasterosteus aculeatus	Three-spined stickleback	4	3
Kiev01	Pungitius pungitius	Ninespine stickleback	7	1
Kiev01	Pungitius pungitius	Ninespine stickleback	5	1
Kiev01	Pungitius pungitius	Ninespine stickleback	4	1
Kiev02	Gasterosteus aculeatus	Three-spined stickleback	4	1

Kiev02	Pungitius pungitius	Ninespine stickleback	5	2
Kiev02	Umbra pygmaea	Eastern mudminnow	8	1
Kiev02	Umbra pygmaea	Eastern mudminnow	6	2
Kiev02	Umbra pygmaea	Eastern mudminnow	5	1
Kiev03	Gasterosteus aculeatus	Three-spined stickleback	5	2
Kiev03	Gasterosteus aculeatus	Three-spined stickleback	4	1
Kiev03	Proterorinus semilunaris	Western tubenose goby	7	1
Kiev04	Gasterosteus aculeatus	Three-spined stickleback	5	2
Kiev04	Pungitius pungitius	Ninespine stickleback	6	1
Kiev05	Carassius gibelio	Prussian carp	9	2
Kiev05	Carassius gibelio	Prussian carp	8	1
Kiev05	Carassius gibelio	Prussian carp	6	1
Kiev05	Pungitius pungitius	Ninespine stickleback	4	1
Kiev06	Gasterosteus aculeatus	Three-spined stickleback	4	11
Kiev06	Gasterosteus aculeatus	Three-spined stickleback	3	10
Kiev06	Gasterosteus aculeatus	Three-spined stickleback	2	3
Kiev06	Pungitius pungitius	Ninespine stickleback	5	4
Kiev06	Pungitius pungitius	Ninespine stickleback	4	1
Kiev06	Scardinius erythrophthalmus	Common rudd	5	1
Kiev07	Gasterosteus aculeatus	Three-spined stickleback	4	5
Kiev07	Umbra pygmaea	Eastern mudminnow	8	1
Kiev07	Tinca tinca	Tench	12	6
Kiev07	Gasterosteus aculeatus	Three-spined stickleback	6	1
Kiev07	Gasterosteus aculeatus	Three-spined stickleback	5	2
Kiev07	Gasterosteus aculeatus	Three-spined stickleback	4	2
Kiev07	Tinca tinca	Tench	10	2
Kiev07	Gasterosteus aculeatus	Three-spined stickleback	5	6
Kiev07	Scardinius erythrophthalmus	Common rudd	15	1
Kiev07	Tinca tinca	Tench	11	1
Kiev07	Tinca tinca	Tench	10	1
Kiev08	Gasterosteus aculeatus	Three-spined stickleback	4	1
Kiev08	Gasterosteus aculeatus	Three-spined stickleback	5	2
Kiev09	Gasterosteus aculeatus	Three-spined stickleback	6	26
Kiev09	Carassius gibelio	Prussian carp	7	1
Kiev09	Gasterosteus aculeatus	Three-spined stickleback	6	6
Kiev09	Gasterosteus aculeatus	Three-spined stickleback	5	4
Kiev09	Gasterosteus aculeatus	Three-spined stickleback	4	2
Kiev09	Carassius gibelio	Prussian carp	10	1
Kiev09	Carassius gibelio	Prussian carp	7	1
Kiev09	Gasterosteus aculeatus	Three-spined stickleback	6	4
Kiev09	Gasterosteus aculeatus	Three-spined stickleback	5	4
Kiev09	Carassius gibelio	Prussian carp	16	1
Kiev09	Carassius gibelio	Prussian carp	11	1
Kiev09	Carassius gibelio	Prussian carp	7	1
Kiev10	Gasterosteus aculeatus	Three-spined stickleback	6	12
Kiev10	Proterorinus semilunaris	Western tubenose goby	6	1
Kiev10	Gasterosteus aculeatus	Three-spined stickleback	6	4
Kiev10	Gasterosteus aculeatus	Three-spined stickleback	5	3

Kiev10	Gobio gobio	Gudgeon	10	1
Kiev10	Gasterosteus aculeatus	Three-spined stickleback	6	1
Kiev10	Gasterosteus aculeatus	Three-spined stickleback	5	1
Kiev10	Scardinius erythrophthalmus	Common rudd	15	1
Kiev10	Tinca tinca	Tench	15	1
Kiev10	Tinca tinca	Tench	12	1
Moes01	Umbra pygmaea	Eastern mudminnow	10	6
Moes01	Umbra pygmaea	Eastern mudminnow	8	4
Moes01	Umbra pygmaea	Eastern mudminnow	7	4
Moes01	Umbra pygmaea	Eastern mudminnow	6	13
Moes01	Umbra pygmaea	Eastern mudminnow	5	4
Moes01	Tinca tinca	Tench	14	2
Moes01	Tinca tinca	Tench	12	1
Moes01	Gasterosteus aculeatus	Three-spined stickleback	5	5
Moes02	Umbra pygmaea	Eastern mudminnow	9	4
Moes02	Umbra pygmaea	Eastern mudminnow	7	2
Moes03	Umbra pygmaea	Eastern mudminnow	9	1
Moes04	Umbra pygmaea	Eastern mudminnow	11	1
Moes04	Umbra pygmaea	Eastern mudminnow	9	2
Moes04	Umbra pygmaea	Eastern mudminnow	14	1
Moes04	Umbra pygmaea	Eastern mudminnow	11	1
Moes04	Umbra pygmaea	Eastern mudminnow	9	1
Moes04	Umbra pygmaea	Eastern mudminnow	8	2
Moes04	Umbra pygmaea	Eastern mudminnow	6	1
Moes04	Umbra pygmaea	Eastern mudminnow	9	2
Moes04	Umbra pygmaea	Eastern mudminnow	8	2
Moes04	Umbra pygmaea	Eastern mudminnow	7	1
Moes04	Umbra pygmaea	Eastern mudminnow	5	1
Post01	Misgurnus fossilis	Weather loach	16	1
Post01	Esox lucius	Northern pike	23	1
Post01	Tinca tinca	Tench	15	1
Post01	Tinca tinca	Tench	12	1
Post01	Tinca tinca	Tench	11	2
Post01	Tinca tinca	Tench	10	1
Post01	Tinca tinca	Tench	9	1
Post01	Tinca tinca	Tench	8	1
Post02	Misgurnus fossilis	Weather loach	15	1
Post02	Misgurnus fossilis	Weather loach	9	1
Post02	Misgurnus fossilis	Weather loach	6	2
Post02	Tinca tinca	Tench	11	1
Post02	Tinca tinca	Tench	10	3
Post02	Tinca tinca	Tench	8	1
Post02	Tinca tinca	Tench	4	1
Post02	Carassius gibelio	Prussian carp	13	1
Post02	Carassius gibelio	Prussian carp	12	2
Post02	Carassius gibelio	Prussian carp	11	3
Post02	Carassius gibelio	Prussian carp	10	1
Post03	Misgurnus fossilis	Weather loach	8	1
Post03	Tinca tinca	Tench	25	1

Post03	Tinca tinca	Tench	11	2
Post03	Tinca tinca	Tench	10	1
Post03	Tinca tinca	Tench	9	2
Post03	Tinca tinca	Tench	8	1
Post03	Perca fluviatilis	European perch	10	1
Post03	Perca fluviatilis	European perch	9	1
Post03	Perca fluviatilis	European perch	5	3
Post03	Pungitius pungitius	Ninespine stickleback	4	2
Post04	Lampetra planeri	Brook lamprey	12	1
Post04	Carassius gibelio	Prussian carp	20	1
Post04	Carassius gibelio	Prussian carp	13	1
Post04	Tinca tinca	Tench	10	2
Post04	Tinca tinca	Tench	8	1
Post04	Scardinius erythrophthalmus	Common rudd	12	1
Post04	Pungitius pungitius	Ninespine stickleback	6	1
Post04	Pungitius pungitius	Ninespine stickleback	4	1
Stein01	Leucaspius delineatus	Sunbleak	5	2
Stein01	Scardinius erythrophthalmus	Common rudd	17	1
Stein01	Scardinius erythrophthalmus	Common rudd	15	1
Stein01	Scardinius erythrophthalmus	Common rudd	12	1
Stein01	Scardinius erythrophthalmus	Common rudd	9	1
Stein01	Scardinius erythrophthalmus	Common rudd	7	2
Stein01	Scardinius erythrophthalmus	Common rudd	6	1
Stein01	Scardinius erythrophthalmus	Common rudd	5	4
Stein01	Tinca tinca	Tench	10	1
Stein01	Tinca tinca	Tench	5	1
Stein01	Carassius gibelio	Prussian carp	8	1
Stein02	Tinca tinca	Tench	8	1
Stein03	Scardinius erythrophthalmus	Common rudd	16	2
Stein03	Scardinius erythrophthalmus	Common rudd	15	1
Stein03	Scardinius erythrophthalmus	Common rudd	14	1
Stein03	Scardinius erythrophthalmus	Common rudd	13	1
Stein03	Scardinius erythrophthalmus	Common rudd	12	3
Stein03	Scardinius erythrophthalmus	Common rudd	11	1
Stein03	Scardinius erythrophthalmus	Common rudd	9	1

Stein03	Scardinius erythrophthalmus	Common rudd	5	1
Stein03	Leucaspius delineatus	Sunbleak	5	4
Stein03	Leucaspius delineatus	Sunbleak	4	1
Stein03	Ambramis brama	Common bream	8	3
Stein03	Ambramis brama	Common bream	7	1
Stein03	Ambramis brama	Common bream	6	3
Stein03	Leuciscus leuciscus	Common dace	10	1
Stein03	Leuciscus leuciscus	Common dace	7	1
Stein04	Scardinius erythrophthalmus	Common rudd	10	1
Stein04	Scardinius erythrophthalmus	Common rudd	6	1
Stein05	Scardinius erythrophthalmus	Common rudd	9	1
Stein05	Scardinius erythrophthalmus	Common rudd	8	1
Stein06	Scardinius erythrophthalmus	Common rudd	16	1
Stein06	Scardinius erythrophthalmus	Common rudd	15	1
Stein06	Scardinius erythrophthalmus	Common rudd	14	1
Stein06	Scardinius erythrophthalmus	Common rudd	12	1
Stein06	Scardinius erythrophthalmus	Common rudd	10	1
Stein07	Scardinius erythrophthalmus	Common rudd	18	1
Stein08	-	-	-	-
Stein09	Scardinius erythrophthalmus	Common rudd	14	1
Stein09	Scardinius erythrophthalmus	Common rudd	12	1
Stein09	Scardinius erythrophthalmus	Common rudd	10	1
Stein09	Scardinius erythrophthalmus	Common rudd	7	1
Stein09	Scardinius erythrophthalmus	Common rudd	6	1
Stein09	Pseudorasbora parva	Topmouth gudgeon	7	1
Stein09	Tinca tinca	Tench	9	1
Stein10	Scardinius erythrophthalmus	Common rudd	8	1
Stein10	Carassius gibelio	Prussian carp	10	1
Uffel01	Lepomis gibbosus	Pumpkinseed	7	1
Uffel01	Gobio gobio	Gudgeon	9	1
Uffel01	Lepomis gibbosus	Pumpkinseed	9	1
Uffel01	Gobio gobio	Gudgeon	9	1
Uffel02	Gobio gobio	Gudgeon	9	1

Uffel03	Barbatula barbatula	Stone loach	8	1
Uffel03	Gobio gobio	Gudgeon	8	2
Uffel03	Barbatula barbatula	Stone loach	8	1
Uffel04	Tinca tinca	Tench	15	1
Uffel04	Gasterosteus aculeatus	Three-spined stickleback	5	1
Uffel05	Rutilus rutilus	Common roach	9	1
Uffel05	Gobio gobio	Gudgeon	13	1
Uffel05	Barbatula barbatula	Stone loach	8	2
Uffel05	Gobio gobio	Gudgeon	12	3
Uffel05	Gobio gobio	Gudgeon	10	2
Uffel05	Gobio gobio	Gudgeon	9	1
Uffel05	Gobio gobio	Gudgeon	7	1
Uffel05	Gobio gobio	Gudgeon	12	2
Uffel05	Gobio gobio	Gudgeon	10	1
Uffel05	Gobio gobio	Gudgeon	9	2
Uffel05	Lepomis gibbosus	Pumpkinseed	7	1
Uffel05	Rhodeus amarus	European bitterling	6	3
Uffel05	Rhodeus amarus	European bitterling	5	1
Uffel05	Barbatula barbatula	Stone loach	9	1
Uffel05	Barbatula barbatula	Stone loach	8	1
Uffel06	Gobio gobio	Gudgeon	10	1
Uffel06	Rutilus rutilus	Common roach	9	4
Uffel06	Rutilus rutilus	Common roach	8	3
Uffel06	Rutilus rutilus	Common roach	7	1
Uffel06	Gobio gobio	Gudgeon	10	2
Uffel06	Gobio gobio	Gudgeon	9	2
Uffel06	Tinca tinca	Tench	11	1
Uffel06	Pungitius pungitius	Ninespine stickleback	7	1
Uffel06	Rhodeus amarus	European bitterling	5	1
Uffel06	Rhodeus amarus	European bitterling	4	1
Uffel07	Gobio gobio	Gudgeon	9	1
Uffel08	Gobio gobio	Gudgeon	9	1
Uffel08	Rutilus rutilus	Common roach	8	1
Uffel09	-	-	-	-
Uffel10	Barbatula barbatula	Stone loach	8	1
Uffel10	Rhodeus amarus	European bitterling	6	1
Uffel10	Rutilus rutilus	Common roach	6	1
Uffel10	Gasterosteus aculeatus	Three-spined stickleback	5	1
Uffel11	Esox lucius	Northern pike	40	1
Uffel12	Pungitius pungitius	Ninespine stickleback	4	2
Uffel12	Gasterosteus aculeatus	Three-spined stickleback	4	2
Uffel13	Gobio gobio	Gudgeon	12	2
Uffel13	Rutilus rutilus	Common loach	7	1
Uffel13	Barbatula barbatula	Stone loach	9	1
Uffel14	Barbatula barbatula	Stone loach	8	2
Uffel14	Barbatula barbatula	Stone loach	7	3
Uffel14	Gobio gobio	Gudgeon	10	1
Uffel14	Gobio gobio	Gudgeon	8	2
Uffel14	Rhodeus amarus	European bitterling	5	1
Uffel14	Gobio gobio	Gudgeon	12	1

Uffel14	Gobio gobio	Gudgeon	11	2
Uffel14	Gobio gobio	Gudgeon	9	3
Uffel14	Gobio gobio	Gudgeon	8	3
Uffel14	Gobio gobio	Gudgeon	7	6
Uffel14	Rhodeus amarus	European bitterling	6	2
Uffel14	Rhodeus amarus	European bitterling	5	3
Uffel14	Barbatula barbatula	Stone loach	10	2
Uffel14	Barbatula barbatula	Stone loach	8	1
Uffel15	Gobio gobio	Gudgeon	7	2
Uffel15	Barbatula barbatula	Stone loach	8	1
Uffel15	Rhodeus amarus	European bitterling	5	2
Uffel15	Rhodeus amarus	European bitterling	4	1
Uffel15	Barbatula barbatula	Stone loach	10	1
Uffel15	Barbatula barbatula	Stone loach	9	2
Uffel15	Barbatula barbatula	Stone loach	8	6
Uffel15	Rhodeus amarus	European bitterling	6	4
Uffel15	Rhodeus amarus	European bitterling	5	4
Uffel15	Rhodeus amarus	European bitterling	4	3
Uffel15	Gobio gobio	Gudgeon	7	1
Uffel15	Barbatula barbatula	Stone loach	9	2
Uffel15	Barbatula barbatula	Stone loach	8	8
Uffel15	Barbatula barbatula	Stone loach	7	3
Uffel15	Barbatula barbatula	Stone loach	6	1
Uffel15	Rhodeus amarus	European bitterling	6	3
Uffel15	Rhodeus amarus	European bitterling	5	2
Uffel15	Rhodeus amarus	European bitterling	4	1
Uffel15	Gobio gobio	Gudgeon	13	2
Uffel15	Gobio gobio	Gudgeon	12	1
Uffel15	Gobio gobio	Gudgeon	10	4
Uffel15	Gobio gobio	Gudgeon	9	2
Uffel15	Pseudorasbora parva	Topmouth gudgeon	8	1
Uffel16	Rhodeus amarus	European bitterling	6	1
Uffel16	Rhodeus amarus	European bitterling	5	2
Uffel16	Barbatula barbatula	Stone loach	8	8
Uffel16	Barbatula barbatula	Stone loach	7	1
Uffel16	Gasterosteus aculeatus	Three-spined stickleback	6	4
Uffel16	Gasterosteus aculeatus	Three-spined stickleback	5	2
Vloed01	Gasterosteus aculeatus	Three-spined stickleback	5	2
Vloed01	Gasterosteus aculeatus	Three-spined stickleback	4	21
Vloed01	Gasterosteus aculeatus	Three-spined stickleback	3	14
Vloed01	Gasterosteus aculeatus	Three-spined stickleback	2	2
Vloed01	Pungitius pungitius	Ninespine stickleback	5	1
Vloed02	Gasterosteus aculeatus	Three-spined stickleback	5	10
Vloed02	Gasterosteus aculeatus	Three-spined stickleback	4	12
Vloed02	Gasterosteus aculeatus	Three-spined stickleback	3	8
Vloed02	Esox lucius	Northern pike	10	1
Vogt01	Tinca tinca	Tench	14	1
Vogt01	Gasterosteus aculeatus	Three-spined stickleback	6	1
Vogt01	Gasterosteus aculeatus	Three-spined stickleback	5	1
Vogt01	Cyprinus carpio	Common carp	5	1

Vogt01	Pseudorasbora parva	Topmouth gudgeon	6	2
Vogt01	Pseudorasbora parva	Topmouth gudgeon	5	1
Vogt01	Pseudorasbora parva	Topmouth gudgeon	4	1
Vogt01	Pseudorasbora parva	Topmouth gudgeon	3	1
Vogt01	Pseudorasbora parva	Topmouth gudgeon	2	1
Vogt02	Rhodeus amarus	European bitterling	3	1
Vogt03	Tinca tinca	Tench	9	1
Vogt03	Gasterosteus aculeatus	Three-spined stickleback	6	2
Vogt04	Tinca tinca	Tench	19	1
Vogt04	Pungitius pungitius	Ninespine stickleback	6	1
Vogt05	Pseudorasbora parva	Topmouth gudgeon	8	1
Vogt05	Pseudorasbora parva	Topmouth gudgeon	6	1
Vogt05	Carassius gibelio	Prussian carp	7	1
Vogt05	Pungitius pungitius	Ninespine stickleback	7	1
Vogt05	Pseudorasbora parva	Topmouth gudgeon	7	1
Vogt06	Pseudorasbora parva	Topmouth gudgeon	8	1
Vogt06	Pseudorasbora parva	Topmouth gudgeon	7	1
Vogt06	Pseudorasbora parva	Topmouth gudgeon	6	5
Vogt06	Pseudorasbora parva	Topmouth gudgeon	5	2
Vogt06	Carassius gibelio	Prussian carp	12	1
Vogt06	Carassius gibelio	Prussian carp	8	1
Vogt06	Carassius gibelio	Prussian carp	7	2
Vogt06	Carassius gibelio	Prussian carp	6	1
Vogt06	Pungitius pungitius	Ninespine stickleback	7	1
Vogt06	Pungitius pungitius	Ninespine stickleback	6	1
Vogt06	Gasterosteus aculeatus	Three-spined stickleback	6	1
Vogt06	Gasterosteus aculeatus	Three-spined stickleback	5	1
Vogt06	Tinca tinca	Tench	11	1
Vogt06	Cyprinus carpio	Common carp	6	1
Vogt06	Gasterosteus aculeatus	Three-spined stickleback	6	2
Vogt06	Gasterosteus aculeatus	Three-spined stickleback	5	1
Vogt06	Pseudorasbora parva	Topmouth gudgeon	7	2
Vogt07	-	-	-	-
Vogt08	Pseudorasbora parva	Topmouth gudgeon	8	1
Vogt09	Tinca tinca	Tench	20	1
Vogt09	Tinca tinca	Tench	6	1
Vogt10	-	-	-	-