Our significant otter

An overview of habitat improvements in the north and east of the Netherlands since the extinction of the Eurasian otter (*Lutra lutra*) in 1988

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Source picture: Ellen van Norren

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Summary

Background: Since the extinction of the Eurasian otter in the Netherlands in 1988, a restoration program has been initiated to improve the Dutch wetlands with areas in which otters can rest, eat, and produce offspring. Since the reintroduction in 2002, the Dutch otter population has grown into viable a metapopulation of approximately 450 individuals in 2020. Yet, factors such as traffic, genetic diversity, insufficient habitat improvement, water quality, and bycatch remain a concern. Overviews regarding traffic bottlenecks, genetic diversity, otter distribution, and population size already exist. it is clear that the water quality in the north and east of the Netherlands is now sufficient. There was, however, no overview of measures to improve the natural habitat in terms of creating areas with freshwater bodies, eco-friendly banksides, and riparian vegetation.

Aim: To provide an overview of how the Dutch wetlands have improved in terms of eco-friendly bankside structures, riparian vegetation, and new nature with freshwater bodies since 1988.

Organism: The Eurasian otter (*Lutra lutra*)

Place of Research: The north and east of the Netherlands

Research questions: 1. What was the condition of the Dutch wetlands in 1988? 2. Which measures have been taken to improve the Dutch wetlands in terms creating new nature with freshwater bodies, eco-friendly banksides, and riparian vegetation since 1988? 3. What is the current distribution of otters in the north and east of the Netherlands? 4. What limits areas in becoming repopulated or subpopulations in becoming independent from other supopulations in terms of bankside quality and the presence of fresh water bodies? 5. (Why) do provinces differ in what has been achieved so far to improve the Dutch wetlands?

Methods: I obtained information from literature and interviewing involved organisations (e.g., Dutch Mammal Society, Water Boards, Rijkswaterstaat, Staatsbosbeheer, and Natuurmonumenten) in the north and east of the Netherlands.

Conclusion: Improvements as part of the Nature Network Netherlands (NNN), Water Framework Directive (WFD), and Room for the River (RftR) have strengthened the connection between areas with reproduction. These projects have increased the overall otter habitat in the Netherlands by creating areas with freshwater bodies and improving bankside quality. Apart from traffic bottlenecks, subpopulations are limited in their growth mostly by bad bankside quality. Providing vegetation near water bodies throughout the year may reduce otters migrating to adjacent areas searching for a place to rest. This may in turn reduce traffic victims. Compared to the Water Boards in Overijssel and Gelderland, the Water Boards in Fryslân, Groningen, and Drenthe changed their mowing policy relatively earlier to a policy providing vegetation throughout the year.

Recommendations:

I recommend reassessing current mowing policies to determine whether more riparian vegetation can be present throughout the year. Appointing or creating resting areas in adjacent areas can be an efficient alternative. I also recommend to occasionally monitor in areas adjacent to those populated by otters to get a better view whether otters are migrating to new areas.

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Introduction

Eurasian otter (*Lutra lutra*) populations in the Netherlands drastically declined in the 20th century from 700 individuals around 1900 to just 40 individuals in 1941 (Liere & Liere, 2008). Otters first lived throughout the Netherlands near rivers and freshwater lakes but were eventually driven back to a few areas. Hunting was allowed, even promoted by extermination campaigns, as the Dutch fishery regarded the otter as competition (Brouwer, 1940). The severe winters between 1938 and 1941 worsened the situation as ice on water bodies complicated hunting on fish, and hunters could spot otters easier in the snow. Hunting was therefore thought to be the main reason for the population decline to the brink of extinction until hunting was prohibited between 1947-1954 (Walter, 1989). The population slightly recovered to approximately 300 individuals in 1960 but collapsed once again due to the following factors (Walter, 1989):

1. Habitat fragmentation.
2. Water pollution (especially due to heavy metals and PCBs).
3. The disappearance of riparian vegetation.
4. The impoverishment of bankside structures.
5. An increase in disturbances caused by recreational activities (and no wildlife refuges).
6. A decrease in suitable freshwater areas (e.g., land consolidation and land reclamation).
7. A decrease in prey availability.
8. Traffic accidents.
9. Bycatch accidents.

A reintroduction program was initiated in 1989, a year after signs of any remaining otters in the Netherlands had stopped (Nolet & Martens, 1989). It became clear that not just the otter as species needed to be reintroduced but the Dutch wetlands, the natural habitat of the otter, needed to be restored to maintain an otter population in the future. National Park Weerribben-Wieden was chosen to start with the reintroduction because the water quality had improved and was no longer a constraint, the area was large enough to eventually maintain a vital population of at least 40 individuals, and the area was well connected to potential habitats nearby (Jongh, 1998). The first otters were released in 2002 and the growing metapopulation of otters spread to other lakes and rivers in the north and east of the Netherlands, mostly in the provinces of Overijssel and Fryslân. The subpopulations in Flevoland, Drenthe and Groningen are showing a fast increase since approximately 2013-2015 as well, while the reintroduced (2014) subpopulation in Gelderland seems to lag behind. Some otters have settled in provinces further away: Zuid-Holland, Noord-Holland, and Utrecht (Dutch Mammal Society, 2020).

Similar to the situation in the Netherlands, otters are making a comeback in the eastern part of Germany as well (Figure 1). The population is slowly expanding to the west but is not yet connected to the Dutch metapopulation (Kuiters *et al.*, 2020). The Dutch metapopulation consists of subpopulations in the Dutch north-eastern provinces mentioned above, in western North Rhine-Westphalia (Germany), western Lower Saxony (Germany), and the province of Antwerp (Belgium). While the distance between the Dutch metapopulation and the population in eastern Germany seems to be the smallest in the north (through Groningen and western Lower Saxony), a corridor located further south might develop faster because of the small subpopulations in Gelderland and North Rhine-Westphalia. Wageningen University is currently researching whether gene exchange already occurs between the Dutch metapopulation and the eastern

German population. Yearly, the distribution of the otter is determined by mapping the location of found spraints. Genetic analysis of spraints (2002-2020) and of dead otters (traffic victims, continues after 2020) was then used to estimate the population size. Monitoring and mapping locations with spraints provide insight into which areas are already successfully colonized and which areas are not and might need to be improved. Habitat improvement of nature areas that function as migration routes secures connectivity between subpopulations in the long term. Connecting with the population in eastern Germany would enable the gene exchange of new genes into a metapopulation that is vulnerable to inbreeding caused by isolation. Therefore, habitat improvement in each of the eastern provinces Groningen, Drenthe, Overijssel, and Gelderland is important, as it remains unclear which migration route will develop sooner.

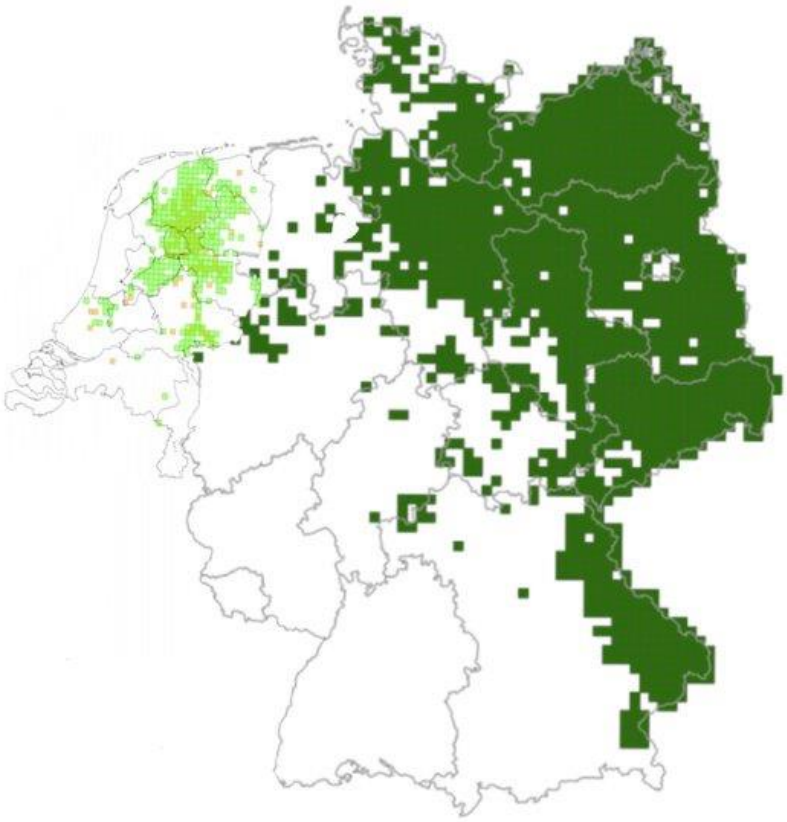


Figure 1 Distribution of the Eurasian otter (*Lutra lutra*) in the Netherlands between 2002-2020 and in Germany between 2007-2017. Source: Dutch Mammal Society

Water bodies occupied by otters can only be considered as core areas when otters can rest, eat, and produce offspring permanently without depending on surrounding subpopulations for their survival (Walter, 1989). Currently, NP Weerribben-Wieden contains, however, the only population that can now grow without depending on surrounding subpopulations. Even though the otter population in NP Weerribben-Wieden has grown to approximately 100 individuals, spatial obstacles remain a limiting growth factor for its population. For example, traffic bottlenecks reduce connectivity between subpopulations as many otters die in traffic when migrating to a new area or within a territory (Kuiters *et al.*, 2020). Yearly, a quarter to a third of the total metapopulation dies in traffic accidents (Kuiters *et al.*, 2020). By creating wildlife crossings above and underneath roads and bridges, traffic accidents could be

prevented (Kuiters & Lammertsma, 2014). I have visualised how a connection between two different areas gradually improves once bottlenecks are resolved and bankside quality is improved in Figure 2-4.

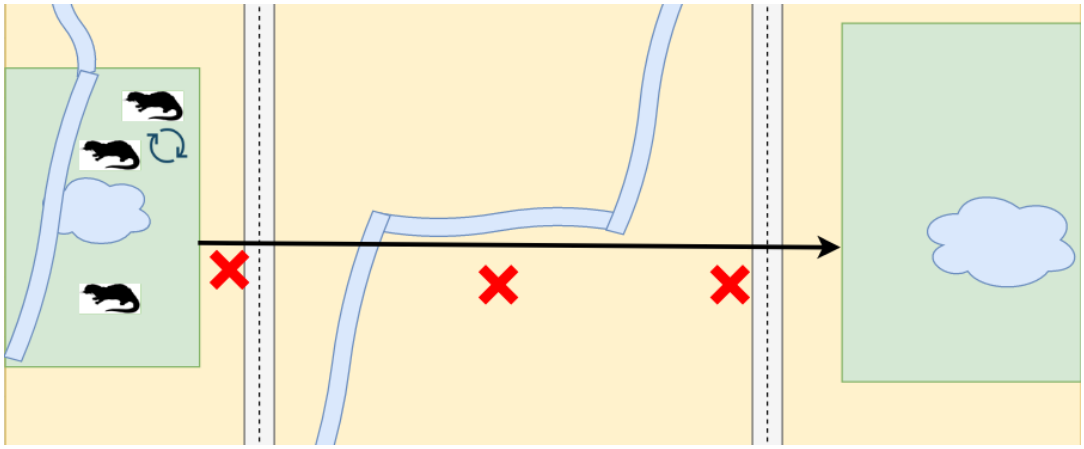


Figure 2: An example of how a core area with a subpopulation is not connected to a new area. Individuals are not able to reach the new area to create a new subpopulation.

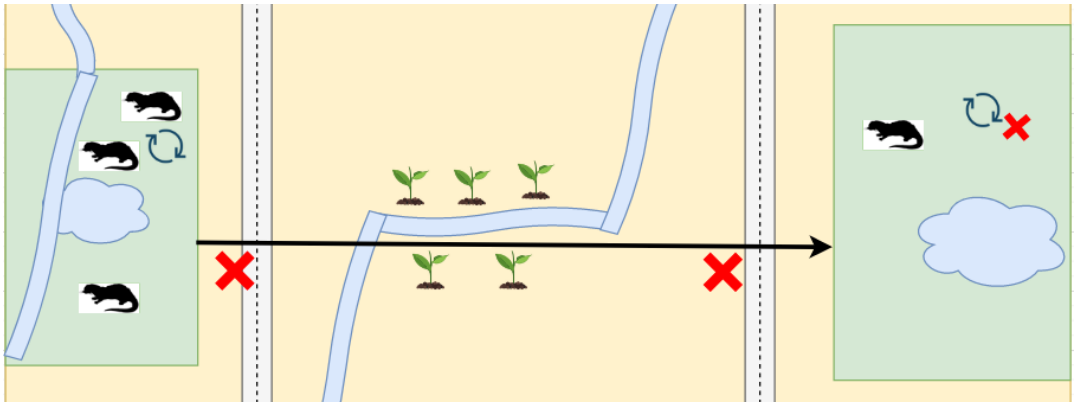


Figure 3: An example of how a core area is partly connected to a new area. Because vegetation is present, the river now functions as a stepping stone to the new area. Individuals can reach the new area to form a subpopulation but are not able to create a new core area due to a high number of traffic accidents.

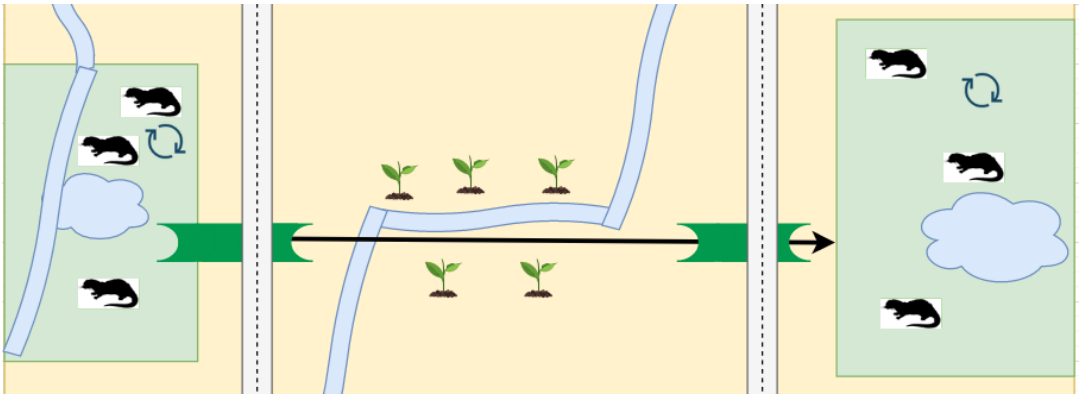


Figure 4: An example of how a core area is well-connected to a new area. Because vegetation is present and deadly obstacles are removed, an ecological corridor is created. The new area can now develop into a new core area.

Currently, the Dutch metapopulation has grown into a viable population, consisting of 450 individuals due to improvements by many organisations (Kuiters *et al.*, 2020). The water quality has improved significantly and is currently sufficient in most water bodies in the north and the east of the Netherlands (De Wit *et al.*, 1991; Kurstjens, 2009; Lammertsma & Brink, 2012). Also, stop-grids in fish fykes are now mandatory in areas such as NP Weerribben-Wieden in which otters were reintroduced (Jansman, 2016: Bekker *et al.*, 2018). Nevertheless, traffic, genetic diversity (e.g., its connection to eastern Germany), insufficient habitat improvement, water quality, and bycatch remain a concern (interview Ellen van Norren, Dutch Mammal Society).

The success story of the otter is the result of different measures applied by many organisations, but the literature does not show an overview of which measures applied by which organisations have improved the Dutch wetlands in terms of creating new nature areas with freshwater bodies, eco-friendly bankside structures, and riparian vegetation. I found overviews regarding traffic bottlenecks, genetic diversity, otter distribution, and population size but no overview regarding new nature areas with freshwater bodies, improving eco-friendly bankside structures, and improving riparian vegetation (Kuiters & Lammertsma, 2014; Bosma, 2019; Kuiters *et al.*, 2020).

In this study, I will give an overview of which measures have been taken to improve the Dutch wetlands into otter habitat in terms of new nature with freshwater bodies, eco-friendly banksides, and riparian vegetation. An overview of this information can help in redesigning future otter habitat by looking what has been applied to create current otter habitat. The overview also shows what has been achieved by different organisations so far to create a viable subpopulation of 450 otters in 2020. I used the following research questions to create this overview:

1. What was the condition of the Dutch wetlands in 1988?
2. Which measures have been taken to improve the Dutch wetlands in terms of creating new nature with freshwater bodies, eco-friendly banksides, and riparian vegetation since 1988?
3. What is the current distribution of otters in the north and east of the Netherlands?
4. What limits areas in becoming repopulated or subpopulations in becoming independent from other supopulations in terms of bankside quality and the presence of fresh water bodies?
5. (Why) do provinces differ in what has been achieved so far to improve the Dutch wetlands?

To answer my research questions, I obtained information from literature and by interviewing involved organisations (e.g., Dutch Mammal Society, Water Boards, Rijkswaterstaat, Staatsbosbeheer, and Natuurmonumenten) in the north and east of the Netherlands. The fourth research question is based on factors I could obtain information from. Water quality, bycatch (such as in fish fykes) and genetic diversity are not taken into account. In Chapter 1 I will describe the otter's ecology such as what otters require in both aquatic and riparian environments. In Chapter 2 I will describe the condition of the Dutch wetlands until 1988, because this year of extinction shows what should be avoided in the future. I will also elaborate on how nature conservation arose in the Netherlands. In Chapter 3 I will elaborate on how the Dutch wetlands started to improve, based on the nine factors that were described in the National recovery plan

for otter habitats "*De otter in perspectief; een perspectief voor de otter: herstelplan leefgebieden otter* (Walter, 1989)". Lastly, in Chapter 4 I provide an overview of the current otter habitat and which measures are applied to improve these water bodies in each of the following provinces: Fryslân, Groningen, Drenthe, Overijssel, and Gelderland. For each province, I will provide the highlights of improvements since 1988 and the current condition in terms of mowing policy, bankside quality, and estimated habitat type for each of the largest, and in my opinion the most relevant, water bodies. I will give an answer on the first four research questions for each province separately, while the last one will be answered by comparing the provincial conclusions in the general conclusion.

Chapter 1: Otter's ecology

The Eurasian otter (*Lutra lutra*) is the only truly amphibious member of the weasel family. They are semi-aquatic predators that can live near both salt water bodies and freshwater bodies. Their behaviour as a top predator affects the diversity and abundancy of many species in both aquatic and riparian ecosystems. They can be regarded as an umbrella species whose conservation causes the conservation of other species using the same habitat (Bifolchi & Lodé, 2005). Focusing on umbrella species is efficient to conserve as many species as possible when conservation is limited due to funding and policymaking. Otters can also be regarded as a flagship species whose conservation is positively correlated with the quality of a defined habitat (Effenberger & Suchentrunk, 1999; Cianfrani et al., 2011; Stevens *et al.*, 2011). Its presence indicates a high quality of aquatic ecosystems regarding among others water quality and prey populations. Flagship species act as an ambassador to raise awareness for their habitat because they are often well-known and considered charismatic in western cultures. By focusing on a species such as the Eurasian otter who is both a flagship species and an umbrella species, the conservation of many species can be realized. Therefore, the growth of the otter population in the Netherlands since the reintroduction in 1988 indicates an improvement of the Dutch wetlands, because the improvement affects the conservation status of many other species positively. In this chapter, I will discuss what otters require in their aquatic and riparian habitat.

1.1 Water body requirements

Otters inhabit many different freshwater bodies such as lakes, rivers, creeks, canals, flood plains, and polders. They prefer clear and calm water bodies with a constant water level to hunt. Due to their territorial behaviour, otters require a relatively large habitat. The size of an otter's home range depends on sex, competition of other otters nearby, food supply, and the type of water body (Walter, 1989). Males have a larger home range than females. The male's territory often includes the territories of multiple females. The bankside length of a territory varies from 4-6 km of lakes to 10-15 km of creeks and rivers, depending on the food supply. They mostly eat fish but occasionally eat crustaceans, amphibians, molluscs, reptiles, small birds, and smaller mammals as well. According to Walter (1989), fish populations are most optimal in water bodies with a depth between 2 and 4 meters. When the water level is too high (> 10 meters), the concentration of oxygen can become too low on the bottom of the water body. Reduced oxygen levels also occur in water bodies in which the water level is too low. This occurs especially during winter when the water is covered by ice. When the temperature rises in summer, however, eutrophication may occur in water bodies with a low water level. Water bodies such as creeks and ditches might occasionally be deepened to prevent the water body from silting up. The water level in ditches in agricultural areas (polders) is often kept low to promote drainage of water. These areas might still function as stepping stones or corridors but might not develop into core areas (Figure 2-4). Lastly, otters and their

prey such as fish are vulnerable to water pollution such as heavy metals and PCBs. Even though little is known about the effect of heavy metals and chemical compounds such as PCBs on a population level, it is known that they have a detrimental accumulative effect on an individual level (Lammertsma & van den Brink, 2012).

1.2 Bankside requirements

Otters spend most of their time on the banksides of water bodies to forage, eat, rest, produce offspring, and to defend their territory (patrolling). Natural banksides are often an ecosystem in itself because of the water nearby and the riparian vegetation that can grow on the slopes. The slope (<60%) of banksides facilitates the otter's natural behaviour of living near and in the water. In urbanized areas, humans have shaped the river for its own purpose (e.g., canalization). Unlike natural slopes of banksides, human-made structures such as sheet piles retain soil to a slope. The retention prevents natural processes such as erosion. Replacing slopes for sheet piles benefits infrastructure and drainage of water but is detrimental for the ecosystem and its biodiversity. By removing the natural slopes of banksides, the main habitat of otters is drastically impoverished or even removed. Even though the banksides in, for example, canals are less optimal, it could still be used by otters. Otters can jump on land if the sheet piles are lower than 50 cm. This height is reduced to 30 cm when carrying young or large prey. Otters might drown if they are not able to exit the water when sheet piles are taller than 50 cm. Creating inlets with wildlife-friendly bankside structures enables wildlife to exit the water. Walter (1989) recommends an inlet every 500 meters in water bodies without natural banksides.

1.3 Vegetation requirements

Vegetation such as reed (e.g., *Poaceae spp.*), blackberry (*Rubus spp.*), black alder (*Alnus glutinosa*), white willow (S*alix alba)*, ash (*Fraxinus excelsior*) can provide coverage for otters to rest (Figure 5 and 8). Which plant or tree species suits the best in an area depends on amongst other soil, water level, and the slope of the bank. Otters prefer to use the same routes to enter and exit the water (Figure 6 and 7). Preferably, this system of tunnels is completely covered by undergrowth. Therefore, it is recommended to minimalize the distance between the undergrowth and the water. Vegetation such as reed is often found in developing ecosystems and needs to be maintained to prevent succession into an ecosystem that does not provide coverage anymore. Vegetation management such as mowing is very useful but could be improperly executed. It is important to keep a part of the vegetation present throughout the year (e.g., phased and sinus management), so a part of the area can function as a resting area while another part can grow back. Resting areas are essential in facilitating long-term residency and connectivity. Areas cannot become core areas if there is no place without human disturbances to rest or produce offspring. Resting areas can also facilitate migration in less suitable areas. According to Roos and Stegink-Wei (1993), a resting area of at least 100m^2 should exist every 1000 meters in connections (corridors and stepping stones) between core areas. Compared to core areas, corridors are suboptimal in terms of, for example, food supply, vegetation, or bankside structures, while stepping stones consist of just a few habitat patches within an unsuitable area such as water bodies used for shipping. Enough resting areas near a water body will prevent the otter from leaving the water body to find a place to rest further inland during the day. This is important as terrestrial migration of otters may lead to increased traffic accidents, especially in urbanized areas. Improper mowing management can exacerbate this risk.

Figure 5 Covered area in reed used by otters to rest. Source: Johann Prescher

Figure 6 A tunnel covered by reed used by otters to enter and exit the water. Source: Johann Prescher

Figure 7 Freshwater body in the core area De Wieden with banksides covered in reed with a tunnel used by otters in the centre of the picture. Source: Johan Prescher

Figure 8 Covered area in reed used by otters to rest. Source: Ellen van Norren

Chapter 2: Otter habitat and nature conservation before 1988

Nature conservation in the Netherlands was started by the establishment of associations such as Staatsbosbeheer and Natuurmomumenten in 1899 and 1905, respectively. The land was bought by associations or offered by estate owners to protect nature and to protect it from becoming, for example, agricultural land (Vries, 2002). Within twenty to thirty years, most ownership switched from private landowners (e.g., nobility) to recreational organisations and the government. Nature and its conservation were required to have an esthetical appearance, rather than having an ecological value of high quality.

Because of this philosophy, both wildernesses and cultural landscapes were protected by the same laws (Windt *et al.*, 1997). Between the '40s and '70s, people started to reconsider whether nature was developing in the right direction. The population of Eurasian otters in the Netherlands had already collapsed once during this period and was only slowly recovering.

Preferably, otter habitat would resemble a water body with sufficient food supply, high water quality, low level of human disturbance, natural banksides, vegetation that can provide coverage, and no spatial obstacles to limit its connectivity towards surrounding areas (Walter, 1989). Back then, these areas became scarce due to the high Dutch population density and its infrastructure. Just a few areas such as NP Weerribben-Wieden resembled such areas, but they were scattered across the country. Most water bodies outside nature areas were often reshaped to meet human purposes: rivers became canals to facilitate infrastructure and the drainage of water, lakes became hotspots for recreation such as fishing, swimming, and water sports, and flood plains were seasonally used for agriculture. Aquatic and riparian vegetation was often kept short to minimize costs in maintenance, optimize the drainage of water, and give the water body an orderly appearance.

The societal position of Natuurmonumenten changed around the '70s as the number of members increased. Natuurmonumenten insisted the government to change its policy between nature and agriculture in rural areas because both the environment and biodiversity continued to deteriorate (Vries, 2002). The same ecological decline occurred in other European countries. The following national and European laws were the first steps in nature conservation we know today:

Table 1 Significant laws, policies, and programs from before 1988 that have benefitted future otter habitat.

Year	Name of the law or policy	Description
1971	Ramsar-convention	Protection and sensible use of wetlands of international importance.
1975	Relatienota	Introduction of two separate management strategies: 1. Nature areas in which nature would be prioritized and 2. Managed areas in which cultural landscapes such as agricultural land should implement or take nature conservation into account.
1979	Bern and Bonn-convention	Protection of European migrating flora and fauna (and its habitat).
1979	Birds Directive	Protection of wild bird species (and its habitat).
1981	Structuurschema Natuur- en Landschapsbehoud (SNL)	Protecting and conserving already existing nature areas and its ecological value and quality. The term *nature development* was used for the first time, indicating that nature had to be restored into a previous condition rather than maintaining and protecting what was left of it.
1987-2000	Rhine Action Program (RAP)	The program's goals were to: 1. return fauna species, 2. continue the production of drinking water; and 3. reduce the pollutant contents of river sediments.

During this time, the Dutch otter population continued to deteriorate once again after it had slightly recovered since the prohibition of hunting around the '50s. People became aware of its decline, but still overestimated the total number of remaining otters in the Netherlands until 1989 (Walter, 1989; Baerselman *et al.*, 1989). Walter published his book with recommendations to save the remaining otter

population based on the nine factors affecting its decline, but his recommendations eventually had to be used to reintroduce the otter in the Dutch wetlands as it was already extinct. Many studies such as those of the ministry of Agriculture, Nature, and Food Quality (LNV) recommended an area-oriented strategy to develop ecological core areas: *"in which the ecosystems have a high degree of completeness and self-regulation*". These areas could function as a reservoir for species populations in surrounding suboptimal areas to survive. Back then, NP Weerribben-Wieden was one of the few remaining areas that resembled an ideal otter habitat in which otters would be able to rest, eat, and produce offspring to create a self-regulated population. Furthermore, its geographical position and connection to other nature areas nearby made it a potential place to start. Therefore, NP Weerribben-Wieden was appointed to become the first new otter core area of the Netherlands.

Chapter 3: Otter habitat between the extinction in 1988 and the reintroduction in 2002

The European Union and the Dutch government launched new laws and policies (Table 2) because the deterioration of many species and their habitats continued. The Nature Policy Plan (1990) is the foundation of nature conservation we still apply nowadays (Vries, 2002). It prioritizes the conservation, restoration, and development of national and international important ecosystems within a spatially stable ecological main structure (EMS) and to promote and realize this outside the EMS as well. Its goal is to maintain and restore natural diversity of wildlife (both flora and fauna) as elements within their ecosystems. Some of these species were appointed as target species whose importance should also be implemented. The Water Framework Directive (WFD) and the Third Note Water Management are the foundation of water quality we still apply nowadays.

Table 2 Significant laws, policies, and programs between 1988 and 2002 that have benefitted future otter habitat.

Year	Name of the law or policy	Description
1990	Nature Policy Plan (NPP)	Governmental policy, based on laws, on national scale with goals and strategies for nature conservation (Vries, 2002; LVN, 1990).
1990	Habitats Directive	Protection of specific wild flora and fauna species (and its habitat).
1990-1994	Third Note Water Management	To have and maintain land which has safety and habitability as primary preconditions and to develop and maintain water management that guarantees sustainable use.
1992	Biodiversity agreement	Conservation and sustainable use of biodiversity and fair share of beneficial and disadvantageous use.
1995-2018	Room for the River Program (RftR)	To provide a.o. the rivers Rhine, Meuse, Waal, and IJssel more space to flood safely on 30 different locations.
1997-2017*	Law of Flora and Fauna	Protection of indigenous Dutch plant species, indigenous Dutch mammals, amphibians, reptiles, fish, and European indigenous bird species against damage control, hunt, trade, ownership, and other human-related detrimental effects.
1998-2017*	Nature Conservation Law	Protection of nature areas in the Netherlands by implementing a.o. Birds Directive, Habitats Directive, and Ramsar-convention.

2000->2027	Water Framework Directive	To achieve good qualitative and quantitative status of all water bodies. Each water body requires an update every six years: 2000-2008 was explorative, 2009-2015: first improvements, followed up by 2016-2021 and 2022-2027.
>~2001	Natura-2000	Implementation of Bird Directive and Habitat Directive to protect and restore both nature areas (biotopes) and its species. It protects areas from the negative effects of developments from a.o. infrastructure, agriculture, and industry use nearby.
2001	Rhine-2020	Successor of Rhine Action Program: Program on the sustainable development of the Rhine with among others: improve water quality and habitat patch connectivity.

* Fused into the Law for Nature Conservation in 2017 (Page 19)

The laws, policies, and programs from Tables 1 and 2 show the first measures to improve nature in the Netherlands, including the wetlands. Walter (1989) described nine factors that had affected the population and caused its decline during the previous century:

1. Habitat fragmentation.
2. Water pollution (especially due to heavy metals and PCBs).
3. The disappearance of riparian vegetation.
4. The impoverishment of bankside structures.
5. An increase in disturbances caused by recreational activities (and no wildlife refuges).
6. A decrease in suitable freshwater areas (e.g., land consolidation and land reclamation).
7. A decrease in prey availability.
8. Traffic accidents.
9. Bycatch accidents.

He recommended reducing or resolving their effect before the reintroduction because these nine factors would limit the growth and development of a (sub)population into becoming self-regulatory. In this chapter, I will now describe how each of these factors has improved between 1988 and 2002, and whether they still affect the metapopulation nowadays.

3.1 Habitat fragmentation

The ecological main structure (EMS) is part of the NPP from 1990. Its goal was to create a cohesive network of core areas, corridors, and areas with high potential to develop into nature areas throughout the Netherlands. The EMS would consist of 8.000.000 ha of which 750.000 would be terrestrial nature (Vries, 2002). Most of the areas in the Netherlands that are assigned as bird directive, habitat directive, or Natura 2000, would become part of the EMS. I obtained Figure 9 from Vries' RIVM report (2002) which shows the fragmented situation of nature in the Netherlands in 2002 and what is planned to develop in the next twenty years. The EMS was eventually tuned down due to cuts by minister Hans Bleker. It was not finished in 2018 as planned. However, most of the EMS was eventually implemented in the Nature Network Netherlands (NNN) in 2013. In Figure 9, you can see by the green colours that nature already developed in nature areas such as NP Weerribben-Wieden (Overijssel) and NP Alde Feanen (Fryslân). Both national parks were already relatively well connected to surrounding existing nature which would be strengthened

in the following years. The water bodies Drentsche Aa (Drenthe), ‘t Roegwold (Groningen), Ruiten Aa (Groningen), and the Dinkel (Overijssel) are shown as well. These areas, however, were less optimal to start the reintroduction because of, for example, their connectivity compared to NP Weerribben-Wieden.

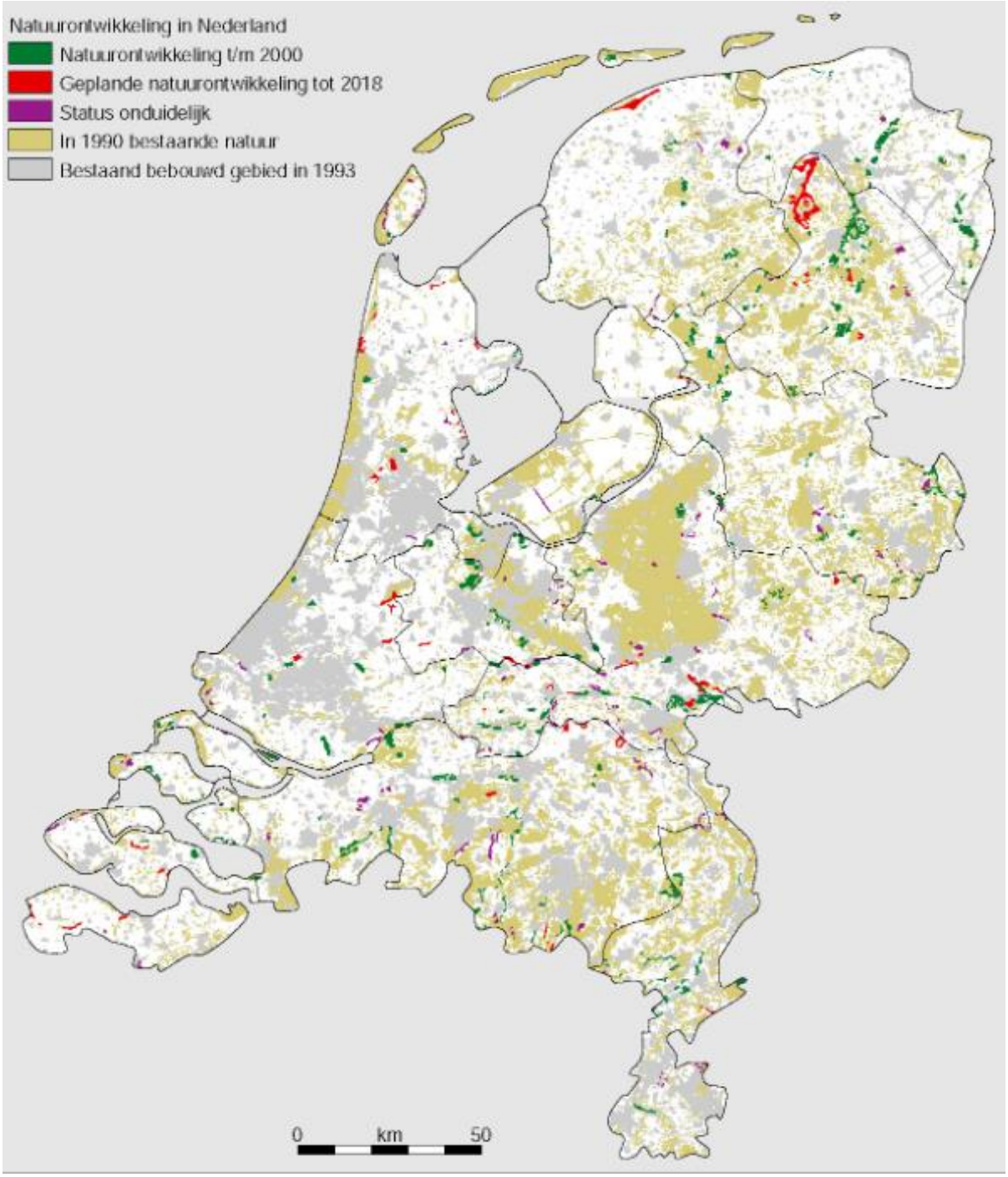


Figure 9: Nature development, including the Dutch wetlands, until 2002. Brown indicates already existing nature in 1990, green indicates nature development until 2000, and red indicates nature development planned to finish before 2018. This figure is obtained from the RIVM report (Vries, 2002).

3.2 Water pollution

During the previous century, water bodies in Europe were heavily polluted due to emissions originating from waste combustion and the chemical industry (e.g., mercury, DDT, dieldrin, and polychlorinated biphenyls (PCBs)). Many European rivers (e.g., Rhine and Meuse) deposit their pollutants in the Netherlands before they end up in the sea. The Netherlands became 'the sink' or 'the drain' of Europe due to its geographical downstream position. The effect of these pollutants on otters has broadly been discussed in the last few decades. Many studies suggest high concentrations of mercury could cause erratic behaviour and high concentrations of PCBs could cause among others reduced reproduction, dermal lesions, as well as neurotoxic, teratogenic, and carcinogenic effects (Walter, 1989; Risico's van giftige stoffen en verkeer voor otters, 2006; Lammertsma & Brink, 2012). Even though, these pollutants seem to affect otters on an individual level as the result of bioaccumulation, the effect on a population level remains unclear. According to Lammertsma and Brink (2012), the concentration of PCBs in eels in the main rivers (Rhine, Meuse, and IJssel) was still too high in 2012, but the population of otters in the Netherlands was growing again. Otters do not only forage in the main river stream, but also in adjacent waters that have a relatively better water quality. Overall, the water quality of Dutch freshwater bodies has already improved significantly due to international programs such as the Rhine Action Program (RAP) and the Water Framework Directive (WFD). These pollutants seem no longer to limit the otter population in the north and east of the Netherlands as the population is growing (Lammertsma & Brink, 2012; CLO, 2020). Therefore, I will not take water quality in terms of water pollution into account during the rest of this study.

3.3. The disappearance of riparian vegetation

The goal of the ecological main structure (EMS) was to reconnect, develop, and restore nature within and in-between nature areas. In practice, this also means improving the quality of water bodies in terms of riparian vegetation and bankside structures. Before 1988, most water bodies outside nature areas lost their riparian vegetation. Cultural landscapes such as agricultural land had to look orderly and decently, while riparian vegetation would give cultural landscapes a messy appearance. Furthermore, riparian vegetation would limit profit as it would take up agricultural land, would limit the drainage of water, and would be grazed by cattle near meadows. Even though riparian vegetation slowly reappeared in existing or restored nature areas, the green colours in Figure 9, its reappearance took longer in agricultural areas between 1988-2002. In 2000, the explorative phase of the Water Framework Directive (WFD) was launched in which the Water Boards (and Rijkswaterstaat) would actively improve the quality of water bodies, riparian vegetation in agricultural areas included. Improvements regarding riparian vegetation as the result of the WFD will be described in the next chapter. Important to note is that if riparian vegetation is reintroduced, it depends on the function of the water body whether it needs to be maintained. In nature areas, riparian vegetation can often be left alone for a while until succession might become a concern. However, riparian vegetation outside nature areas, such as near rivers and polders, needs to be maintained (e.g., mowing). Especially in narrow ditches and creeks do aquatic vegetation, and riparian vegetation to some extent, limit the drainage of water. Intensive mowing (complete removal by mowing multiple times a year) is often applied in narrow water bodies. Gradually, extensive mowing (mowing a few times a year) has become more common in larger creeks and rivers in which one side of the bankside is skipped during spring/summer. During winter, riparian vegetation is then often completely removed (<25% left) as water bodies must drain larger quantities of water.

3.4 The impoverishment of bankside structures

Water bodies such as rivers and creeks were often straightened before 1988 to increase land used for agriculture, optimize infrastructure, and optimize the drainage of water. Natural banksides were replaced for sheet piles to prevent erosion. Many rivers and creeks started to resemble and obtained the function of canals. The habitat of many species that live mostly on banksides, including the Eurasian otter, disappeared. As part of the EMS and the WFD, many water bodies will regain their natural course by redesigning meanders and eco-friendly banksides to improve among others biodiversity and to store water. Weather extremes because of climate change occur more frequently in the Netherlands. Water bodies are redesigned to store water in areas that experience drought, i.e., when water drainage exceeds the supply of water, and to promote the drainage of water in areas that risk flooding, i.e., when the water supply exceeds the drainage of water. By (re)creating meanders and floodplains, a larger quantity of water is stored in a water body, increasing otter habitat. The Drentsche Aa and the Hunze, rivers in Groningen and Drenthe, are an example of how otter habitat can be recreated. Both rivers were being redesigned before the start of the WFD and are now already repopulated by a relatively large subpopulation. However, this does not mean that each water body is suited to have nature-friendly banksides. Especially in large rivers (e.g., Rhine, Meuse, and IJssel) and canals (e.g., prinses Margriet canal and Winschoterdiep) used for infrastructure, sheet piles and armour rock are often necessary to withhold waves created by ships and to prevent erosion. In such water bodies, animal-friendly inlets and artificially made holts can function as alternatives to make these water bodies as eco-friendly as possible. Bankside improvements as the result of the WFD will be described in the next chapter.

3.5 An Increase in human disturbances caused by recreational activities (and no wildlife refuges).

Disturbances caused by recreational activities have increased since the beginning of the previous century as the Dutch population continued to grow, yet its impact on the Eurasian otter is hard to measure or determine (Walter, 1989). While almost all lakes in Fryslân are now inhabited by otters, they are also used for recreational sailing, swimming, and, if possible, ice-skating. It is safe to say that the otter requires a safe place that provides shelter against species such as humans and dogs while resting. There is, however, proof of otters swimming in the canals within the city of Groningen, finding shelter in niches underneath bridges and docks that could function as holts. It is unlikely that otters will choose these crowded places to produce offspring, but it is not ruled out. In most nature areas in the Netherlands nowadays, it is common to have restricted areas that are off-limits to humans (and dogs). These areas are often created to function as a refuge for species such as birds (e.g., during breeding seasons) and can benefit otters as well. In National Park Weerribben-Wieden, these inaccessible areas exist as well, at which visitors can only look at by going into an enclosed cabin meant for bird watching. Wildlife refuges are often implemented when new nature areas are created (e.g., Blauwe Kamer in Gelderland, 1992). Management of water bodies outside nature areas is often a combination of different interests such as nature conservation, recreation, economy, and water safety. Management within nature areas is, however, focused mainly on nature conservation and to some extent recreation, while within wildlife refuges nature conservation is prioritized. Therefore, lobbying for creating or improving habitat in favour of the Eurasian otter is relatively easier in nature areas, especially in wildlife refuges, because it is less likely to conflict with other interests.

3.6 A decrease in suitable freshwater bodies (e.g., land consolidation and land reclamation).

Walter (1989) mentions land consolidation as one of the factors resulting in the decrease in suitable freshwater areas during the previous century. Land consolidation was applied especially in areas such as peat meadows but does not occur frequently anymore since most of these areas are protected by both national and international legislation. Nature areas such as Fochteloërveen (inhabited by otters) and Bargerveen (yet uninhabited) in Drenthe are examples of such peat meadows. Although Fochteloërveen is inhabited by otters, one of its largest limitations remains the insufficient prey availability. On the contrary, land reclamation projects have also created new suitable freshwater areas throughout the Netherlands. The reclamation of the province Flevoland between 1916 and 1986 is with 2.412 km^2 the largest example of this. Nature areas such as the Oostvaardersplassen and Nature Park Lelystad in Flevoland are both inhabited by otters. Lauwersmeer in Fryslân was created in 1969 by closing off the Lauwers Sea and is now also inhabited by the Eurasian otter. Some of the lakes we know today are created for recreational purposes after/by excavating sand (quarries). The lakes Bussloo, Hilgelo, and Hambroekplas in Gelderland are an example of this, although recreational activities might cause disturbance once otters reach and inhabit these areas.

3.7 A decrease in prey availability.

Prey populations such as fish decreased during the previous century, partly because of the same reasons the Eurasian otter population collapsed: water pollution, habitat fragmentation (barrages, dams, locks, pumping stations, fykes), the disappearance of aquatic and riparian vegetation, and the disappearance of bankside structures (De Nie & Van Ommering, 1997). According to van Herpen *et al.* (2015), the decline in fish biomass occurred between 1980 and 2000 due to fishery and a decline in nutrients. Species such as bream have monopolized freshwater bodies. The behaviour of bream causes cloudy water that complicates hunting by otters. Measures such as fish steps and eco-friendly banksides as part of the WFD resulted in relatively higher water quality and connectivity between different water bodies. Pumping stations are a big obstacle for fish and block their migration. Water Boards are removing or redesigning pumping stations as part of the WFD by creating fish steps. Since then, water bodies have a greater variety of species after these mitigations. However, the total biomass of fish will eventually decrease when the proportion of bream, a relatively large fish compared to other fish, will decrease. The effect of these mitigations will be noticeable over a longer period of time. The ecological status is measured by Water Boards by trying to establish a Good Ecological Potential (GEP) which is defined as “the state where there are slight changes in the values of the relevant biological quality elements as compared to the values found at Maximum Ecological Potential (MEP)” and “by selecting the mitigation measures necessary for achieving MEP and considering their practicability and realization” (Kampa & Hansen (2004). Whether fish species thrive also depends on, for example, the chemical status and clarity of water bodies. The decrease in concentrations of pollutants has had a positive effect on fish populations as well. Aquatic species also benefit from ecological management such as phased mowing because aquatic vegetation can function as spawning grounds. Whether aquatic and riparian species thrive depends among others on oxygen concentration, water clarity, and nutrient concentrations (e.g., level of eutrophication). It is worth mentioning that different species of exotic crayfish have become an alternative food source (Dijkstra *et al.*, 2012). Most of the crayfish species are, however, invasive alien species from America and reduce water clarity which affects the aquatic and riparian ecosystem. GEP improvements of most water bodies can be found in the appendices 4,7,10,13, and 16.

3.8 Traffic accidents.

Traffic accidents have affected the otter population before 1988 and still severely affect the otter population since the reintroduction in 2002. The number of traffic victims has only increased as the population continued to grow (Kuiters *et al.*, 2020). Since the reintroduction, potential bottlenecks in traffic have been identified as part of the Multi-Year Programme for Defragmentation (MYPD). Its goal was to reconnect fragmented areas by constructing ecoducts, eco culverts, wildlife tunnels, and fences next to existing infrastructure. The project started in 2004 and ended in 2018 in which 176 bottlenecks have been resolved (MJPO, 2020). The MYPD had similar objectives as the EMS. In 2013, the EMS changed its name to Nature Network Netherlands (NNN) and the national government passed its responsibility for the implementation to provincial authorities in 2014. Provincial authorities still resolve bottlenecks nowadays as part of the NNN, because new bottlenecks appear when the distribution of the otter increases. Nowadays, traffic accidents remain the leading cause of death for the Eurasian otter in the Netherlands: 135 out of the total Dutch population of 450 individuals died in traffic in 2020 (Kuiters *et al.*, 2020).

Table 3 Significant laws, policies, and programs after the reintroduction in 2002 that have benefitted otter habitat.

Year	Name of the law or policy	Description
2005-2018	Multi-Year Programme for Defragmentation	To connect fragmented areas by constructing ecoducts and wildlife passages. Because of this program, many traffic bottlenecks have been solved in the past.
2013	Nature Network Netherlands (NNN)	Continuation of EMS and how this could be connected to similar ecological structures in adjacent countries. Since 2014, the government assigned its executive role to the provinces.
*2017	Law for Nature Conservation	Fusion of Nature conservation-law, Forest Law (protection of forests), and the law of Flora and Fauna to 1. Protection biodiversity, 2. Decentralization of nature conservation, and 3. Simplification of regulations.

3.9 Bycatch accidents

Even though the number of otters that die as bycatch is relatively small compared to those that die in traffic, it is also less documented. Most reported bycatch is from traps meant for invasive species such as muskrats (*Ondatra zibethicus)* and coypus (*Myocastor coypus)*. Authorities such as the Water boards often use these traps to protect dikes as these species tend to dig holes and, therefore, jeopardize the dike's function. Incidents with these traps occur rarely and are usually reported (Kuiters *et al.*, 2020). Bycatch in fish fykes occurs, however, more often. While fish fykes were first used of a material of which otters were able to escape from, the material changed around approximately 1988 into a stronger artificially made type (interview Ellen van Norren, Dutch Mammal Society). In areas where otters were reintroduced such as NP Weerribben-Wieden, fish fykes are required to have a stop grid. These stop grids prevent large species such as the otter from entering with the risk of drowning (Dekker & De Jong, 2018; Kuiters *et al.*, 2020). Juveniles may, however, be too small to be stopped by stop grids. Most incidents occur in illegal fish fykes, and these incidents are hardly reported. Therefore, its effect on the total population is hard to determine and will not be taken into account in the next chapter.

Chapter 4: Overview of current otter habitat and its improvements since the reintroduction in 2002

Since the reintroduction of the Eurasian otter in 2002, several programs such as the MYPD, WFD, and NNN have contributed or are still contributing to habitat defragmentation. In Figure 10, the progress of the NNN until 2015 is visualized. Nature areas owned and managed by nature organisations such as Natuurmonumenten, Staatsbosbeheer, Het Drentse Landschap, and Groninger Landschap are shown in Figure 11. Both figures show that most nature areas in the north and east of the Netherlands already form a well-connected network. Relatively less connected to this network are areas in the northwest of Fryslân, the east of Groningen, the east of Drenthe, near the centre of Overijssel, and the centre and east of Gelderland.

In this chapter, I will elaborate on each of these provinces and whether the NNN overlaps with the current otter distribution. For each province, I will provide the highlights of improvements since 1988 and the current condition in terms of mowing policy, bankside quality, and estimated habitat type for each of the largest, and in my opinion the most relevant, water bodies. Sometimes, a part of the water body contains sufficient bankside quality, while another part is, for example, located in an urbanized area. For these water bodies, the "/" indicates that bankside quality differs between different areas of the water body. The description of the keywords used in Table 5, 7, 9, 11, and 13 can be found in Appendix 1. For each province, the complete list of habitat improvements can be found in the appendices 2, 5, 8, 11, and 14. Remaining information regarding whether it is being monitored, whether spraints are found, population size, confirmed offspring, existing bottlenecks, function of the water body as an indicator of human disturbance, and the ecological status of the water body (GEP) can be found in appendices 3, 4, 6, 7, 9, 10, 2, 13, 15, and 16.

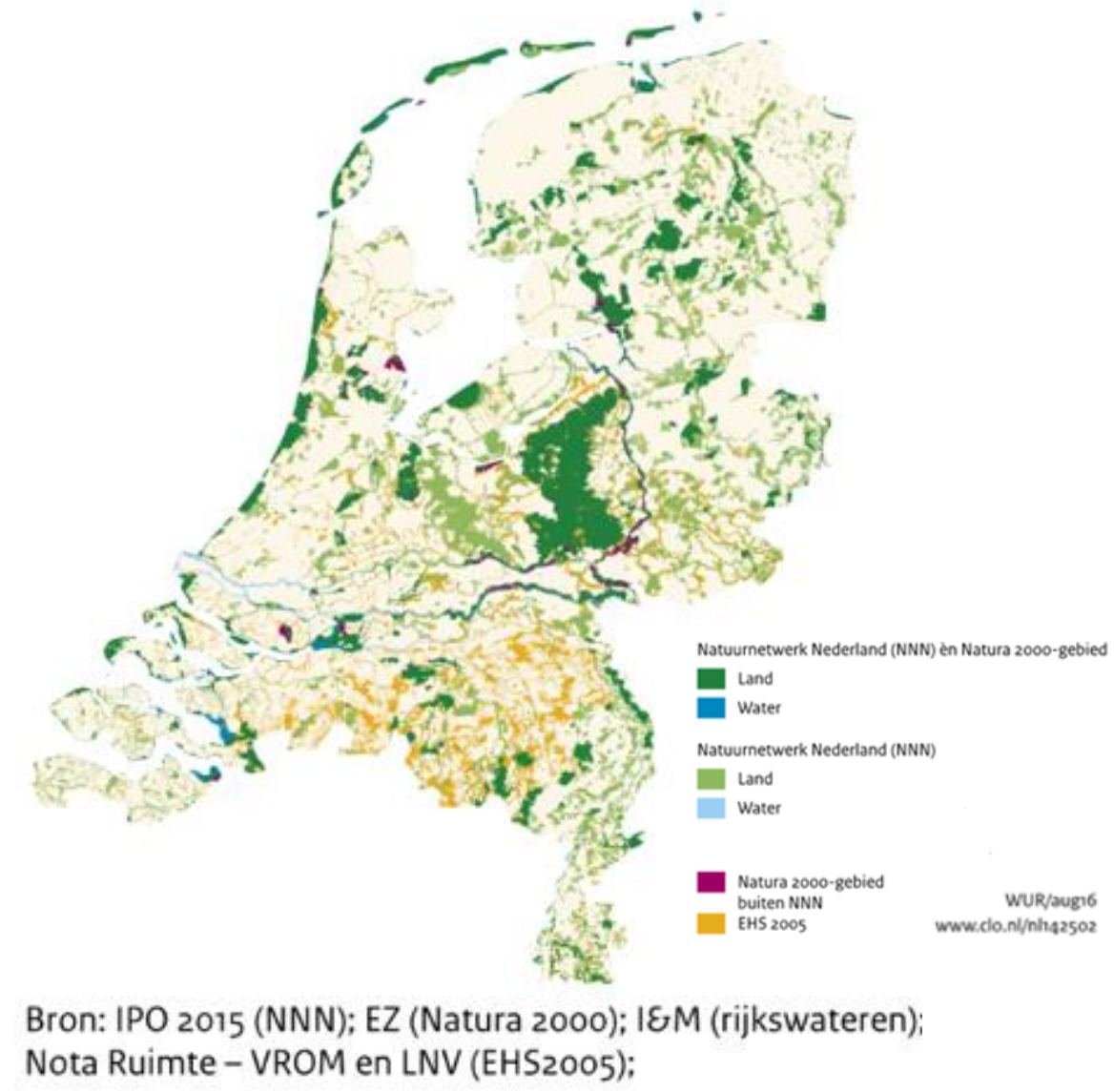


Figure 10 Map of the Netherlands in which nature areas are shown. Dark green (land) and dark blue (water) indicate nature areas which are both NNN and Natura2000, while light green (land) or light blue (water) indicate only NNN. Purple indicates Natura2000 areas.

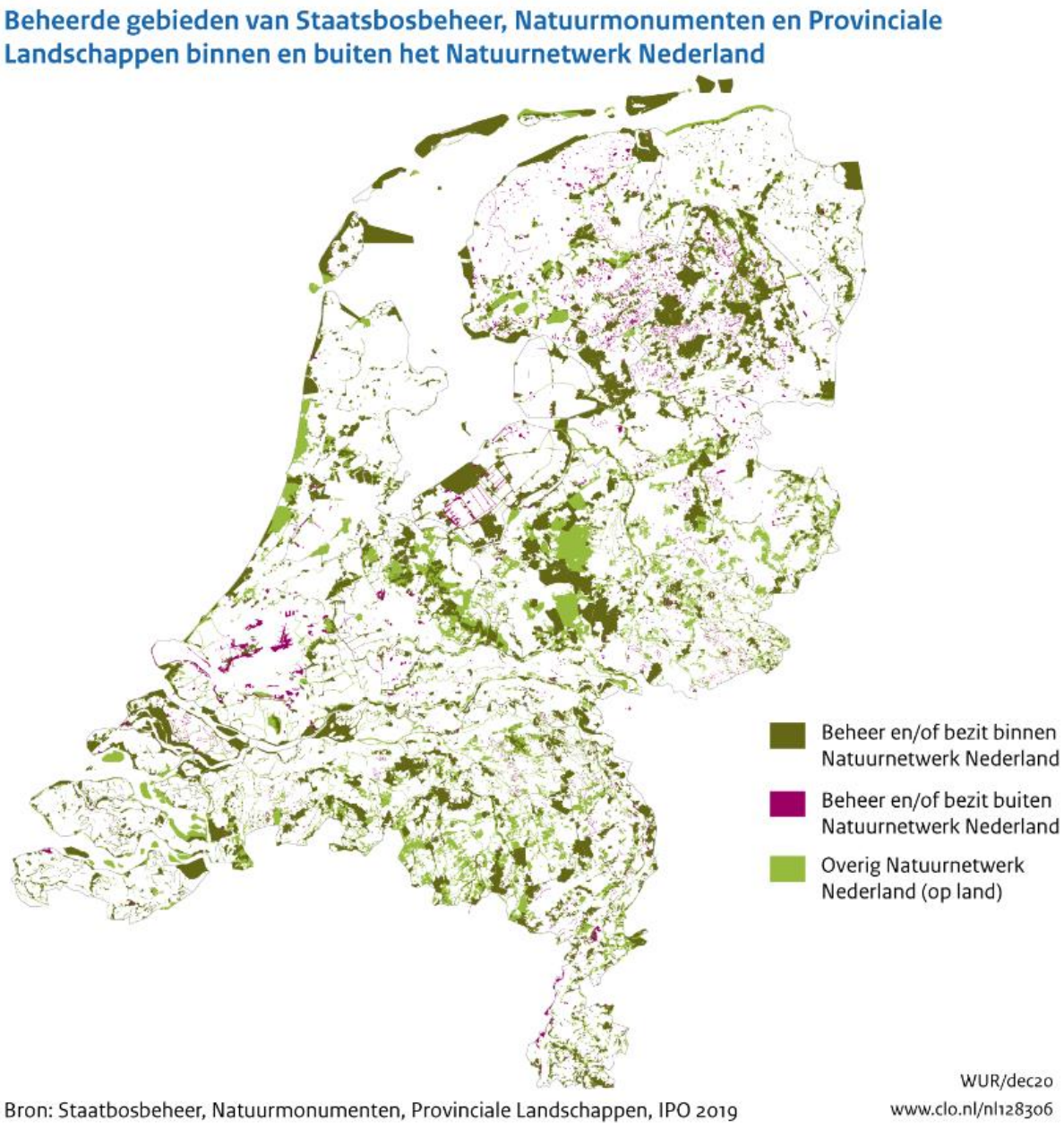


Figure 11 Map of the Netherlands in which areas owned and managed by nature organisations such as Staatsbosbeheer, Natuurmonumenten or Provincial organisations (e.g., Drentse Landschap and Groninger Landschap) are shown. Dark green indicates nature areas within NNN, purple indicates areas outside NNN, and light green indicates remaining NNN which is not owned and management by nature organisations.

4.1 Fryslân

Fryslân was inhabited by otters shortly after the reintroduction in 2002. A few years later, several otters were released in the nature areas Rottige Meente (2004-2007), Lindevallei (2002-2008) and Alde Feanen (2010-2011) to strengthen the growing subpopulation and to facilitate its distribution. Fryslân is known for its many freshwater lakes that together already form a cohesive network by rivers such as the Tsjonger/Kuinder, the Linde, and the Ouddiep, and canals such as the Prinses Margriet canal and Van Harinxma canal. This cohesive network is the main reason the Eurasian otter could distribute easily in Fryslân. The majority of the lakes are Natura2000 areas, and are protected by the Birds Directive and/or Habitats Directive.

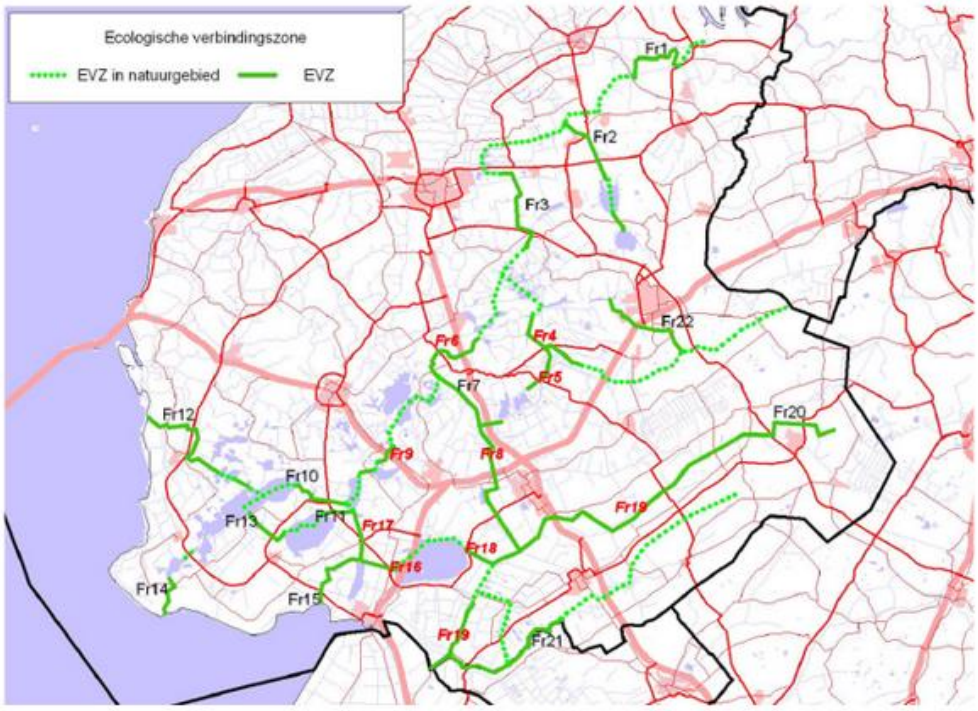


Figure 12 Ecological connections for otters in the Province of Fryslân: Fr1-Fr21, of which the ones highlighted in red had priority to be improved. Source: Lammertsma et al. (2011)

In 2011, Lammertsma *et al.* (2011) published a report in which they visualized the ecological connections for otters between different nature areas, distinguished by the numbers Fr1 to Fr21, of which the ones highlighted in red had priority for improvements (Figure 12). Lammertsma *et al.* (2011) recommended solving the obstacles and traffic bottlenecks especially in these highlighted areas, because it would improve the distribution of otters in Fryslân the most. Nowadays, it is assumed that the otter has reached virtually every water body in Fryslân, which holds a quarter to a third of the total Dutch population (Interview Harrie Bosma; Kuiters *et al. 2020*). There is much overlap between the ecological connections proposed by Lammertsma *et al*. 2011 (Figure 12) and the Nature Netwerk Netherlands (NNN) in 2020 (Figure 13) because the otter was implemented as target species while creating the NNN. Today, most observations and spraints are found within the NNN and its nature areas. Otters seem to inhabit the northwest of Fryslân less as there is relatively less optimal habitat compared to the southwest, southeast and northeast. However, observation bias may also play a role, as there are fewer volunteers active in the northwest of Friesland, i.e., between Sneek, Harlingen, and Dokkum.

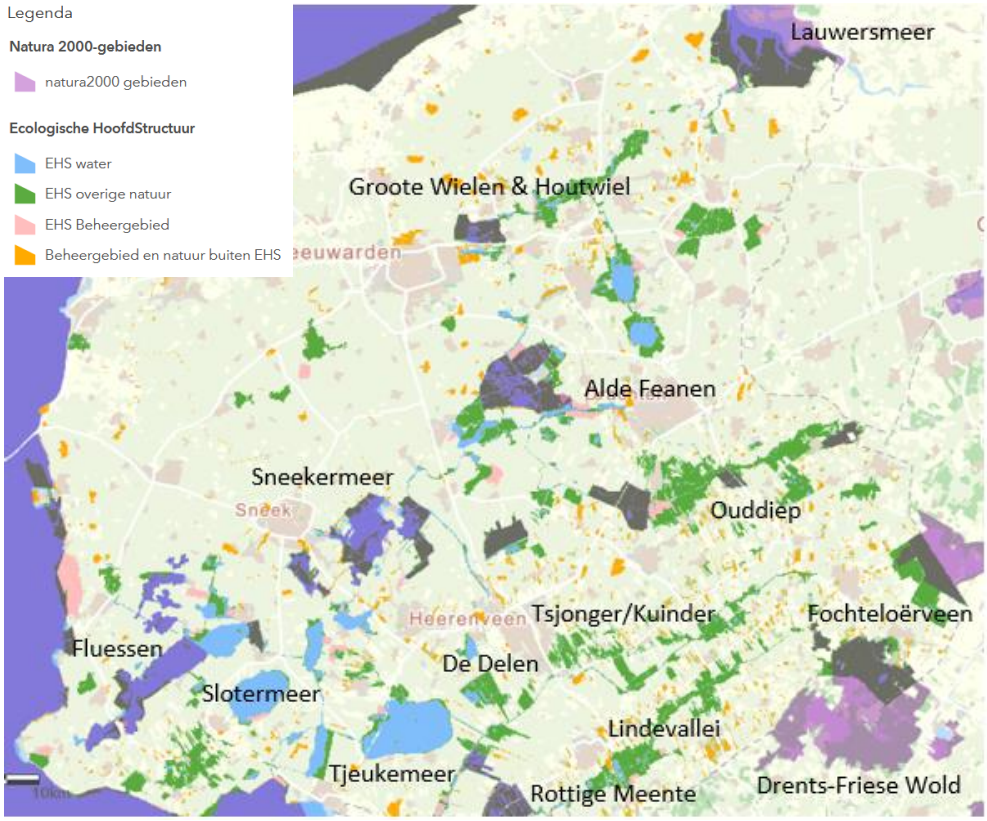


Figure 13 Current NNN in Fryslân. Green indicates the nature that is part of the EMS/NNN and purple indicates the nature areas that are also Natura2000. Source: Province Fryslân, 2020 but text edited by me.

Several organisations have contributed to habitat improvement in Fryslân: The Province of Fryslân, Water Board Fryslân, and the nature organisations It Fryske Gea, Staatsbosbeheer, and Natuurmonumenten. In most nature areas owned and managed by nature organisations in all provinces, vegetation near water bodies is present throughout the year. They often apply phased mowing, grazing, or do not cut the vegetation at all. This means that these nature areas provide shelter throughout the year and the subpopulation in these nature areas might be relatively bigger compared to other nature areas. This is also the case for most nature areas in Fryslân. Water Board Fryslân also applies a slightly different mowing policy compared to other Water Boards. Vegetation near water bodies is often mowed only when necessary (interview Eva Ruiter, Water Board Fryslân). In practice, this means vegetation is mowed in phases once every three to five years to either prevent ecological succession or to protect the function of dikes. Compared to other Water Boards, Water Board Fryslân started relatively early in redesigning water bodies by reconstructing eco-friendly and reed-friendly bankside structures: approximately around 2004 (interview Eva Ruiter). There are, however, a few water bodies in Fryslân with relatively less otter-friendly bankside structures or vegetation (Figure 14). Especially the larger canals such as Prinses Margriet canal, which is managed by Rijkswaterstaat, is suboptimal as its main function is infrastructure. The canal may function as a stepping stone for otters to reach different areas, although many adjacent alternative water bodies are present as well. Furthermore, larger lakes do not necessarily suggest better otter habitats compared to smaller lakes. The banksides of larger lakes such as Tjeukemeer usually contain armour rock to protect the banksides from erosion due to wind and wave action. Amour rock takes up the space of vegetation, giving most of the banksides a bare appearance (interview Harrie Bosma) . The nature on the

northside of the lake with reed enables otters to settle, while the size of the lake ensures sufficient food availability.

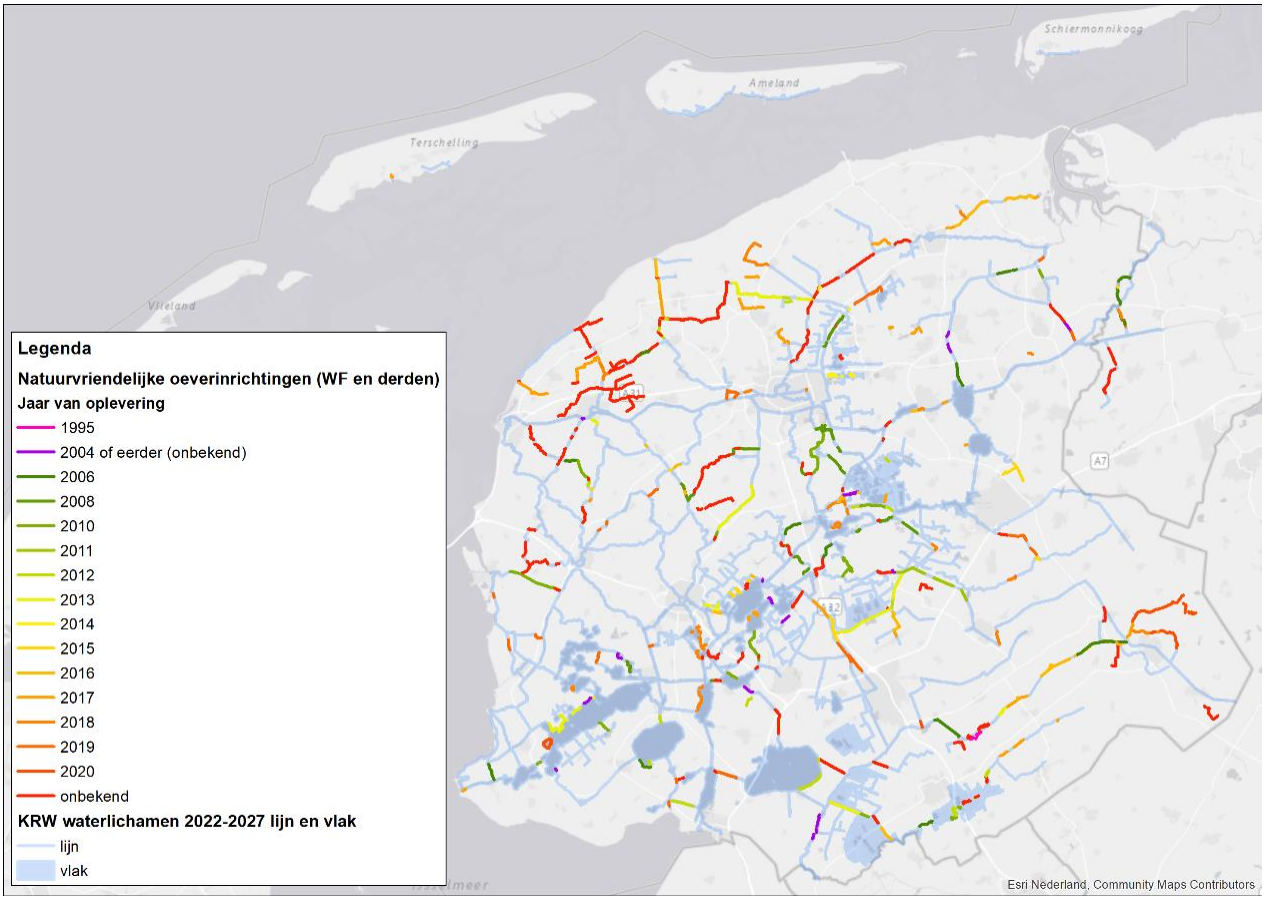


Figure 14: Bankside improvements in Fryslân. The colours indicate the year of improvement. Source: Eva Ruiter, Water Board Fryslân.

Besides the improvements shown in Figure 14, there are some improvements on a larger scale that are worth mentioning (Table 4). The complete list of the improvements in Fryslân can be found in Dutch in Appendix 2.

Table 4 Highlights of improvements in Fryslân. The complete list of improvements in Fryslân can be found in Appendix 2.

Name of water body	Year of improvement	Description of improvement	Size of project
Butefjild	2002-2017	Restoration of nature reserve	337 ha
Ouddiep	2004-2023	Landscape redevelopment (e.g., meanders)	500 ha
Groote Brekken	2008	Expansion of new nature	108 ha
Lindevallei	2009-2027	Landscape redevelopment (e.g., meanders)	650 ha
Alde Feanen	2014	Landscape redevelopment (e.g., meanders)	400 ha
Achtkarspelen-Zuiden	2014-2017	Project Mieden Op Zijn Mooist: Restoration of a nature reserve	752 ha
Dulf-Mersken	2015-2020	Restoration of nature reserve	199 ha

Baarderadeel	2017	Landscape redevelopment (e.g., meanders)	268 ha
De Burd	2018	Restoration of nature reserve	2300 ha

Most water bodies in Fryslân contain sufficient to excellent bankside quality (eco-friendly banksides and vegetation providing coverage), especially in the south adjacent to NP Weerribben-Wieden and its corridors to Alde Feanen, Van Oordt's Mersken, Lauwersmeer, Fochteloërveen, and Drents-Friese Wold (Table 5). The Friesian mowing policy does not seem to be a limiting factor for population growth. Except for the water bodies that function as infrastructure, most of the water bodies contain a relatively low level of disturbance, even outside nature areas. Bottlenecks remain the most limiting factor that prevents *Developing Core Areas* from becoming *Core Areas*. Fochteloërveen, however, is also limited by its food availability (mail exchange Roos Veeneklaas, forest guard of Natuurmonumenten), while Bergumermeer, De Leijen, and Wilde Le experience eutrophication and growth of cyanobacteria during summer (interview Jakob Hanenburg, forest guard of Staatsbosbeheer). Jakob Hanenburg also mentions reed vegetation slightly decreased in the last few decades as the result of land reclamation of the Zuiderzee. The water level, however, became more constant which benefits the otter.

Table 5 Current condition of each relevant Friesian water body in terms of mowing policy and bankside quality. *The estimated habitat type is based on mowing policy, bankside quality and the other information which can be found in appendix 3 and 4. The description of the words used in this table can be found in Appendix 1. The backslash underneath mowing policy and bankside quality indicates there is variation within a water body.

Water body	Mowing policy	Bankside quality (2021)	Estimated habitat type*
Alde Feanen	Never/Once a year (summer or winter)	Excellent	Developing Core Area
Bergumermeer, de Leijen, Wilde Le	Phased/Extensive: Present throughout the year	Good	Developing Core Area
Braandemeer (Weststellingwerf)	Present throughout the year: Phased/Not necessary	Good	Developing Core Area
Brandemeer	No vegetation	Insufficient	Developing Core Area
Broeresloot of Vierhuistervaart	When necessary	Sufficient	Corridor
De Delen	Present throughout the year: Phased/Not necessary	Excellent	Developing Core Area
De Moark	When necessary	Sufficient/Good	Corridor
Dokkumer Ee/Dokkumergrootdiep	When necessary	Insufficient	Stepping Stone
Easterskar, Oranjewoud & Nannewijd	unknown	Good	Developing Core Area
Fluessen	Phased/When necessary/Present throughout the year (Reed cutters)	Sufficient/Good	Developing Core Area
Fochteloërveen	When necessary (grazing)	Excellent	Potential Core Area
Follegasloot	Phased	Bad/Insufficient	Stepping Stone
Franekervaart	No vegetation/ Phased	insufficient/sufficient	Stepping Stone

Groote Brekken	Not Present/Present throughout the year (reed cutters)	insufficient/sufficient	Developing Core Area
Groote Wielen, Houtwiel & de Rijd	unknown	Good	Developing Core Area
Harlingen	No vegetation	Bad	Pioneering
IJsselmeer	Phased	Bad/insufficient	Developing Core Area
It Deel – Heerenveensekanaal	Phased	Bad/sufficient	Stepping Stone/Corridor
Johan Frisokanaal	No vegetation	Bad	Stepping Stone
Jonkers of Holemavaart	Phased	Good	Developing Core Area
Kuikhornstervaart, Nieuwe Zwemmer, Dokkumer Diep	When necessary	sufficient/good	Corridor
Kuinder of Tsjonger	Phased/When necessary	Good	Developing Core Area
Lauwersmeer	Phased/Grazing	Excellent	Developing Core Area
Lindevallei	Present throughout the year: Phased/Not necessary	Good	Developing Core Area
Nieuwe Diep	When necessary	Sufficient	Potential Core Area
Ouddiep	When necessary	Sufficient	Potential Core Area
Prinses Margriet canal	unknown	Bad/Insufficient	Stepping Stone
Rottige Meenthe	Present throughout the year: Phased/When necessary/Extensive	Excellent	Developing Core Area
Scharster of Nieuwe Rijn	No vegetation/ When necessary	Insufficient	Potential Core Area
Slotermeer	No vegetation/Present throughout the year (reed cutters)	Bad/sufficient	Stepping Stone/Potential Core Area (Southwest)
Sneekermeer	Phased/When necessary/Present throughout the year (Reed cutters)	sufficient/good	Developing Core Area
Stroomkanaal en Sylroede	No vegetation	Bad	Stepping Stone
Tjeukemeer	Not present/Present throughout the year (reed cutters)	Bad/Good	Developing Core Area (North), Stepping Stone (South)
Van Harinxmakanaal	No vegetation	Bad	Stepping Stone
Van Oordt's Mersken	Yearly (winter)/ Extensive	Excellent	Developing Core Area
Willaerts of Bolswardertrekvaart/ Snekervaart	When necessary	insufficient/sufficient	Pioneering

Witte & Zwarte Brekken, Langweerder Wielen, Koevordermeer en Aldhof	Not Present/Present throughout the year (reed cutters)	Good (N) and Sufficient (S)	Developing Core Area (North), Corridor (South)
Workumer Trekvaart	No vegetation	Insufficient	Stepping Stone
Zuider Ee	When necessary	insufficient/sufficient	Stepping Stone/Corridor

Conclusion for Fryslân:

1. Compared to the other provinces, the condition of Frisian water bodies was relatively good in Fryslân in 1988. A cohesive network of water bodies with a low level of disturbance already existed in 1988 but the bankside quality had deteriorated.
2. The situation improved when many Frisian water bodies became protected by Natura2000. Fryslân started relatively early with improving banksides compared to other provinces as well: before the WFD. The Friesian watersystem allows a situation in which vegetation is only mowed when necessary to avoid ecological succession
3. Otters are currently distributed throughout Fryslân, but there are less volunteers active in the northwest of Fryslân to monitor. This may have led to an underestimation in the northwest of Fryslân.
4. Most subpopulations in Fryslân are limited by traffic accidents. The connection between some areas, such as the northeast of Fryslân, may also be limited by the absence of riparian vegetation in polders.

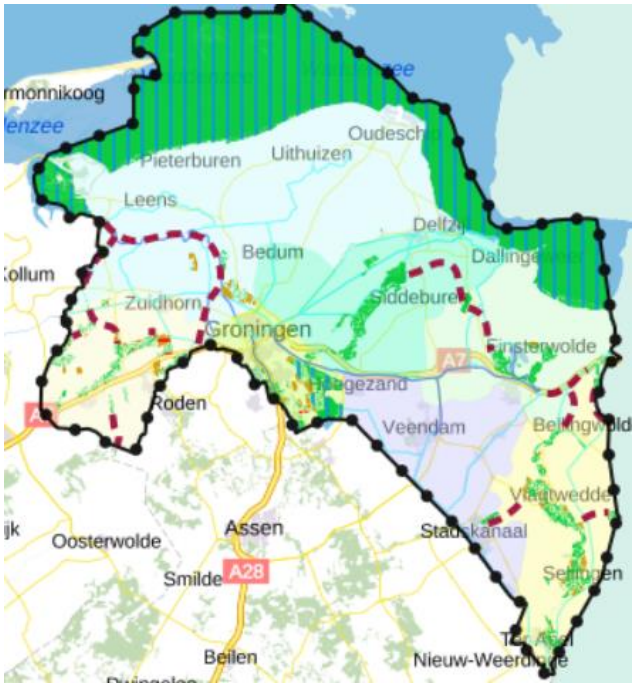
Recommendation for Fryslân:

- I recommend increasing the monitoring of otters outside lakes and/or Natura2000 areas, such as in the northwest of Fryslân.
- I recommend increasing the vegetation in polders because they function as an important connection between the lakes and/or Natura2000 areas (e.g., the improvements in northeast of Fryslân as part of the NNN).

4.2 Groningen

One of the first otters in the province of Groningen died in traffic near Stedum one year after the reintroduction in Overijssel in 2002. This demonstrated that otters were already able to reach the Province of Groningen. However, otters did not seem to settle until approximately 2011-2013 when the Lauwersmeer (Fryslân-Groningen), De Onlanden (Drenthe), Drentsche Aa (Drenthe), and Zuidlaardermeer (Drenthe) became populated by otters (Figure 16). It is likely that most otters in Groningen nowadays depend on these developing core areas (DCA) for survival. Since approximately 2016, the Hunze (Drenthe) started to contribute as habitat as well. Many areas in the west of Groningen became populated by otters. On the contrary, the north and east of Groningen seemed to lag behind. Also, it remains uncertain whether otters had settled in these areas, because only few volunteers monitored the east of the province. The current distribution can be explained by the development of the NNN and the traffic bottlenecks that are resolved. The west of Groningen contains relatively more vegetation near water bodies such as in polders compared to the north and east of Groningen. Subsequently, the polders in the west are currently more suited as otter habitat compared to the polders in the north and east. The nature in the area called Zuidelijk Westerkwartier to the north of the Onlanden and to the west of the city of Groningen is being restored. The Zuidelijk Westerkwartier can function as an expansion of the developing core area Onlanden after a

fauna tunnel is built under Highway A7. Currently, the highway A7 is still a traffic bottleneck for otters migrating from the Onlanden to Zuidelijk Westerkwartier. The NNN in the province of Groningen will consist of three main connections (the three brown dashed lines in Figure 15). The two dashed lines on the left will strengthen the connection between the Onlanden/Zuidelijk Westerkwartier and the Lauwersmeer Area. Water bodies such as the Matslootlanden, Wolddiep, Kommerzijlsterdiep, Dwarsdiep, Aduarderdiep, and Reitdiep are currently being improved in terms of eco-friendly banksides, vegetation, and its mowing policy. The projects are expected to be finished before 2027 (interview, Brigitte van Berkel, province Groningen) Both connections are crossed by the Van Starkenborgh canal. This canal is used for infrastructure and possibilities for improvements regarding eco-friendly banksides are limited because sheet piles are necessary to withhold wave action. The province is currently working on creating inlets where the NNN crosses the canal.



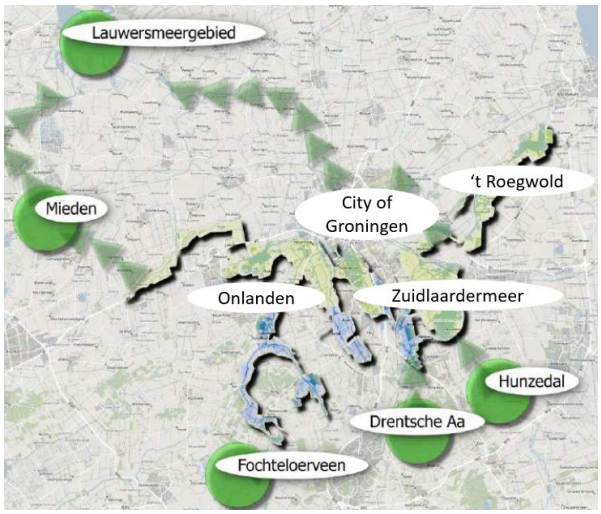


Figure 15 Future habitat improvement as part of the NNN in Groningen. The green areas represent existing nature and the three brown dashed lines what is yet to improve.

Figure 16 Nature areas near the border of the province of Groningen. Picture obtained from Natuurmonumenten but edited by me.

The provincial authorities have already solved some traffic bottlenecks such as on Highway N372, which crosses the Onlanden, and on Highway A28 which is between the Onlanden and Zuidlaardermeer (interview Brigitte van Berkel, province of Groningen). However, these highways remain a concern. Another provincial goal is to reconnect the Onlanden and Zuidlaardermeer to the nature to the east and north of Groningen (the dashed line on the right in Figure 15). Until recently, otters had difficulty reaching the east of north of Groningen because of the high density of highways around the city of Groningen.
Starting in 1992 and 1997 respectively, nature was restored in Ruiten Aa (near the border of Germany) and in 't Roegwold. Lakes such as Hondhalster and Oldambt were created in 1980 and 2007, respectively. The Hondhalstermeer contains islets to reduce wave action that benefits potential otter residency. Otters had, however, difficulty in reaching these areas until the area Westerbroek was restored in 2020 as a corridor between the Zuidlaardermeer and 't Roegwold. Since then, spraints are already found

occasionally in ‘t Roegwold, Westerwoldse Aa, and B L Tijdens canal (interview with Leon Luijten of Staatsbosbeheer and Freek Niewold of Niewold Wildlife Infocentre). Recently, an otter was also sighted in the A.G. Wildervanck canal. It seems that the first otters are now pioneering the east of Groningen, while highways (e.g., A7, N33, N385, and N361) and water bodies meant for infrastructure (e.g., Eems canal, Winschoterdiep) still limit connectivity. I expect the number of otters in the east of Groningen to increase because of the established corridor in Westerbroek. I also expect no measures are needed for the first otters to reach Ruiten Aa. Table 6 shows the highlights of habitat improvement in the province of Groningen. The complete list can be found in Appendix 5.

Table 6 Highlights of improvements in Groningen. The complete list of improvements in Groningen can be found in Dutch in Appendix 5.

Name of water body	Year of improvement	Description of improvement	Size of project
Hondhalstermeer	1980	Creation of new nature	180 ha
Ruiten Aa	1992-2021	Landscape redevelopment (e.g., meanders)	2500 ha
Oldambtmeer	1997-2007	Creation of new nature	800 ha + 350 ha
t Roegwold	1997-2014	Restoration of nature reserve	1710 ha
Aduarderdiep	2009-2015	Landscape redevelopment (e.g., eco- friendly banksides)	approximately 30.4 km
Damsterdiep	2009-2015	Landscape redevelopment (e.g., eco- friendly banksides)	approximately 26.8 km
Reitdiep (en Maren)	2009-2027	Landscape redevelopment (e.g., eco- friendly banksides and meanders)	Approximately 31.2 + 63.3 km
Woldmeer + Kardinge + Meerstad	2011-2020	Creation of new nature	approximately 130 ha
Westerwoldse Aa	2016-2021	Landscape redevelopment (e.g., eco- friendly banksides and meanders)	12 + 15 km
Zuidelijk westerkwartier	2019-2027	Landscape redevelopment (e.g., eco- friendly banksides and meanders)	2800 ha

The mowing policy that is applied in Groningen depends on who manages the water body. Both Water Boards Noorderzijlvest (>2014) and Hunze And Aa’s (>2013) apply an extensive mowing policy in which they mow one bankside each year of larger water bodies. Smaller water bodies are mowed more intensively primarily for drainage of water. Nature organisations such as Natuurmonumenten, Staatsbosbeheer, and Groninger Landschap often have a mowing policy, providing vegetation throughout the year as well. According to local forest guards and the regional otter coordinator (coordinator for otter monitoring) in Groningen, the main concern is in water bodies, for example polders, that have hardly to no vegetation at all. This is especially the case in the east and north of Groningen. Table 7 contains a list of all large, relevant, water bodies in the province of Groningen and their respective mowing policy, bankside quality, and estimated habitat type. Information regarding the other factors for each water body can be found in Appendix 6 and 7.

Table 7 Current condition of each relevant water body in Groningen in terms of mowing policy and bankside quality. The estimated habitat type is based on mowing policy, bankside quality and the other information which can be found in appendix 6 and 7. The description of the words used in this table can be found in Appendix 1. The backslash underneath mowing policy and bankside quality indicates there is variation within a water body.

Waterbody	Mowing policy	Bankside quality	Estimated habitat type
Aduarderdiep	Extensive (each year one bankside)	Sufficient	Corridor
AG Wildervanckkanaal + Veendam-Musselkanaal	Extensive (each year one bankside)	Bad	Pioneering
B L Tijdens canal	Extensive (each year one bankside)	Sufficient/good	Pioneering
Boterdiep	Extensive (each year one bankside)	Insufficient/Sufficient	No sightings
Damsterdiep	Extensive (each year one bankside)	Sufficient/Good	No sightings
Dwarsdiep	Extensive (each year one bankside)	Sufficient/Good	Developing Core Area
Eemskanaal (+ surroundings north)	Extensive (each year one bankside)	Bad	No sightings
Hondhalstermeer	Extensive (each year one bankside)	Sufficient/Good	No sightings
Kommerzijlsterdiep	Extensive (each year one bankside)	Insufficient/Sufficient	Stepping Stone → Corridor
Lauwersmeer	Phased	Good/Excellent	Developing Core Area
Matsloot & Wolddiep area	Extensive (each year one bankside)	Sufficient	Stepping Stone → Corridor
Mussel Aa-kanaal	Extensive (each year one bankside/)	Sufficient	No sightings
Oldambtmeer	Unknown	Bad	No sightings
Paterwoldsemeer + Hoornsemeer (en Onlanden)	Phased	Good	Developing Core Area
Reitdiep	Not Applicable/Phased	Insufficient/Sufficient	SS → Corridor
Roegwold + schildmeer	Unknown	Sufficient/Good	Pioneering
Ruiten Aa	Unknown	Good	No sightings
Ruiten Aa kanaal	Extensive (each year one bankside/)	Sufficient	No sightings
Sellingerbeetse	Unknown	Sufficient	No sightings
Stadskanaal	Extensive (each year one bankside/)	Bad	No sightings
Van Starkenborghkanaal	Not Applicable	Bad	Stepping Stone
Vloeivelden near Stadskanaal	Unknown	Sufficient/Good	No sightings
Westerbroek (+ Foxholstermeer and Drentsche Diep)	Unknown	Sufficient → Good	Corridor
Westerwoldse Aa (+Pekel Aa)	Extensive (each year one bankside/)	Insufficient → Sufficient	No sightings

Winsumerdiep	Extensive (each year one bankside)	Sufficient	No sightings
Wintschotersdiep	Extensive (each year one bankside/)	Bad	Pioneering → Stepping Stone
Woldmeer + Kardinge + Meerstad	Unknown	Sufficient	Pioneering
Zeilplas Langebosch (Veendam)	Unknown	Sufficient	No sightings
Zijdiep/De Lauwers	Extensive (each year one bankside/)	Insufficient	Stepping Stone
Zuidelijk westerkwartier (e.g. Oosterwold) (above Onlanden)	Extensive (each year one bankside)	Good	Developing Core Area

Conclusion for Groningen:

1. Compared to the other provinces, the situation was relatively bad in Groningen in 1988: polders contained hardly vegetation, many rivers were canalized or straightened, the condition of nature areas had deteriorated, and the high density of highways limited connectivity.
2. The situation improved when nature areas were restored (e.g., 't Roegwold and Ruiten Aa), created (e.g., Oldambt and Hondhalster), and reconnected as part of the NNN (e.g., corridor Westerbroek). Many water bodies such as rivers, especially in the west of Groningen, are (being) redesigned: meanders, eco-friendly banksides, and with vegetation. Water Boards Noorderzijlvest and Hunze And Aa's changed their mowing policy in 2014 and 2013, respectively. This occurred in the same year the first otters started to settle in the province of Groningen.
3. Otters in the province of Groningen currently depend on developing core areas near the border of the province for their survival (e.g., Lauwersmeer, Onlanden, Zuidlaardermeer, Drentsche Aa, and Hunze). Most otters in Groningen are distributed between these developing core areas in the west of Groningen. However, there are less volunteers active to monitor in the east of Groningen.
4. The growth of otter subpopulations in the province of Groningen is currently limited by riparian vegetation in polders outside nature areas such as in the east of Groningen.

Recommendation for Groningen:

- I recommend increasing the quantity of vegetation outside nature areas such as in polders in the north and east of the province Groningen.
- I recommend increasing the monitoring of otters in the north and east of the province of Groningen.

4.3 Drenthe

Just as in Groningen, the repopulation of otters in Drenthe had a slow start. Even though otters were already sighted in, for example, the Hoogeveensche Vaart in 2004, it took until the completion of the Onlanden in 2013 before otters started to settle (Table 8). The complete list of improvements in Drenthe can be found in Appendix 8. In 2015, three orphaned otters were released in the Zuidlaardermeer to support the subpopulation that managed to reach this area four years earlier. From there, it is assumed that the otters have repopulated the three main rivers in Drenthe: Peizerdiep, Drentsche Aa, and the Hunze. Drenthe consists of a tributary river system which provides a low level of human disturbance. Most water bodies are connected by either this tributary river system or by the canals that crosses the province such as the Drentse Hoofdvaart, Linthorst Homan canal, and Oranje canal. Compared to the tributary river system, these canals are less suited for otter habitat because they contain, in general, a higher level of human disturbance due to infrastructure, less vegetation and less eco-friendly banksides. Figure 1 shows

that most sightings occur in the western part of Drenthe, near the border of the provinces of Overijssel and Fryslân, and near the west of Groningen. Highways such as A28 and N34 separate western tributary rivers such as Peizerdiep and Drentsche Aa from the eastern Hunze, which was populated by otters in 2016. The area near the city of Emmen was long thought to be uninhabited by otters, until a new volunteer started to monitor in that area as well (interview Cindy de Jonge, regional otter coordinator Drenthe). It appeared that the distribution of otters in Drenthe, and therefore maybe the number of otters as well, was underestimated. In 2017, it was thought that there were 20-25 otters in Drenthe (RTV Drenthe, 2017). Three years later, this number had increased to 53 (Kuiters *et al.*, 2020).

Table 8 Highlights of improvements in Drenthe. The complete list of improvements in Drenthe can be found in Dutch in Appendix 8

Name of water body	Year of improvement	Description of improvement	Size of project
Hunze	1995-2027	Restoration of nature reserve	4806 ha
Onlanden	2005-2013	Creation of new nature	2500 ha
Drentsche Aa	2006-2012	Expansion of new nature	744 ha
Fochteloerveen	2008	Expansion of new nature	63 ha
Peizerdiep	>2013	Landscape redevelopment (e.g., meanders) + Restoration of nature reserve	900-4600 ha
Reest	2014	Landscape redevelopment (GGOR project)	1250 ha
(Hoogeveen) Oude Diep	2016-2017	Restoration of nature reserve	700 ha
Boereveensche plassen	2021	Landscape redevelopment (e.g., meanders)	17 km
Drents-Friese Wold	2021	Restoration of nature reserve	450 ha
Vledder Aa/Wapserveensche Aa	>2021	Landscape redevelopment (e.g., meanders)	204 ha

Besides the many water bodies in Drenthe that are suited for subpopulations of otters to become (developing) core areas, there are a few nature areas that seem to lag behind due to its ecological characteristics. Fochteloërveen (inhabited) and Bargerveen (uninhabited) are both nature areas that consist mostly of raised bogs. Although both nature areas may function as refuge for otters to rest, there is hardly any prey available such as fish. Some argue that otters in such areas may change their diet to alternative prey, while most believe otters will travel to the nearest water body that does have sufficient prey. The increased migration between one area used to rest and another area used to hunt may result in an increased number of traffic victims such as the existing bottlenecks near Fochteloërveen (Appendix 10). There are a few areas that will be further improved such as Peizerdiep and the Hunze. The area Eelde will be improved too as an elongation in the south of the Onlanden (Figure 17).

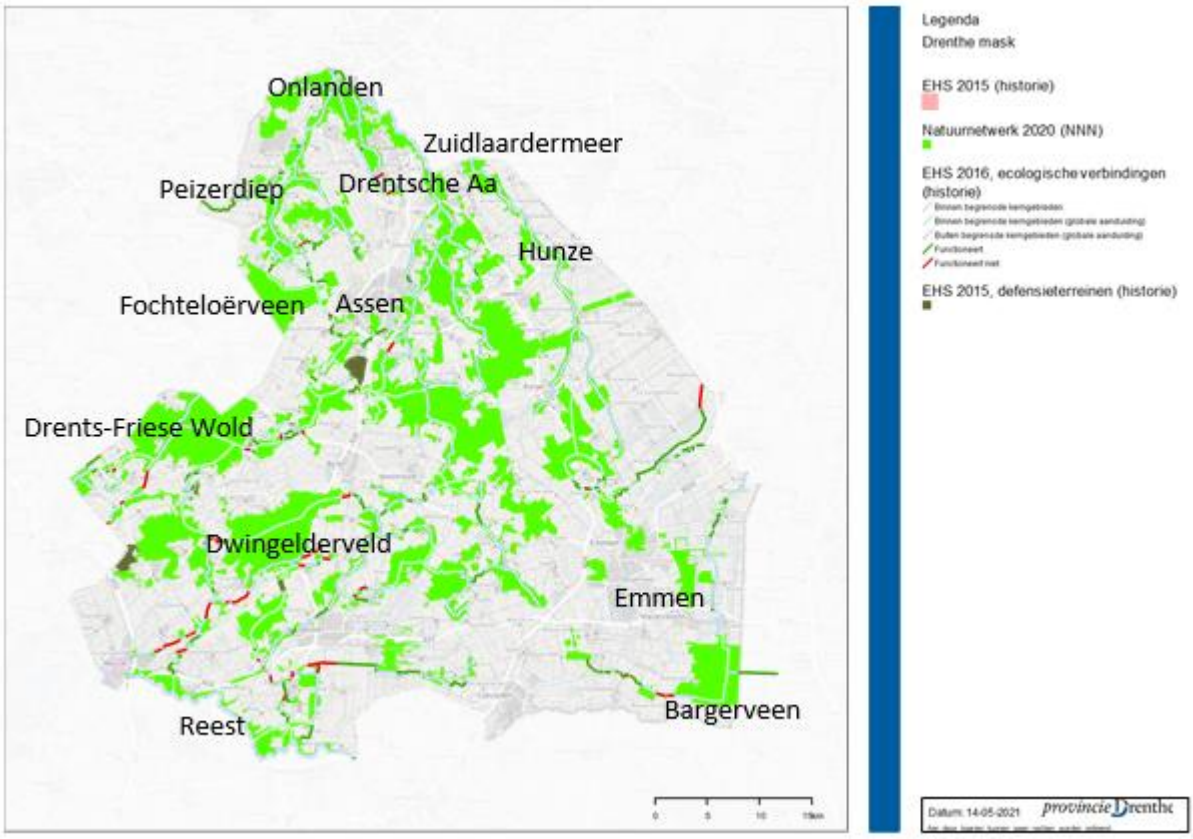


Figure 17 Current NNN (light green areas) in Drenthe, including ecological connections that are functional (dark green lines) or not functional yet (red lines) as part of the EMS. The light green lines are the connections within ecological core areas. Dark green areas are outside the NNN but be an ecological relevanc. Picture obtained from the website of the province of Drenthe (Geoportaal Drenthe). The text is added by me.

Table 9 Current condition of each relevant water body in Drenthe terms of mowing policy and bankside quality. The estimated habitat type is based on mowing policy, bankside quality and the other information which can be found in appendix 9 and 10. The description of the words used in this table can be found in Appendix 1. The backslash underneath mowing policy and bankside quality indicates there is variation within a water body.

Waterbody	Mowing policy	Bankside quality	Estimated habitat type
Bargerveen	Present throughout the year (grazing)	Good	No Sightings
Beilerstroom, Beilervaart & Brunstinger Leek,	Extensive	Sufficient	Corridor
Boerenveensche plassen en Gijssertelkoelen	Not necessary	Good/Excellent	No Sightings
Coevorden Vechtkanaal-Stieltjeskanaal	No vegetation present (CK), Extensive (S)	Insufficient/Sufficient	Stepping Stone
Drentsche Aa (rivier and NP)	Present throughout the year (Not necessary, phased, extensive, grazing)	Good	Developing Core Area
Drentse Hoofdvaart	unknown	Bad/Insufficient	Stepping Stone
Drents-Friese Wold & Leggelderveld + achtersteplas	Present throughout the year (grazing)	Good	Potential Core Area

Dwingelderveld NP	Present throughout the year (grazing)	Excellent	Potential Core Area
Fochteloërveen	Present throughout the year (Not necessary, phased, extensive, grazing)	Good/Excellent	Potential Core Area
Holtingerveld	Present throughout the year (grazing)	Good/Excellent	Developing Core Area
Hoogeveen Oude Diep	unknown	Insufficient/Sufficient	Stepping Stone
Hoogeveensche Vaart	Extensive	Insufficient/Sufficient	Stepping Stone
Hunze or Oosermoersche Vaart	unknown	Good	Developing Core Area
Noord Willemskanaal	unknown	Insufficient/Sufficient	Stepping Stone → Corridor
Onlanden (incl. Leekstermeer, Friese Veen)	Present throughout the year	Excellent	Developing Core Area
Oranjekanaal	unknown	Sufficient	Stepping Stone/Corridor
Oude Vaart	Extensive	Bad/Insufficient	Stepping Stone
Peizerdiep/Oude Diep/Slokkert	unknown (Eco-friendly)	Sufficient/Good	Developing Core Area
Reest	Extensive	Insufficient/Sufficient	Stepping Stone/Corridor
Vledder Aa, Wapserveensche Aa	unknown	Sufficient	Corridor
Wold Aa, Ruiner Aa	unknown	Sufficient	Corridor
Zuidlaardermeer	Present throughout the year (Not necessary, phased, extensive, grazing)	Good/Excellent	Developing Core Area

Most nature areas managed by Natuurmonumenten and Staatsbosbeheer have vegetation present throughout the year (Table 9). In some of their nature areas grazing by cattle is applied to maintain the vegetation, combined with phased and/or extensive mowing. There are four Water Boards present in Drenthe: Noorderzijlvest, Hunze And Aa's, Drents-Overijsselse Delta, and Vechtstromen. Water Boards Noorderzijlvest and Hunze And Aa's have changed their mowing policy in 2014 and 2013, respectively, as described for Groningen. Both water boards seem to apply a mowing policy that enables vegetation to be present throughout the year. This is, however, only applied at relatively large water bodies that have vegetation. Relatively smaller water bodies such as creeks and polders are in some cases mowed more often for drainage purposes. Water Board Drents Overijsselse Delta applies an extensive mowing policy since 2019 (information obtained from Evelien Bakker, Water Board Drents-Overijsselse Delta). While one bankside is usually skipped during June-August, everything is removed during September-November. The river Reest at the border of Overijssel is an example of their extensive mowing policy. According to different interviews such as with Bertil Zoer from Het Drentse Landschap, this river has hardly any vegetation during winter. Water Board Drents Overijsselse Delta explains this is important for water level management: in narrow water bodies more vegetation needs to be mowed for the drainage or supply of water compared to broader water bodies. Nature organisations such as Het Drentsche Landschap believe, however, it is possible to keep more vegetation present near relatively broad water bodies such as the Reest throughout the year. Water Board Vechtstromen applies many different mowing strategies as well,

based on the function of the water body. Since a couple of years, they mostly apply an extensive, phased or differentiated mowing policy. According to Tom Pikkemaat (Water Board Vechstromen), the north of their working area, which is located in the province of Drenthe, is mowed more often (extensively) compared to the south which is located in the province of Overijssel. The seasonal lack of vegetation may cause increased migration of otters because otters have to move further land inwards to find vegetation to rest. This may in turn cause seasonal peaks in traffic accidents.

Conclusion for Drenthe:

1. Compared to the other provinces, the situation was relatively adequate in Drenthe in 1988 because a cohesive network of water bodies already existed: a tributary river system with a low level of disturbance and a system of canals. The bankside quality had, however, deteriorated, when many water bodies were canalized or straightened.
2. The situation improved when nature near rivers such as the Hunze (>1995), Drentsche Aa (>2006), and Peizerdiep (>2013) was restored or created such as the Onlanden (>2005). Water Boards Noorderzijlvest and Hunze And Aa's in the north of the province Drenthe changed to a mowing policy with vegetation throughout the year in 2014 and 2013, respectively. Water Boards Drents Overijsselse Delta (>2019) and Vechtstromen (exact year unknown) changed to an extensive mowing policy recently.
3. The largest subpopulations of otters in the province of Drenthe are currently located in nature areas with vegetation throughout the year: the Hunze, Zuidlaardermeer, Onlanden, Drentsche Aa, Peizerdiep, Fochteloërveen, and Drents-Friese Wold. The area near the city of Emmen was long thought to be uninhabited by otters, until a new volunteer started to monitor in that area as well. Little is known about the distribution of otters in Dwingelderveld, Bargerveen, and to the east of the Hunze near the border of the province of Groningen, because these areas are less monitored.
4. The growth of subpopulations is in some areas such as Fochteloërveen and Bargerveen limited by food availability, while other subpopulations seem to be limited by lack of vegetation during winter, reducing the suitability of otter habitat seasonally (e.g., Reest).

Recommendations for Drenthe:

- I recommend reassessing current extensive mowing policies. Water bodies such as the Reest could function as an important corridor. However, its connection towards the east is now reduced during winter as most vegetation is removed.
- I recommend increasing the monitoring to the east of the Hunze and in Bargerveen. This may provide new information regarding the connection with Germany and to which extent eastern Groningen is being repopulated.

4.4 Overijssel

Overijssel has two different water networks that are to some extent intertwined. The first water network consists of river such as Zwarte Water, Reest, Overijsselse Vecht, Regge, and Dinkel (Figure 19). The second water network consists of canals such as the main canals in Overijssel (e.g., Almelo-Vroomshoop and Zwolle-Vroomshoop) and the Twente canal. These canals are used for infrastructure and may only function as stepping stones or corridors if inlets are present.

The situation was relatively bad in Overijssel in 1988. Most rivers were canalized or straightened with hardly any vegetation left. The few nature areas with sufficient water bodies and vegetation became fragmented. As described in the introduction, the first otters were reintroduced in National Park Weerribben-Wieden in 2002 and some a few years later in Olde Maten (2002-2008) as well. National Park Weerribben-Wieden already resembled suitable otter habitat, because it contained water bodies with a sufficient food supply, the presence of vegetation throughout the year and water quality had improved significantly. It took five to six years before the subpopulation in national park Weerribben-Wieden started to grow because many individuals spread and/or died in traffic while migrating to surrounding nature areas (CLO, 2020). Since 1995, nature to the south of NP Weerribben-Wieden was redesigned to create habitat for marsh birds (interview Mark Zekhuis, former regional otter coordinator and working for Landschap Overijssel). Otters could benefit from the improvements in bankside quality as well. According to Johann Prescher and Rosalie Martens (interview Natuurmonumenten Wieden), the connection between NP Weerribben-Wieden and Olde Maten improved after the first traffic bottlenecks were resolved and bankside quality was improved. The first spraints of otters were found in Ketelmeer (2004-2008), Zwarte Meer (2004-2008), and Zwarte Water (approximately >2012). These three areas are now protected by Natura2000 as well and are developed into excellent otter habitat.

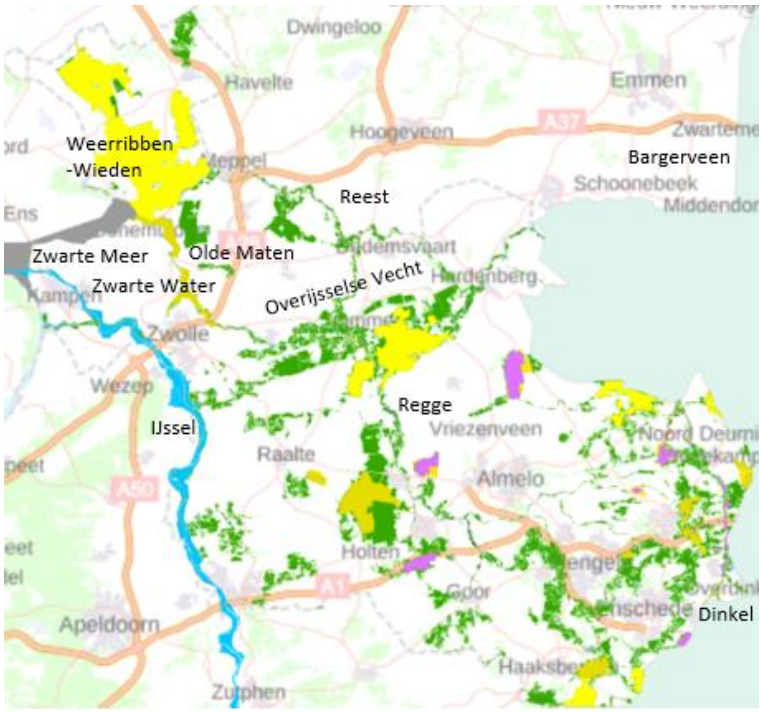


Figure 18 Current NNN in Overijssel (green). The remaining colours indicate Natura2000 areas. Even though the river IJssel is used for infrastructure, its flood plains are part of Natura2000.

Since 2012, otters have gradually distributed towards the east and south of the province Overijssel. Remarkably, otters have settled in water bodies just after these were improved as part of the NNN and/or Natura2000 (Table 10 and Appendix 12). When migrating to the east, otters could choose between the canal Hoogeveensche Vaart and the river Reest. While the first otters were sighted in the Hoogeveensche Vaart in 2004, no otters settled in this canal because of the infrastructure and Bargerveen with a lack of food supply was the only destination otters could reach from there. The first otter spraints were found in the Reest in 2013, the same year the first projects "Stadsrandzone Meppel-Reestdal" and "Gewenst Grond- en oppervlaktewater Regime (GGOR)" started to improve the bankside quality of the river (Appendix 8).

Table 10 Highlights of improvements in Overijssel. The complete list of improvements in Overijssel can be found in Appendix 11.

Name of water body	Year of improvement	Description of improvement	Size of project
Zwarte water	1995-2021	Expansion of nature reserve	150 ha
Dinkel	1996	Expansion of water body by creating a by-pass canal	12 km
Regge	1989	Broadening and deepening river	6.5 km
	2015	Project Doorbraak: Connecting Regge to Loolee	13 km
	2019	Project Reggedal: landscape redevopment	115 ha
Overijsselse Vecht	>2009	Landscape redevelopment (e.g., meanders) + Restoration of nature reserve (Project Room for the Vecht)	Approximately 244 ha
Weerribben-Wieden	2010, >2020	Expansion of new nature Landscape redevelopment	109 ha 108 ha
Olde Maten	2014	Creation of new nature	1080 ha
IJssel	2015	Creating a.o. side-channels near the flood plains Bolwerksplas, Worp en Ossenwaard, Keizers-, Stobben- en Olsterwaarden (RftR)	10 km
	~2016	Improving flood plains Scheller and Oldeneler	130 ha
	2017	Side-canal Veessen-Wapenveld	7 km
	2019	13 resting areas for birds appointed	565.5 ha
Reevediep	2019	Creation of new nature (project RftR)	350+40 ha
Ommer canal	2020-2021	Connecting Overijssele Vecht and Ommer canal	6.5 km
Vledders en Leijerhooilanden	2021	Restoration of nature reserve	18 km

There are different water bodies that otters have used to migrate to the south of the province of Overijssel. From Ketelmeer and Zwarte Meer, otters repopulated the IJssel (>2009) and Veluwemeer (>2013). Even though Veluwemeer is a relatively large water body, it is used for infrastructure and the amount of riparian vegetation is relatively limited. The river IJssel is a dynamic river used for infrastructure that has seasonal differences in water level. During winter, the river needs to drain excessive water or store it in the surrounding flood plains. This temporarily reduces otter habitat because the resting areas in flood plains will be flooded during winter. Even though the quantity of water in the river increases during winter, the quantity of fish remains the same. Therefore, it becomes harder to catch fish for otters because the density of fish is 'diluted'. In 2019, thirteen resting areas were appointed for birds (Table 10). These resting areas might also benefit otters as they may function as an alternative when resting areas in the flood plains are

flooded. Otters can also use the Zwarte Water to travel to the IJssel, but they can also use it to travel to canals such as the Zwolle-Vroomshoop canal (>2015) or to rivers such as the Overijsselse Vecht (>2012). Project 'Room for the Vecht) started in 2009 and has improved the river significantly in terms of eco-friendly banksides. It also connected existing otter habitat in the Weerribben-Wieden to the rivers further south such as the Regge and the Dinkel. Both rivers were repopulated by otters in 2012 and 2014, respectively. The Regge (the middle part) was already improved in 1989 by broadening and deepening the river. Since then, the river is improved as part of the WFD (>2010), project 'Doorbraak' (2015), project 'Reggedal' (2019). The Dinkel already contained a low level of human disturbance but was relatively isolated until it became connected by the Overijsselse Vecht to the otter populations in Weerribben-Wieden. In 1996, a bypass canal was created to redirect excessive water. By doing this, the original river did not need to be canalized. In the last couple of years (>2020) many projects have started to restore the river (e.g., meanders with eco-friendly banksides) as well (Appendix 11). The Dinkel may become an important connection to the subpopulations in western Germany. The number of otter sightings in the south is lower compared to the north of the province Overijssel. Although this may be explained by differences in monitoring, otters are less frequently sighted in water bodies such as Twente canal and Twickelervaart.

There are three Water Boards in Overijssel: Drents Overijsselse Delta, Vechtstromen, and Rijn And IJssel of which the latter one will only be discussed for Gelderland due to its relatively small working area in Overijssel. Water Board Drents Overijsselse Delta (>2019) applies for most water bodies an extensive mowing policy in which most of the vegetation (>75%) is removed during winter. Rivers such as the Reest, Regge, and Overijsselse Vecht are mowed extensively as well. Water Board Vechtstromen applies (exact year unknown) different mowing policies based on the function of the water body: extensive, phased and differentiated. Large rivers such as the Overijsselse Vecht, Regge, and the Reest are mowed extensively to drain excessive water during winter. According to Mark Zekhuis, there is a peak of otters dying in traffic during winter near these rivers as a result of otters moving further inland to find an alternative place to rest. The area Vledders and Leijerhooilanden is currently being restored and may function as an alternative during winter for otters between the IJssel, Overijsselse Vecht, and the Regge. Even though it is not certain whether otters have settled there, it may become an important refuge soon (Table 10 and 11). This project is an example of how surrounding nature can be improved when options are limited to maintain sufficient vegetation near large rivers throughout the year. Maintaining a sufficient number of resting areas throughout the year can reduce the migration of otters and, therefore, reduce traffic accidents. While resolving traffic bottlenecks has benefitted the distribution of otters in Overijssel, it was the improvements of water bodies that made otters settle and develop into a subpopulation (Table 10 and Appendix 11). Currently, National Park Weerribben-Wieden has the largest subpopulation of otters in the Netherlands. The subpopulation has grown from approximately 92 individuals in 2019-2020 (Kuiters *et al.*, 2020) to 108-119 individuals in 2020-2021, which is about a quarter of the Dutch metapopulation (intern files from the Dutch Mammal Society).

Table 11 Current condition of relevant water bodies in Overijssel in terms of mowing policy and bankside quality. The estimated habitat type is based on mowing policy, bankside quality and the other information which can be found in appendix 11 and 12. The description of the words used in this table can be found in Appendix 1. The backslash underneath mowing policy and bankside quality indicates there is variation within a water body.

Waterbody	Mowing policy	Bankside quality	Estimated habitat type
Almelo - Vroomshoop - De Haandrik	No Vegetation	Bad	Stepping Stone
Dedemsvaart	Extensive	Sufficient	Corridor
Dinkel	Not necessary (Undergrow and shrubberies)	Good/Excellent	Developing Core Area
Engbertsdijksvenen	Intensive and grazing	Good	Pioneering
Hoogeveense Vaart	No Vegetation	Bad	Stepping Stone
IJssel	Unknown/Not Present	Bad/sufficient	Stepping Stone → Corridor
Kanaal Almelo-Nordhorn	Unknown	Sufficient	Pioneering
Ketelmeer + Vossemeer	Phased/Not necessary	Excellent	Developing Core Area
Lemelervelt-Deventer	Unknown	Sufficient/Good	Corridor
Olde Maten & Veerslootlanden	Extensive, Phased, Not Necessary	Good/Excellent	Developing Core Area
Ommerkanaal (kanaal)	Extensive	Sufficient/Good	Corridor
Overijsselse Vecht	Extensive	Insufficient/Sufficient	Developing Core Area
Regge Beneden	Extensive	Sufficient/Good	Developing Core Area
Regge Boven	Extensive	Sufficient/Good	Developing Core Area
Regge Midden	Extensive	Sufficient/Good	Developing Core Area
Schipbeek + Buurserbeek	Phased	Sufficient	No sightings
Twentekanaal (Z -E)	Extensive	Bad/Sufficient	No sightings
Twentekanaal (zijkanaal Almelo)	Extensive (N), Phased (S)	Bad/Sufficient	No sightings
Twickelervaart	Not necessary/Not present	Sufficient/Good	No sightings
Vledders en Leijerhooilanden	Extensive	Good	Pioneering
Weerribben-Wieden and surroundings	Phased/Not necessary	Excellent	Core Area
Zwarte Meer (+ kadoelermeer en vollehovemeer)	Phased/Not necessary	Excellent	Developing Core Area
Zwarte Water	Not necessary (occasionally)	Sufficient	Corridor/Developing Core Area
Zwolle - Lemelerveld - Vroomshoop	Unknown	Sufficient	Stepping Stone/Corridor

Conclusion for Overijssel:

1. Compared to the other provinces, the situation was relatively bad in Overijssel in 1988. Apart from fragmented nature areas such as NP Weerrribben-Wieden, most water bodies such as rivers and canals were canalized or straightened with hardly any eco-friendly banksides or vegetation.
2. The situation improved when many water bodies became protected by Natura2000 and improved as part of the NNN. Projects such as Room for the River, Room for the Vecht, Doorbraak, and Reggendal have increased otter habitat and improved the connectivity between different water bodies. Water Boards Drents Overijsselse Delta (>2019) and Vechtstromen (exact year unknown) changed to an extensive mowing policy recently of which Vechstromen also applies a phased or differentiated policy wherever possible. The Overijsselse Vecht and the Dinkel may become an important connection between the population in NP Weerribben-Wieden and western Germany due to improving bankside quality.
3. The largest subpopulation of otters in the province of Overijssel is currently located in NP Weerribben-Wieden, approximately 108-119 individuals. The subpopulations in nature areas such as Zwarte Meer, Zwarte Water, Olde Maten, Overijsselse Vecht, Regge, Dinkel are slowly growing as well, varying between 1-6 individuals.
4. The growth of subpopulations is mostly limited by the number of sufficient resting areas throughout the year near water bodies. Traffic accidents may in turn be reduced when alternative resting areas are closer to water bodies such as the rivers IJssel, Reest, Overijsselse Vecht, and Regge.

Recommendations for Overijssel:

- I recommend reassessing mowing policies near water bodies to maintain a sufficient number of resting areas throughout the year. Surrounding areas such as polders could be redesigned to function as an alternative during winter as well. Nature area Vledders And Leijerhooilanden (>2021) is an example of how surrounding nature can function as an alternative, although no otters have settled yet.
- I recommend increasing the monitoring in the south of the province Overijssel because I expect the number of otters to increase since water bodies such as the IJssel and Regge are being improved. This may also provide new information regarding the connection with the northern part of the province Gelderland.

4.5 Gelderland

The largest water bodies in Gelderland are the four rivers: Meuse, Waal, (Neder)Rhine, and the IJssel. The rivers are used for infrastructure and managed by Rijkswaterstaat. The first three rivers are located in the south of the province, while the IJssel branches off from the (Neder)Rhine and flows to the north into the IJsselmeer (Figure 19). The four rivers have seasonal differences in their water level and contain a high level of human disturbances. Each of these rivers also contains armour rock to withhold wave action created by ships. The situation was worse in Gelderland in 1988. Chances were that the four rivers would not be able to drain the excessive amount of water and the dikes would break. This almost happened in 1993 and 1995 when the water level became too high. It became clear that the applied water management had to change. Project 'Room for the Rivers' would provide the rivers more space to flood safely on thirty different locations by creating, broadening, and deepening the flood plains (Table 11 and Appendix 14). Since 1988, new nature areas were created such as Duursche Waarden, Blauwe Kamer, Millingerwaard, and Passewaaij and some flood plains were appointed as nature areas. The four rivers (likely) function as stepping stones because they contain patches of otter habitat (nature areas), while tributary rivers are entirely being improved as part of the FWD. Therefore, tributary rivers such as the Oude IJssel are more suitable for otters because they provide a relatively better bankside quality with less disturbed resting areas.

The first spraints in Gelderland were found near the Oude IJssel in 2008 which is a remnant of the previous river course of the IJssel. A year later, sprains were also found near the IJssel. Seven otters were reintroduced in the Gelderse Poort in 2014 after an otter was sighted (Van der Spek 2017, Pekel, 2019). The Gelderse Poort consists of three main areas: (Oude) Rijnstrangen, Millingerwaard, and Ooijpolder. Both the Waal and the (Neder)Rhine/Pannderdensch canal cross the Gelderse Poort, limiting the connection between the three areas. Most otters in Gelderland are in the Gelderse Poort and the Oude IJssel near Doesburg, but some are occasionally sighted in the Berkel near the German border as well. The otters in the Berkel are likely originating from the subpopulations in western Germany. The Berkel and the Gelderse Poort may become an important connection between the Dutch metapopulation and the few subpopulations in western Germany. The number of otters in Gelderland has varied between three to nine individuals since 2014. The growth of the otter subpopulations in Gelderland lags behind compared to the provinces discussed before (Kuiters *et al.*, 2020). It remains unclear what causes the subpopulations to grow slowly, but there are a few reasons that may partly explain it. Firstly, the flood plains near the four main rivers are flooded yearly to store excessive water. This reduces the number of resting areas seasonally. Secondly, a part of the vegetation in flood plains is often removed as part of project 'Stroomlijn'. Vegetation could limit the drainage of water as obstruct river flow. The remaining reasons will be explained for each working area of the three different Water Boards: Vallei And Veluwe, Rivierenland, and Rijn And IJssel.

Figure 19 Current NNN in Gelderland (dark green). Light green indicates nature to be developed. The figure is obtained from the website of the province Gelderland and edited by me.

Table 11 Highlights of improvements in Gelderland. The complete list of improvements in Gelderland, including other projects of Room for the River, can be found in Appendix 14.

Name of water body	Year of improvement	Description of improvement	Size of project
IJssel	1989	Creating new nature Duursche Waarden (project RftR)	120 ha
	2016	Cortenoever and Voorsteklei, creation of flood plains (project RftR)	290 ha + 200 ha
Millingerwaard	1992 and 2013-2021	Creating new reserve Millingerwaard (project RftR)	800 ha and 265 ha
(Neder)Rhine	1992-2010	Creating new nature area De Blauwe Kamer (project RftR)	120 ha
	2015	Improving flood plains in Huissensche Waarde (project RftR)	740 ha
	2015	Improving flood plains in Meinerswijk (project RftR)	300 ha
Waal	1996	Creating new nature area Passewaaij (project RftR)	40 ha
Rijnstrangen	>2009	Restoration of nature area Rijnstrangen	28 ha
Waal	2013-2015	Creation of a side-channel: Spiegelwaal	4 km
	2016	Improving flood plains Munnikenwaard and Brakelse Benedenwaard (project RftR)	500-700 ha
Berkel	2016-2021	Landscape redevelopment (e.g., meanders)	13 km and 115 ha
Apeldoornsch Kanaal	2016-2021	Eco-friendly maintenance	51.2 km
Keizerbeek	2022-2027	Landscape redevelopment (e.g., meanders)	14 km

The area to the north of the Rhine and to the west of the IJssel is managed by Water Board Vallei And Veluwe. Their working area contains the Veluwe which only has a few water bodies, making it unfavourable for otters. The remaining areas can, however, contribute to the distribution of the otter in Gelderland because they are located next to already existing stepping stones managed by Rijkswaterstaat: Drontermeer, Veluwemeer, Wolderwijd, and the IJssel. These stepping stones are unlikely to become corridors but the areas around them could still be improved. According to Robin Buitink (Water Board Vallei And Veluwe), the water board applies an extensive mowing policy since 2020 at which they leave, if possible, one bankside untouched until the next year (Table 12). He also mentions that private landowners often mow what is skipped by the water board which results in complete removal of the vegetation. Robin Buitink explains that the area can still be improved by informing private landowners about their new ecological management. It remains unclear to which extent otters already have settled in this area because the monitoring of otters mostly occurs near the IJssel. In the last few years, spraints are more often found near Apeldoornsch Kanaal, Bottenstrank, and Voorsterbeek. This indicates that the connection between the IJssel and the area to the west is sufficient for otters to reach. The improvements of these water bodies mentioned in Appendix 14 are the first steps in providing new otter habitat.

The area to the west of the Gelderse Poort and to the south of the Rhine is managed by Water Board Rivierenland. Some otters have died in traffic, indicating that otters can already reach this area, but having trouble crossing highways (Kuiters *et al.*, 2020). Most large water bodies in Rivierenland such as (Neder)Rhine, Meuse, and Waal are managed by Rijkswaterstaat and are used for infrastructure. The four main rivers often contain remnants of the previous river course. These remnants are often patches of nature areas in an unsuitable landscape (the main rivers). It may be that otters have difficulty reaching these patches. Rivierenland is located to the south of highway A12 and many highways (A15, A50, A325) cross this area. The largest water body that might be potential otter habitat is the Linge. While the part located upstream is canalized, the part downstream already has some eco-friendly banksides (Interview, Henne Ticheler, Water Board Rivierenland). However, the Linge has little vegetation. Since approximately 2019, Water Board Rivierenland changed its mowing policy in smaller (tributary or distributary) rivers/creeks to an extensive policy, and one bankside is not mowed until next year (Table 12). Rivierenland is an area with a high level of disturbance (highways and canals with sheet piles) and little to no riparian vegetation, yet it may play an important role once otters have settled/are released in National Park Biesbosch (province Noord Brabant and Zuid Holland). National Park Biesbosch is connected to the Gelderse Poort by rivers Meuse, Waal, and (Neder)Rhine/Lek.

The area to the east of the IJssel and to the north of the (Neder)Rhine is managed by Water Board Rijn And IJssel. Otters inhabit the borders of their working area in de IJssel, the Oude IJssel, Gelderse Poort, and are recently also sighted in the Berkel near the German Border. Most otters in the Gelderse Poort are found in the (Oude) Rijnstrangen. The Rijnstrangen contains the most vegetation compared to the Ooijpolder and Millingerwaard. Even though otters were released in both areas, they do not seem to settle in the Ooijpolder and Millingerwaard as they do in the Rijnstrangen. According to Melanie Pekel (regional otter coordinator Gelderse Poort), no new spraints are found in the Ooijpolder and Millingerwaard since 2020. Otters seem to move away from this area to surrounding areas and/or are killed in traffic. Even though all three areas function as otter habitats, the Gelderse Poort is relatively small and enclosed by highways (N325, A15, and A12) and three cities (Nijmegen, Arnhem, and Doetinchem). There is also a subpopulation in the Oude IJssel which is close to the Gelderse Poort. However, both areas are relatively

isolated to other subpopulations. Most volunteers in Gelderland are active in the Gelderse Poort or near the Oude IJssel (near Doetinchem). There is, however, no clear picture, of how otters distribute the moment they migrate to surrounding areas. According to Matthijs de Vos (Water Board Rijn and IJssel), the water bodies in the centre of their working area, such as near Baakse Beek in Figure 19, differ from the water bodies such as the Oude IJssel. Water bodies near the four main rivers have a sufficient supply of water, while water bodies in the centre often dry up during summer. The seasonal disappearance of water limits the water body from becoming potential otter habitat. Creeks/rivers such as the Slinge, Keizerbeek, and Bielheimerbeek will soon be redesigned (e.g., meanders) to retain water. This may prevent the rivers/creeks from drying up during summer. Approximately in 2019, Rijn and IJssel changed its mowing policy to phased mowing (Table 12). Whether this mowing policy is applied depends on among others the vegetation, slope, and area type. For example, the upstream part of the Slinge is located within a forest that does not need any maintenance.

Table 12 Current condition of relevant water bodies in Gelderland in terms of mowing policy and bankside quality. The estimated habitat type is based on mowing policy, bankside quality and the other information which can be found in appendix 15 and 16. The description of the words used in this table can be found in Appendix 1. The backslash underneath mowing policy and bankside quality indicates there is variation within a water body.

Waterbody	Mowing policy	Bankside quality	Estimated habitat type
Rivierenland			
Edensche Zeeg	Phased (alternate taluds)	Insufficient/Sufficient	No sightings
Linge beneden	Phased (alternate taluds)	Bad/insufficient	Pioneering
Linge boven	Phased (alternate taluds)	Bad/insufficient	No sightings
Linge kanaal	Phased (alternate taluds)	Bad/insufficient	No sightings
Maas	unknown	Bad/insufficient	No sightings
Maas-Waalkanaal	unknown	Bad/insufficient	No sightings
Neder-rijn	unknown	Bad/insufficient	No sightings
Pannerdensch kanaal	unknown	Bad/insufficient	No sightings
Waal	unknown	Bad/insufficient	No sightings
Rijn en IJssel			
Baakse Beek	Phased (alternate taluds)	Sufficient	No sightings
Beneden Slinge	Phased (alternate taluds)	Insufficient	No sightings
Berkel	Phased (alternate taluds)	Sufficient	Pioneering
Bielheimerbeek	Phased (alternate taluds)	Sufficient	Pioneering
Bolsbeek	Phased (alternate taluds)	Insufficient	No sightings
Boven Slinge	Not necessary	Insufficient/Sufficient	Pioneering
Buurserbeek	Phased (alternate taluds)	Insufficient	Pioneering
De Slingeplas	unknown	Bad	No sightings
Groenlose Slinge	Phased (alternate taluds)	Insufficient/Sufficient	No sightings
Groote Beek	Phased (alternate taluds)	Insufficient/Sufficient	No sightings
Hambroekplas	Phased (alternate taluds)	Insufficient	No sightings
IJssel	unknown	Bad/insufficient	Stepping Stone
Keizerbeek	Phased (alternate taluds)	Insufficient	No sightings

Millingerwaard	Throughout the year	Sufficient/Good	Potential Core Area
Ooijpolder	Throughout the year	Sufficient/Good	Potential Core Area
Oosterwijkse vloed	Phased (alternate taluds)	Insufficient	No sightings
Oude IJssel	Unclear	Good	Developing Core Area
Ratumse Beek	Phased (alternate taluds)	Insufficient/Sufficient	No sightings
(Oude) Rijnstrangen	Throughout the year	Excellent	Developing Core Area
Slinge (Meibeek en Gracht)	Phased (alternate taluds)	Sufficient	No sightings
Valeplas, Gieseplas, Lathumse plas	Unclear	Insufficient	Potential Core Area
Veengoot	Phased (alternate taluds)	Insufficient/Sufficient	No sightings
Waalse Water	Phased (alternative taluds)	Excellent	Developing Core Area
Vallei en Veluwe			
Apeldoornsch Kanaal	Extensive (>2020*)	Good	Corridor
Barneveldse Beek	Extensive (>2020*)	Insufficient/Sufficient	No sightings
Bottenstrank	Extensive (>2020*)	Sufficient	Pioneering
Bussloo	Not necessary	Sufficient/Good	No sightings
Drontermeer	unknown	Good	Corridor
Fliert	Extensive (>2020*)	Bad	No sightings
Hierdense Beek (+ Leuvenumsebeek, staverdensebeek)	Extensive (>2020*)	Sufficient	No sightings
Kievitsveld	Extensive (>2020*)	Sufficient/Good	No sightings
Veluwemeer en Wolderwijd	unknown	Insufficient/Sufficient	Stepping stone
Voorsterbeek	Extensive (>2020*)	Bad/Insufficient	Pioneering

Conclusion for Gelderland:

1. Compared to the other provinces, the situation was relatively bad in Gelderland in 1988. The four main rivers Meuse, Waal, (Neder)Rhine, and IJssel were designed to drain excessive water but not to store it. There was a high density of highways and bankside quality had deteriorated.
2. The situation improved when projects were launched to redesign the water bodies in Gelderland. Project Room for the River (RftR) has redesigned flood plains around the four main rivers, while WFD has redesigned the banksides of smaller creeks and rivers. Water Board Rivierenland (>2019) and Vallei And Veluwe (>2020) applies an extensive mowing policy at which they skip one bankside until next year. Water Rijn And IJssel (>2019) applies a phased mowing policy. For each Water Board, it depends on the size of the water body whether vegetation can be skipped.
3. The largest subpopulations in Gelderland are currently in the Oude Rijnstrangen (Gelderse Poort) and the Oude IJssel. Spraints are occasionally found near the IJssel, Apeldoornsch Kanaal, Bottenstrank, and Voorsterbeek. Since 2020, no spraints were found anymore in the Millingerwaard and the Ooijpolder. The first otters are sighted in the Berkel near the German border, since 2020. The monitoring of otters is limited to a few areas, giving an unclear view of the distribution in the rest of Gelderland.
4. The seasonal variation of water level (e.g., flood plains and creeks drying up in summer while flood plains are flooded during winter) and the high level of human disturbances such as on the four main rivers may limit the growth of subpopulations and the distribution of otters in Gelderland the most. Water Boards changed to a promising mowing policy recently of which the effect might not yet be seen.

Recommendations for Gelderland:

- I recommend monitoring occasionally in pioneering areas. For example, there is no clear view of where otters go when they move away from the Gelderse Poort to surrounding areas. I recommend to occasionally monitor in those surrounding areas as well.
- The four main rivers Meuse, Waal, (Neder)Rhine, and IJssel could become important corridors, instead of stepping stones, when a sufficient number of resting areas are provided. The flood plains are limited by the seasonal variation in water level and project Stroomlijn. I recommend creating alternative resting areas such as in polders nearby or by appointing resting areas as is being done for birds in Overijssel.

Conclusion

In 1988, the condition of the Dutch wetlands had deteriorated: many water bodies were canalized or straightened, and most riparian vegetation had disappeared or was mowed intensively. The condition of the previous otter habitat was relatively better in the provinces Fryslân and Drenthe because these two provinces still had their cohesive network of water bodies with a low level of human disturbances.
Since 1988, many organisations have improved the Dutch wetlands in terms of creating new nature with fresh water bodies, eco-friendly banksides, and/or riparian vegetation. New lakes were created in amongst other the provinces Groningen and Gelderland. Flood plains were created or redesigned near rivers such as the IJssel and the (Neder)Rhine as part of the project Room for the River (RftR). Smaller rivers were redesigned (e.g., meanders, eco-friendly banksides, riparian vegetation) as part of the Water Framework Directive (WFD) and the Nature Network Netherlands (NNN). Compared to the Water Boards in the east, the Water Boards in the north were relatively earlier in changing to an ecological mowing policy:

Table 13 An overview of applied mowing policies by the different Water Boards in the north and east of the Netherlands.

Water Boards	Year of changing its mowing policy	Current mowing policy (in general)
Fryslân	<2010	Mow when necessary, approximately every five years
Hunze And Aas	2013	Extensive mowing policy on 1 bankside each year
Noorderzijlvest	2014	Extensive mowing policy on 1 bankside each year
Vechtstromen	~2019	Extensive, phased, and differentiated mowing policy on both banksides each year
Drents Overijsselse Delta	2019	Extensive mowing policy on both banksides each year
Rijn And IJssel	2019	Phased mowing policy each year
Rivierenland	2019	Extensive mowing policy on 1 bankside each year
Vallei And Veluwe	2020	Extensive mowing policy on 1 bankside each year

For some large water bodies, it may not be possible to increase the quantity of riparian vegetation due to drainage or infrastructural purposes. Subpopulations near water bodies such as the Overijsselse Vecht, Reest, and Regge experience the disappearance of resting areas during winter, causing migration further land inwards in search for new resting areas. This may in turn increase the number of traffic victims during winter.
Otters are now distributed throughout the provinces Fryslân and Drenthe due to their cohesive networks of water bodies with a low level of disturbances. Otters have distributed in the province of Groningen mostly in the west near water bodies such as Reitdiep, Aduarderdiep, and Zuidelijk Westerkwartier. Rivers such as the IJssel, Zwarte Water, Overijsselse Vecht, Regge, and Dinkel play an important role in the distribution of the otter in the province of Overijssel. Most otters in the province Gelderland are currently distributed near the IJssel, the Oude IJssel, and the Gelderse Poort.
In terms of bankside quality and the presence of fresh water bodies, the otter distribution and population growth seem to be limited by the (seasonal) absence of riparian vegetation, the absence of eco-friendly banksides, and seasonal variation in water level (e.g., flooded flood plains and creeks that dried up).
A clear view on the distribution is in some areas limited (e.g., east of the provinces of Groningen and Gelderland) because most volunteers monitor in areas that are already populated by otters.

Provinces differ in what has been achieved so far to improve the Dutch wetlands by the following: The provinces Fryslân and Drenthe have a cohesive network of water bodies that provides more different routes to reach new areas compared to water bodies in provinces such as Groningen, Overijssel, and Gelderland. Projects such as Room for the Vecht may have had a huge effect on being able to migrate towards the east of Overijssel, while improving one water body in Fryslân may have had a relatively smaller effect on the overall distribution in Fryslân. Compared to the other Water Boards, the ones in the provinces Fryslân and Groningen started relatively early in changing to a mowing policy with vegetation throughout the year. There are still some important rivers (e.g., Reest and Overijsselse Vecht) that do not have vegetation throughout the year which limits the connection seasonally. Lastly, whether organisations could improve water bodies also depended on the main function of the water body. The distribution of otters in Gelderland depends on large rivers used for drainage and infrastructural purposes, while the province Drenthe also contains a river system that is not used for shipping.

Recommendations

The metapopulation of otters will continue to grow and distribute in the Netherlands as nature is defragmented as part of among others the NNN. I recommend reassessing current mowing policies to strengthening the connection between different subpopulations. Increasing the quantity of riparian vegetation near water bodies also reduces the (seasonal) migration of otters searching for alternative resting areas further land inwards. This will in turn reduce the number of traffic victims as well.
For some large water bodies, it may not be possible to increase the quantity of riparian vegetation due to drainage or infrastructural purposes. I recommend creating alternative resting areas in, for example, the polders nearby. By creating alternative resting areas ourselves, we can redirect the otters away from areas with a high density of highways.
Lastly, most volunteers are monitoring areas known to be populated by otters. This provides important information each year on whether otters still inhabit the area. However, this provides little information on whether the total distribution of otters in the Netherlands has increased compared to the year before. Therefore, I also recommend occasionally searching for spraints in pioneering areas: the thought to be uninhabited areas adjacent to populated areas.

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Figures:

Figure 1: Dutch Mammal Society, https://www.zoogdiervereniging.nl/nieuws/2021/de-otter-gaat-het-jaar-van-de-otter-als-levensvatbare-populatie

Figure 2-4: Created by Martin Brussaard

Figure 5-7: Pictures obtained from Johann Prescher, forest guard of Natuurmonumenten in the Wieden

Figure 8: Obtained from Ellen van Norren

Figure 9: Vries, L. P. de. (2002). *Natuurontwikkeling in Nederland in kaart gebracht* (Ser. Rivm rapport, 408764002). RIVM. http://www.rivm.nl/bibliotheek/rapporten/408764002.pdf.

Figure 10: Natuurnetwerk Nederland (2027). (2017). Retrieved 26 May 2021, from https://themasites.pbl.nl/balans-leefomgeving/indicatoren/nl002755-natuurnetwerk-nederland-2027/

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Figure 13: Website province Fryslân: https://www.Fryslân.frl/home/kaarten_3208/item/planologische-ecologische-hoofdstructuur-kaart-planologische-EMS_736.html https://Fryslân.maps.arcgis.com/home/webmap/viewer.html?webmap=eb4e12aa6eea4591af7c0f48ef6def54&extent=120990,533762,221778,617075,28992

Figure 14: Eva Ruiters, (Water Board Fryslân)

Figure 15: Website province Groningen: https://groningen.tercera-ro.nl/MapViewer/Default.aspx?id=NLIMRO9920omgvisiegeconsol-GV03

Figure 16: Picture obtained from Jacob de Bruin en Nico Altena, Natuurmonumenten 2020 but edited: https://www.klimaatbuffers.nl/uploads/sessie-1-onlanden-als-klimaatbuffer-versie-04032020-gecomprimeerd.388c5b.pdf

Figure 17: Website province of Drenthe: https://geo.drenthe.nl/geoportaal/src/?lang=nl&topic=portaal&bgLayer=openbasiskaart.nl&layers=GBI.FO_MASK_DR_NL,GBI.NAT_FAUNAKNELPT_P

Figure 18: Website province of Overijssel: https://www.geoportaalOverijssel.nl/metadata/dataset/e32ecb1c-a023-4db7-b2d0-f889ee6fac46 https://services.geodataOverijssel.nl/viewer/layer/B46_natuur_en_landschap/B46_Natuurnetwerk_Nederland

Figure 19: Website province of Gelderland: https://gelderland.maps.arcgis.com/apps/opsdashboard/index.html#/c7b302b57c1b4ba4861cf95ca71eefa4

Appendix 1: Keywords used to describe the condition of water bodies.

Keywords	Description	
Being monitored	Whether information is obtained yearly by, for example, volunteers to map the current distribution of otters. Information is mostly obtained from regional otter coordinators.	
Spraints found (since)	Whether spraints (the dung of an otter) are found. Spraints are a sign of long-term residency and distinguishes *pioneers* from long-term residents. If possible, the year that the first spraint was found is given as well. Information is mostly obtained from regional otter coordinators, Otterportaal (private data base of Dutch Mammal Society), Waarneming.nl (public data base), or interviews.	
Population size	The number of confirmed otters settled in this water body. Some water bodies share the same otters as they are part of the same territory, which will then be pointed out. Information is obtained mostly from either Kuiters *et al.* (2020), private files from the Dutch Mammal Society, or interviews.	
Confirmed offspring (since)	Whether offspring is confirmed by observations. Confirmed offspring are a sign of a (developing) core area as habitat requirements seem to be met. If possible, the year that the first offspring was confirmed is given as well. Information is obtained from regional otter coordinators, news articles, and interviews.	
Existing bottlenecks	Existing traffic bottlenecks which are not solved yet. Information is obtained from Kuiters *et al.* 2020.	
Habitat function	Habitat function is an indicator for the expected level of disturbance. Water bodies are categorized from disturbed to undisturbed: City, Infrastructure, Polder, Nature, and Nature Reserve.	
Ecological status of water body (GEP)	the state where there are slight changes in the values of the relevant biological quality elements as compared to the values found at Maximum Ecological Potential (MEP)" and "by selecting the mitigation measures necessary for achieving MEP and taking into account their practicability and realization" (Kampa & Hansen (2004).	
Mowing Policy	The method that is applied to mow the (aquatic and) riparian vegetation near the waterbody. Information is obtained from Water Boards, provincial authorities, and nature organisations. The following methods are distinguished:	
	Present throughout the year	Although it may not be known which method is applied, it is certain that vegetation can provide shelter for otters throughout the year.
	Not necessary	Vegetation does not have to be maintained regularly as succession may not be a concern and is usually present throughout the year. Vegetation in forest areas, which is not reed, is an example of this.
	Grazing	The vegetation in some nature areas is maintained by grazing of cattle: usually present throughout the year
	Phased	The vegetation is mowed in phases, intending to keep a part (usually one bankside with vegetation present throughout the year. During the next mowing round the parts are switched.
	Extensive	Vegetation is, compared to intensive, mowed less frequently. Vegetation is often not mowed during spring/summer (>50% remains), while most of it is mowed during fall/winter (<25% remains). Especially during fall/winter, the shortage of resting areas may become a risk as there may be insufficient vegetation left to provide shelter.
	Intensive	Vegetation is mowed regularly for drainage purposes. This is often applied in small creeks which are in general, not favourable for otters.
	No vegetation	There is hardly to no vegetation present. A certain mowing policy does not have to be applied.
Bankside quality	My personal estimation whether the existing vegetation is sufficient to meet the requirements of providing shelter/resting areas for otters. Information is obtained mostly from interviews but also from street view (Google Maps) and a few fieldtrips. I categorized bankside quality as followed:	
	Excellent	Eco-friendly banksides which are almost completely covered in vegetation, providing shelter. The vegetation is present throughout the year because of the management in, for example, nature areas
	Good	Eco-friendly banksides with many large patches of vegetation which can provide enough shelter to otters. Vegetation is often present throughout the year.
	Sufficient	Eco-friendly banksides with occasionally some patches of vegetation or banksides that are very narrow.
	Insufficient	Water bodies that either have fragmented eco-friendly banksides due to urbanized areas, or just a few vegetation patches.
	Bad	Vegetation is hardly to not present. The water body contains a lot of sheet piles due to its urbanized location or its function for infrastructure.
Estimated Habitat Type	My personal estimation of the water body's function based on the keywords described above.	
	Core Area (CA)	An area in which otters can rest, eat, and produce offspring permanently without depending on surrounding subpopulations for their survival. Genetic diversity is not taken into account.

Developing Core Area (DCA)	An area in which otters can rest, eat, and produce offspring permanently but depends on surrounding subpopulations for their survival. Genetic diversity is not taken into account.
Potential Core Area (PCA)	An area that might become a Developing Core Area (DCA) once the first otters have reproduced. This may happen after a limiting factor has been resolved such traffic bottlenecks or food availability. Genetic diversity is not taken into account.
Corridor	An area with sufficient otter habitat. It enables migration from one CA/DCA/PCA to another CA/DCA/PCA. The corridor itself has become part of the otter's habitat (e.g., spraints) but does not function as an area to produce offspring due to characteristics such as bankside quality or existing traffic bottlenecks.
Stepping Stone	An area with insufficient otter habitat. It enables limited migration from one CA/DCA/PCA to another CA/DCA/PCA. Stepping stones are, for example, just a few habitat patches in an unsuitable landscape. It is debatable whether this area is part of the otter's habitat. Habitat improvements can transform stepping stones into corridors to strengthen connectivity.
Pioneering	An area in which the first otters are sighted but it is not clear yet whether they have settled. Pioneering areas are located adjacent to known otter habitat.

Appendix 2: Improvements in Fryslân:

Naam Waterlichaam	Jaar van verbetering of afronding	Grootte van het project	Omschrijving
Alde Feanen			
	2009-2012	Onbekend	Vernatting van rietpercelen
	2009-2012	Onbekend	Aanleg NVO's, verruimming hoofdvaarten
	2009-2012	Onbekend	Verhoging waterpeil (Bolderen),
	2010-2011	6x	Zes otters uitgezet (verweest of uit Oost-Europa)
	2007	48 ha	Uitbreiding Alde Feanen in het kader van een LIFE-project ten behoeve van o.a. de noordse woelmuis.
	2014	400 ha	Herinrichting natuur: creëren van moerasgebied, verbreden van vaarwegen
	2017	Onbekend	Aanleg van ondiepe luwe zones in het meer
	>2021	1x	Zie De Deelen
	2021	Onbekend	Aanleg NVO (vegetatie onbekend)
Braandemeer (Weststellingwerf)			
	1996-2000	Onbekend	Herstel van de kenmerkende laagveenbiotopen
Brandemeer			
Broeresloot of Vierhuistervaart			
	2020	Onbekend	Aanleg rietoevers
Burgumermeer, de Leijen, Wilde Le			
	?		Aanleg NVO (vegetatie onbekend)
	2022	Onbekend	Wilde Le: aanleg NVO's met riet
	2021	940m	Het project aanleg WFD-oevers boezemkanalen: natuurvriendelijke oevers in de Lits, ten zuiden van Bergumermeer
	2021	1970m	Het project aanleg WFD-oevers boezemkanalen: natuurvriendelijke oevers in het Stoppensoal
De Delen			
	>2021	1x	Verbinding (corridor) tussen Alde Feanen en De Deelen, deel van NNN
Dokkummer Ee/Dokkummergrootdiep			
	2019	Onbekend	Aanleg Rietoevers
Easterskar, Oranjewoud & Nannewijd			
	2016	Onbekend	Extra petgaten gegraven om het verdroge Easterskar van nieuw water te voorzien.
	2019	2 km	Ecologische verbinding tussen Tsjonger en Easterskar, strook van 2 km waardoor Easterskar van nieuw water wordt voorzien
	2021	Onbekend	Verbreden watergangen in Foarutgong polder, vlakbij Nannewiid
Fluessen			
	<2004	Onbekend	Aanleg NVO (vegetatie onbekend)
	2008	Onbekend	Aanleg NVO (vegetatie onbekend)
	2014	Onbekend	Aanleg NVO (vegetatie onbekend)
	2020	Onbekend	Aanleg van ondiepe luwe zones in het meer
	2021	Onbekend	Workumer Nieuwland: verbreden van twee sloten in polder
	2022	Onbekend	Skutepoel: aanleg van NVO's voor groei vegetatie (riet)
Fochteloërveen			
	2017	Onbekend	Verbreden van watergangen
	2020	Onbekend	Verbreden van watergangen
Follegasloot			
	2008	108 ha	Zie Groote Brekken

	2018	Onbekend	Aanleg NVO (vegetatie onbekend)
Franekervaart			
	2006	Onbekend	Aanleg NVO (vegetatie onbekend)
Groote Brekken			
	2008	108 ha	Aankoop van agrarisch land voor nieuw natuurgebied
	2022	Onbekend	Groote brekken: eco-friendly banksides to promote growth of vegetation (reed)
Groote Wielen, Houtwiel & de Rijd			
	2014	Onbekend	Aanleg rietoevers
	2017	Onbekend	Aanleg NVO (vegetatie onbekend)
	2019	Onbekend	Aanleg NVO (vegetatie onbekend)
	2021	Onbekend	Verbreden van sloten in polder Hemriksein Zwerver
	2022	Onbekend	Aanleg rietoevers in Ryptsjerksterfeart
	2022	Onbekend	Aanleg Rietovers en vergroten oppervlakte in Nieuwe Wielen
	2024	Onbekend	Aanleg Rietoevers in het zuiden van Leeuwarden
	2002-2017	~337 ha	Landschapsherinrichting van het Butefjild
Harlingen			
	?-2022	Onbekend	Gebiedsontwikkeling in het Franeker-Harlingen gebied met onder andere NVO's.
	2017	Onbekend	Aanplanten van riet op oevers vlakbij Harlingen
Het Nieuwe Diep			
	>2021	1x	Ecologische verbinding als deel van NNN tussen Groote Wielen en Alde Feanen
	2021	Onbekend	Offerhaus: verbreden van sloten ten oosten van Alde Feanen
IJsselmeer			
	2019	25 ha	Gebied Gaasterlan ingericht voor natuurontwikkeling met NVO's
It Deel-Heerenveense Kanaal			
	2013	Onbekend	Aanleg NVO (vegetatie onbekend)
	2017	Onbekend	Aanleg NVO (vegetatie onbekend)
	2019	Onbekend	Aanleg NVO (vegetatie onbekend)
Johan Frisokanaal			
	2006	Onbekend	Aanleg rietoever
	2017	Onbekend	Aanleg NVO (vegetatie onbekend)
Jongkers of Holemavaart			
	2014	Onbekend	Aanleg NVO met vegetatie
Kuikhoorstervaart, Nieuwe Zwemmer, Dokkemer Diep			
	2006	Onbekend	Aanleg rietoevers
	2017	Onbekend	Aanleg NVO (vegetatie onbekend)
	2021	1640m	Het project aanleg WFD-oevers boezemkanalen: natuurvriendelijke oevers: Kuikhoorstnervaart
	2021	1700m	Het project aanleg WFD-oevers boezemkanalen: natuurvriendelijke oevers: Nieuwe Zwemmer
Kuinder of Tsjonger			
	2006	Onbekend	Aanleggen van beken (meanders, nevengeulen en by-passes
	2014	Onbekend	Aanleggen van beken (meanders, nevengeulen en by-passes
	2015	Onbekend	Aanleg NVO (vegetatie onbekend)
	2020	Onbekend	Aanleggen van beken (meanders, nevengeulen en by-passes
	2021	190m	Het project aanleg WFD-oevers boezemkanalen: in een vaart vlakbij ter Idzard
	2021	2090m	Het project aanleg WFD-oevers boezemkanalen

Lauwersmeer			
	2020	Onbekend	Rietproef: waterpeil tijdelijk met 40 cm verhoogd om de groei van riet te bevorderen en gaat proces van successie tegen. Voor 6 weken, 2 jaar lang, plan ontstaan in 2017
	2022-2027	45 km	Beschermen van vegetatie (riet) op oevers door begrazing van koeien
Lindevallei			
	2006	Onbekend	Aanleg NVO (vegetatie onbekend)
	2011	Onbekend	Aanleggen van beken (meanders, nevengeulen en by-passes
	2012	Onbekend	Aanleg NVO (vegetatie onbekend)
	2014-2016	Onbekend	Landschapsherinrichting: verhoging waterpeil en terugbrengen van meanders.
	2016	Onbekend	Aanleg NVO (vegetatie onbekend)
	2018	Onbekend	Het park 'De Nieuwe Aanleg' opgeknapt voor meer berging van water
	2021	Onbekend	Landschapsherinrichting: terugbrengen van meaners.
	2021	Onbekend	Linde, bij Et Wiede: aanleg van NVO's d.m.v. oeverpalen
	2021	3070m	Het project aanleg WFD-oevers boezemkanalen.
	>2021	1x	Verbinding (corridor) vlakbij De Merriemaden (tussen Driewegsluits en De Linde) als onderdeel van NNN.
	<2027	650 ha	Hermeandering van de Lindevallei.
Moark			
	2006	Onbekend	Aanleg NVO (vegetatie onbekend)
	2019	Onbekend	Aanleg NVO (vegetatie onbekend)
Ouddiep			
	2015-2020	199 ha	Dulf-Mersken: Herinrichten van natuur door waterpeil verhoging, aanleggen kades
	2004-2023	500 ha	Koningsdiep: Natuurontwikkeling voor het NNN
	2021	510m	Het project aanleg WFD-oevers boezemkanalen: natuurvriendelijke oevers in het Stoppensoal
Pikmeer, Wilde Le, Sitebuurder Lee			
	2018	2300 ha	Landbouwgebied herinrichten voor landbouw, natuur en recreatie.
Prinses Margriet canal			
	2014-2027	752 ha	Herinrichting van Achtkarspelen-Zuid van het project 'De Mieden op zijn mooist' voor het NNN
	2019	Onbekend	Gebiedsontwikkeling: Twizelermieden: waterhuishouding, natuurontwikkeling
Rottige Meenthe			
	1996-2000	Onbekend	Herstel van de kenmerkende laagveenbiotopen
	2004-2007	Onbekend	Uitzetten van otters
	2006	Onbekend	Aanleg rietoevers
	2016	Onbekend	Aanleg NVO (vegetatie onbekend)
	2020	Onbekend	Aanleg rietoevers
Scharster of Nieuwe Rijn			
Slotermeer			
	2006	Onbekend	Aanleg NVO met vegetatie in het zuidwesten. Rest van het meer is stortsteen
Sneekermeer			
	<2004	Onbekend	Aanleg NVO (vegetatie onbekend)
	2015	Onbekend	Aanleg van ondiepe luwe zones in het meer
	2018	Onbekend	Aanleg van ondiepe luwe zones in het meer
	2020	Onbekend	Aanleg rietoever
	2022	3x	De Geau (west Sneek): aanleg van NVO's voor groei vegetatie (riet)

Stroomkanaal en Sylroede			
	2021	Onbekend	Het project “Aanleg WFD-oevers boezemkanalen
Tjeukemeer			
	2012	Onbekend	Aanleg NVO (vegetatie onbekend)
Van Harinxmakanaal			
	?	Onbekend	Verbreden watergangen en aanleg NVO's in de gebieden om het Van Harinxmakanaal
	2021	3390m	Het project aanleg WFD-oevers boezemkanalen: aanleg NVO's met riet
Van Oordt's Mersken			
Willaerts of Bolswardertrekvaart/Snekervaart			
	2017	268 ha	Baarderadeel: Herinrichten van landbouwgrond tot natuur en recreatie
Witte & Zwarte Brekken, Langwalder Wielen, Koevordermeer en Aldhof			
	<2004	Onbekend	Aanleg NVO (vegetatie onbekend)
	2010	Onbekend	Aanleg NVO (vegetatie onbekend)
	2018	Onbekend	Aanleg van ondiepe luwe zones in het meer
	2020	Onbekend	Aanleg van ondiepe luwe zones in het meer
Workumer Trekvaart			
Zuider Ee			
	2017	Onbekend	aanleg NVO (vegetatie onbekend)

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Appendix 3: Distribution of the otter in Fryslân.

Water body	Being monitored	Spraints found (since)	Population size	Offspring confirmed (since)
Alde Feanen	Yes	2008	11-15	~2009
Bergumermeer, de Leijen, Wilde Le	Yes	2009	~5	Yes
Braandemeer (Weststellingwerf)	Yes	2006	7 (RM + B)	~2008
Brandemeer	Yes	2010	4 (GB + brandermeer)	Yes
Broeresloot of Vierhuistervaart	Yes	2006	None	None
De Delen	Yes	2008	2-3	<2015
De Moark	Yes	2015	Unclear	None
Dokkummer Ee/Dokkummergrootdiep	Yes	2017	>1	Yes
Eagumerdjip en Wergeasterfeart	Yes	2016	None	None
Easterskar, Oranjewoud & Nannewijd	Yes	2002	6-8	Yes
Fluessen	Yes	2012	5-7	Yes
Fochteloërveen	Yes	2014	4-6	~2016
Folegasloot	Yes	2011	Part GB + brandermeer	~2011
Franekervaart	Yes	2018	Unclear	None
Groote Brekken	Yes	2010	4 (GB + brandermeer)	Yes
Groote Wielen, Houtwiel & De Rijd	Yes	2014	4-6	Yes
Harlingen	Yes	2012	Unclear	None
IJsselmeer	Yes	2011	1-2	Yes
It Deel - Heerenveensekanaal	Yes	2012	Unclear	None
Johan Frisokanaal	Yes	2014	Unclear	Yes
Jonkers of Holemavaart	Yes	2011	1	Yes
Kuikhornstervaart, Nieuwe Zwemmer, Dokkemer Diep	Yes	2015	Unclear	None
Kuinder of Tsjonger	Yes	2010	Unclear	~2010
Lauwersmeer	Yes	2012	3-4	<2016
Lindevallei	Yes	2007	4-11	~2008
Nieuwe Diep	Yes	2016	2-3	None
Ouddiep	Yes	2008	5-7	None
Prinses Margrietkanaal	Yes	2017	Unclear	None
Rottige Meenthe	Yes	2006	7 (RM + B)	~2008
Scharster of Nieuwe Rijn	Yes	2011	4-5	None
Slotermeer	Yes	2012	Unclear	Unclear
Sneekermeer	Yes	2011	3-4	Yes
Stroomkanaal en Sylroede	Yes	2014	Part of IJsselmeer	Yes
Tjeukemeer	Yes	2014	Unclear (>2)	~2014
Van Harinxmakanaal	Yes	2019	Unclear	None
Van Oordt's Mersken	Yes	2007	3-5	Yes
Willaerts of Bolswardertrekvaart/ Snekervaart	Yes	2018	3	None
Witte & Zwarte Brekken, Langweelder Wielen, Koevordermeer en Aldhof	Yes	2011	2-3	Yes
Workumer Trekvaart	Yes	2017	3	Yes
Zuider Ee	Yes	2015	Unclear	None

Appendix 4: Condition of remaining three factors affecting the otter population in Fryslân.

Condition of three factors affecting the otter population: traffic accidents visualized as currently existing bottlenecks, level of disturbance visualized by habitat function, and food availability visualized as GEP, the ecological status of fish populations.

Water body	Existing traffic bottlenecks	Habitat function	Ecological status of the water body (GEP)
Alde Feanen	No	Nature reserve	Mediocre (2009), Good/GEP (2010-2013), Insufficient (2018)
Bergumermeer, de Leijen, Wilde Le	A31 (Drachten-Leeuwarden)	Nature	Bad (de Leijen 2015), Moderate (Bergumermeer 2018)
Braandemeer (Weststellingwerf)	No	Nature reserve	Mediocre (2009), Good/GEP (2010-2013)
Brandemeer	No	Nature	unknown
Broeresloot of Vierhuistervaart	No	Infrastructure	unknown
De Delen	A32 (Heerenveen-Grou)	Nature reserve	Mediocre (2009), Good/GEP (2010-2013), Good/GEP (2015)
De Moark	No	Polder	unknown
Dokkummer Ee/Dokkummergrootdiep	No	Polder	unknown
Eagumerdjip en Wergeasterfeart	No	Polder	unknown
Easterskar, Oranjewoud & Nannewijd	A7 (Heerenveen-Joure)	Nature reserve	Mediocre (2009 Easterkarr), Good/GEP (2010-2013 Easterkarr), Good/GEP (2015 nannewiid)
Fluessen/Fluezen en omgeving	No	Nature/Infrastructure	Bad (2015, 2018)
Fochteloërveen	No	Nature reserve	unknown
Folegasloot	No	Infrastructure/Polder	unknown
Franekervaart	No	Polder	unknown
Groote Brekken	No	Nature/Infrastructure	unknown
Groote Wielen, Houtwiel & De Rijd	No	Nature reserve	Insufficient (GrWi 2018
Harlingen	N31 (ten zuiden van Harlingen)	City	unknown
Het nieuwe diep	No	Polder	unknown
IJsselmeer	No	Nature/Infrastructure	Mediocre (2012-2014, Good/GEP (2015-2016)
It Deel - Heerenveensekanaal	2012-2019	Nature/Polder	unknown
Johan Frisokanaal	No	Infrastructure	unknown
Jonkers of Holemavaart	No	Nature/Polder	unknown
Kuikhornstervaart, Nieuwe Zwemmer, Dokkemer Diep	No	Polder	unknown
Kuinder of Tsjonger	A32 (Wolvega_Heerenveen)	Nature	Mediocre (2009), Bad (2015-2021)
Lauwersmeergebied	No	Nature reserve	unknown
Lindevallei	No	Nature	Mediocre (2009), Good/GEP (2010-2013), Bad (2015-2019),
Ouddiep	A7 (Klaverblad Heerenveen-klaverblad Drachten)	Polder	Bad (2015)
Prinses Margriet canal	A31 (Drachten-Leeuwarden)	Infrastructure	Mediocre (2015)
Rottige Meenthe	N351 (Rottige meenthe-Wolvega)	Nature reserve	Mediocre (2009), Good/GEP (2010-2013)
Scharster of Nieuwe Rijn	No	Infrastructure/ Polder	unknown
Slotermeer	No	Nature/Infrastructure	Bad (2015)
Sneekermeer	A32 (Heerenveen-Grou), A7 (Sneek-Joure)	Nature/ Infrastructure	Insufficient (2015), Bad (2018)

Stroomkanaal en Sylroede	No	Infrastructure	unknown
Tjeukemeer	No	Nature/Infrastructure	Bad (2018)
Van Harinxmakanaal	No	Infrastructure	unknown
Van Oordt's Mersken	No	Nature reserve	unknown
Willaerts of Bolswardertreklvaart/ Snekervaart	No	Polder	unknown
Witte & Zwarte Brekken, Langweelder Wielen, Koevordermeer en Aldhof	A7 -Sneek-Joure)	Nature	Insufficient (2015, 2018)
Workumer Trekvaart	No	Polder	unknown
Zuider Ee	No	Polder	unknown

Appendix 5: Improvements in Groningen.

Naam waterlichaam	Jaar van verbetering of afronding	Grootte van het project	Omschrijving
Aduarderdiep			
	2009-2015	18.7 km	Aanleg NVO's buiten EMS + 1 vispassage
	2009-2015	2.7 km	Natuurvriendelijke rechteroever
	2009-2015	9.0 km	Aanleg NVO binnen EMS
	2016-2021	2.5 km	Herinrichten van oevers in het Aduarderdiep/Hoendiep gebied
	2016-2021	3 km	Landschapsherinrichting van oevers in Aduarderdiep/Hoendiep gebied. Onduidelijk waar, project was uitgesteld in 2009-2015
	2022-2027	0.3 km	Aanleg NVO's, FUP's in het Aduarderdiep/Hoendiep gebied
	2020	9 km*	Aanleg van NVO's
B L Tijdens canal			
	2020	9 km*	Aanleg van NVO's in Nauwe Diep, vlakbij stadskanaal
	2020-2021	Onbekend	Aanleg van NVO's (onderdeel van het Westerwolde-Eems project) voor internationale corridor
Boterdiep			
	see Winsumerdiep		
Damsterdiep			
	2009-2015	4 km	Aanleg NVO's in damsterdiep + 1x vispassage
	2010-2015	7.8 km	Aanleg van NVO's in Damsterdiep
	2010-2015	1.7 km. Width of 6 m	Aanleg van NVO's in Groote Heekt, zijrivier van Damsterdiep
	2010-2015	0.6 km. Width of 6 m	Aanleg van NVO's in Uitwierdermaar, zijtak van Damsterdiep
	2010-2015	1.3 km. Width of 6 m	Aanleg van NVO's in verbindingskanaal (Groeve Noord?), zijtak damsterdiep
	2013	11.4 km	Ter hoogte van Garmerwolde, zuidoever van Damsterdiep: aanleg NVO's
	2016-2021	1.2 km	Landschapsherinrichting zoals NVO's in Eemsgebied (Damsterdiep). Onduidelijk waar
	2022-2027	1.3 km	Aanleg NVO's, FUP's en het verbreden van watergangen
Dwarsdiep			
	2010-2015	25 ha	Aanleg moerasachtig gebied
	2010-2015	1.5 km	Aanleg van moerasachtige oevers in Dwarsdiep
	2010-2015	1x	Herstellen natuurlijke functie van de beek
	2022-2027	6.1 km	Landschapsherinrichting (meanders) in Dwarsdiep
	2022-2027	9.4 km	Verbetering maaibeleid: vegetatie op oevers blijft terwijl alleen de stroomdraad wordt gemaaid

			Vasthouden/bergen van water in Dwarsdiep
	2022-2027	50 ha	
Eemskanaal			
			NVO's bij zijtakken (Maren-DG Fivelingo) boven Eemskanaal
	2010-2015	5.6 km	
			NVO's in polders bij de kust boven het Eemskanaal
	2010-2015	2.2 km	
			NVO's bij zijtak Fiemel
	2016-2021	3.4 km	
			NVO's in polders bij de kust boven het Eemskanaal
	2016-2021	1.7 km	
			NVO's bij zijtakken (Maren-DG Fivelingo) boven Eemskanaal
	2022-2027	0.8 km	
			NVO's in polders bij de kust boven het Eemskanaal
	2022-2027	0.3 km	
Hondhalstermeer			
			Aanleg Hondhalstermeer door ruilverkaveling van Staatsbosbeheer
	1980	180 ha	
			Verbinderen van golfslag en windactiviteit door luwtes te creëren om biodiversiteit te vergroten
	2021	Onbekend	
Kommerzijlsterdiep			
	Zie Reitdiep		
Lauwersmeer			
			Beschermen van vegetatie (riet) op oevers van begrazing door koeien
	2022-2027	45 km	
			Rietproef: waterpeil tijdelijk met 40 cm verhoogd om de groei van riet te bevorderen en gaat proces van successie tegen. Voor 6 weken, 2 jaar lang, plan ontstaan in 2017
	2017-2020	Onbekend	
Matsloot & Wolddiep area			
			Aanleg van NVO's aan 1 oeverkant
	2010-2015	2 km	
			Herinrichting van oevers
	2016-2021	5 km	
			Aanleg van NVO's
	2022-2027	0.3 km	
Mussel Aa-kanaal			
			Aanleg van NVO's
	2020	9 km*	
Oldambtmeer			
			Aanleg van het Oldambtmeer
	1997-2007	800 ha	
			Project Blauwe Stad: nieuwe natuur bij Oldambtmeer
	1997-2007	350 ha	
			Aanleg van NVO's.
	2016-2021	7.5 km	
			Herinrichten van oevers in het Oldambtmeer
	<2024	1 km	
Oosterwold			
Paterwoldsemeer + Hoornsemeer (en Onlanden)			
			Aanleg NVO's, verbreden van sloten en meer vegetatie in polder Lage Wal, vlakbij Paterwoldsemeer
	2016-2019	5 ha	
			Baggeren, verdiepen van water om blauwalg te voorkomen
	2016-2022	25 ha	
			Landschap herinrichting, creëren van een moerasgebied
	2016-2022	25 ha	

Reitdiep	>2020	Onbekend	Ecologische verbinding tussen Paterswoldsemeer en De Onlanden, Leekstermeer and Zuidlaardermeer
	2009-2015	12 km	Aanleg NVO's in Reitdiep-Kommerzeildiep gebied
	2010-2015	3.7 km	Aanleg NVO's in gebied Reitdiep en Maren
	2010-2015	7.5 km	Aanleg NVO's in gebied Reitdiep en Maren buiten EMS
	2010-2015	0.1 km	Aanleg NVO's in Reitdiep-Kommerzeildiep gebied
	2016-2021	21 km	Herinrichting van oevers
	2016-2021	6 km	Aanleg NVO's in Reitdiep-Kommerzeildiep gebied
	2016-2021	4.8 km	Herinrichting landschap (meanders) in Reitdiep-Kommerzeildiep
	>2021	80 ha	Vergroten kerngebied voor vogels in Medenertilsterpolder. Kan ook als rustgebied fungeren voor otters in de NNN tussen Onlanden and Reitdiep
	2022-2027	1.2 km	Aanleg NVO's in gebied Reitdiep en Maren
	2022-2027	37.5 km	Landschapsherinrichting (meanders) of Reitdiep-Kommerzeildiep gebied
	2022-2027	0.7 km	Aanleg NVO's in Reitdiep-Kommerzeildiep gebied
Roegwold + schildmeer			
	1997-2014	1710 ha	Herstel van natuurgebied
	2016-2021	2.7 km	Aanleg NVO's in het Duurwold
	>2021	Onbekend	Aanleg NVO's in Steendam vlakbij Schildmeer
Ruiten Aa			
	1992-2021	2500 ha	Landschap herinrichting (meanders) vanwege NNN
	2021	450.000 m3	Water vasthouden in Ruiten Aa
	>2021	27 km, 3.7 km	Baggeren Ruiten Aa (37 km) and aanleg NVO's 3.7 km
Sellingerbeetse			
Stadskanaal			
Van Starkenborghkanaal	2020	9 km*	Aanleg NVO's in stadskanaal vlakbij Nauwediep
Vloeivelden bij Stadskanaal)			
Westerbroek (+ Foxholstermeer and Drentsche Diep)			
Westerwoldse Aa (+ Pekel Aa)	>2020	Onbekend	Ecologische verbinding tussen Zuidlaardermeer en 't Roegwold: creëren, verdiepen en verbreden van wateren
	1992-2020	Zie Ruiten Aa	
	2016-2021	12 km	In Westerwolde gebied: aanleg 12 km aan NVO's
	2016-2021	15 km	Beekherstel: hermeandering

	2016-2027	1.1 miljoen m3	Zoeken naar extra ruimte om water vast te houden in Westerwolde
	2020	Onbekend	Landschapsherinrichting met NVO's voor vissen
	2020	Verwijderen van obstakels	Obstakels voor vissen weggehaald tussen Westerwoldse Aa en Bargerveen
Winsumerdiep			
	2009-2015	5 km	Aanleg NVO's buiten EMS in winsumer/boterdiep gebied
	2009-2015	2.9 km	Aanleg NVO's binnen EMS in winsumer boterdiep gebied
	2010-2015	1 km	Aanleg NVO's buiten EMS
	2016-2021	7.9 km	Aanleg NVO's buiten EMS
	2016-2021	1.3 km	Herinrichting van oevers Boterdiep-Winsumerdiep gebied
	2022-2027	1.5 km	Aanleg NVO's in Boterdiep-Winsumerdiep gebied
Wintschotersdiep			
Woldmeer + Kardinge + Meerstad			
	2011	~86 ha	Aanleggen van woon- en recreatiegebied Meerstad
	>2019	~ 13 ha	Uitbreiding Woldmeer door De Zeilen uit te graven
	>2020	~ 31 ha	Uitbreiding Woldmeer door de roeibanen uit te graven
	2021	1 miljoen m3	Berging van water bij Meerstad
	2022-2027	2 km	1/6 deel van het meer wordt ingericht als NVO (2km)
	2027	0.5 miljoen m3	Berging van water bij Meerstad
Zeilplas Langebosch			
Zijdiep/De Lauwers			
Zuidelijk westerkwartier (above Onlanden)			
	2009-2015	2 km	Enkelzijdige NVO in de zuitwending
	2009-2015	13.5 km	Aanleg NVO en 3 visspassages binnen EMS in matslootgebied
	2009-2015	8.5	Aanleg NVO buiten EMS in matslootgebied
	2019-2027	2800 ha	Landschaps herinrichting (meanders, oevers) voor NNN

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Appendix 6: Distribution of the otter in Groningen.

Waterbody	Being monitored	Spraints found (since)	Population size	Offspring confirmed (since)
Aduarderdiep	Yes	2016	Unclear	None
AG Wildervanckkanaal + Veendam-Musselkanaal	Yes	Sighting	None	None
B L Tijdens canal	No	Spraint found by Freek Niewold	None	None
Boterdiep	No	No	None	None
Damsterdiep	No	No	None	None
Dwarsdiep	Yes	2015	Part of De Onlanden	None
Eemskanaal (+ surroundings north)	Yes	No	None	None
Hondhalstermeer	Yes	No	None	None
Kommerzijlsterdiep	Yes	Likely	Unclear	None
Lauwersmeer	Yes	2012	3-4	Yes
Matsloot & Wolddiep area	Yes	2015	Unclear	None
Mussel Aa-kanaal	No	No	None	None
Oldambtmeer	Yes	Sighting	None	None
Paterwoldsemeer + Hoornsemeer (en Onlanden)	Yes	2014	~5	Yes
Reitdiep	Yes	2016	Unclear	None
Roegwold + schildmeer	Yes	2020	Unclear	None
Ruiten Aa	Yes	No	None	None
Ruiten Aa kanaal	Yes	No	None	None
Sellingerbeetse	No	No	None	None
Stadskanaal	No	No	None	None
Van Starkenborghkanaal	Yes	2017	None	None
Vloeivelden near Stadskanaal	No	No	None	None
Westerbroek (+ Foxholstermeer and Drentsche Diep)	Yes	2012	Part of Zuidlaardermeer	Yes
Westerwoldse Aa (+Pekel Aa)	Yes	Sighting	None	None
Winsumerdiep	No	No	None	None
Wintschotersdiep	Yes	Sighting	None	None
Woldmeer + Kardinge + Meerstad	No	Sighting	None	None
Zeilplas Langebosch (Veendam)	No	2021	None	None
Zijdiep/De Lauwers	Yes	2013	None	None
Zuidelijk westerkwartier (e.g. Oosterwold) (above Onlanden)	Yes	2013	Part of De Onlanden	2020

Appendix 7: Condition of remaining three factors affecting the otter population in Groningen.

Waterbody	Existing traffic bottlenecks	Habitat function	Ecological status of the water body (GEP)
Aduarderdiep	No	Polder (NNN)	Insufficient (2009), Good/GEP (2014,2017), but declining
AG Wildervanck canal + Veendam-Mussel canal	No	Infrastructure	Good/GEP (2017)
B L Tijdens canal	No	Infrastructure	unknown
Boterdiep	No	Polder/Infrastructure	Mediocre (2009-2016)
Damsterdiep	No	Polder	Mediocre (2008-2017)
Dwarsdiep	No	Polder (NNN)	Insufficient (2009), Mediocre (2013), Insufficient (2017)
Eems canal (+ surroundings north)	No	Infrastructure	Insufficient (2014)
Hondhalstermeer	No	Nature area (NNN)	Bad (2015) --> exp Insufficient (2021)
Kommerzijlsterdiep	No	Polder (NNN)	Insufficient (2009-2013)
Lauwersmeer	N361 Marneweg	Nature reserve	Insufficient (2009), Mediocre (2011,2014) to Good/GEP (2017)
Matsloot & Wolddiep area	No	Polder (NNN)	Medicore (2011) --> Good/GEP (2014, 2017)
Mussel Aa-canal	No	Infrastructure	insufficient (2008) --> bad to good/GEP (2017)
Oldambtmeer	No	Recreation	Medicore (2006-2008), Insufficient (2016)
Paterwoldsemeer + Hoornsemeer (en Onlanden)	A28 (Groningen-De Punt), N861 (Meerweg)	Nature reserve/Recreation	Insufficient (2009-2018)
Reitdiep	No	Polder/Infrastructure	Insufficient (2009-2013), Mediocre (2016)
Roegwold + schildmeer	No	Nature reserve	Medicore (2018)
Ruiten Aa	No	Nature	Bad (2014)
Ruiten Aa canal	No	Infrastructure	Insufficient (N) and Mediocre (S) (2008)
Sellingerbeetse	No	Recreation	unknown
Stads canal	No	Infrastructure	Medicore (2017)
Van Starkenborgh canal	N388 (south of Grijpskerk)	Infrastructure	unknown
Vloeivelden near Stads canal	No	Nature	unknown
Westerbroek (+ Foxholstermeer and Drentsche Diep)	No	Nature reserve	Bad (2018)
Westerwoldse Aa (+Pekel Aa)	No	Nature	North: insufficient (2011, 2014) to Good/GEP (2017), South: Bad (2008-2017)
Winsumerdiep	No	Polder/Infrastructure	Mediocre (2009-2016)
Wintschotersdiep	No	Infrastructure	Insufficient (2014)
Woldmeer + Kardinge + Meerstad	No	Recreation	Good/GEP (2016)
Zeilplas Langebosch (Veendam)	No	Recreation	Unknown
Zijdiep/De Lauwers	No	Polder	Bad (2015)
Zuidelijk westerkwartier (e.g. Oosterwold) (above Onlanden)	A7 (Drachten-Groningen)	Polder (NNN)	Matslootgebied: Mediocre (2009), Insufficient (2013)

Appendix 8: Improvements in Drenthe.

Naam waterlichaam	Jaar van verbetering of afronding	Groote van project	Omschrijving van verbetering
Bargerveen			
	>2019		Verhoging waterpeil vanwege WFD en Natura2000
Beilerstroom, Beilervaart & Brunstinger Leek			
Boerenveensche plassen/ Hoogeveensche plassen/Gijssertelkoelen			
	2021	17 km	Natuurlijke herinrichting van watergangen
Coevorden Vecht canal/Stieltjes canal			
Drentsche Aa (rivier en NP)			
	2006	377 ha	De Strubben-Kniphorstbos: in beheer van Staatsbosbeheer als natuurgebied
	2012	367 ha	Balloerveld: in beheer van Staatsbosbeheer als natuurgebied
	2016-2021	3x	Beekbodemverhoging Drentsche Aa
	2016-2021	4 km	Hermeandering Drentsche Aa
	2021	400.000 m3	Water vasthouden in Drentsche Aa
	2022	180.000 m3	Water vasthouden in Geelbroek
	2026	5 km	Hermeandering Drentsche Aa (Rolderdiep en Amerdiep)
	2027	374.000 m3	Water vasthouden in Rolderdiep
	2027	94.000 m3	Water vasthouden in Amerdiep
Drentse Hoofdvaart			
Drents-Friese Wold & Leggelderveld + achtersteplas			
	2021	450 ha, 6 km	Herstellen van de beek Oude Willem. Opdroging tegengaan door waterberging en toevoer naar Vledder Aa bevorderen
Dwingelderveld NP			
	2021	Onbekend	Habitat herstel van Dwingelder NP, tegegegaan van opdroging
Fochteloërveen			
	1999-2003	Onbekend	Maatregelen genomen om het bergen/vasthouden van water te verbeteren om zo droogte te voorkomen
	2008	63 ha	Gebied Stallaan toegevoegd aan Fochteloërveen
	2016-2021	4 km	Herinrichten van oevers bij Veenhuizerkanaal of Leekster Hoofddiep
	>2021?	Onbekend	Project om het gebied Kolonievaart natter te maken, bovenste laag aarde verwijderd
	>2021?	Onbekend	Waterpeil in de gebieden Norger Petgaten en Esmeergebied verhoogd en bomen verwijderd
	>2021?	Onbekend	Waterpeil in het gebied Stallaan verhogen, sloten verwijderd en verbetering van dammen
Holtingerveld			
(Hoogeveen) Oude Diep			
	>2016-2017	700 ha	Herinrichten van landbouwgrond tot natuurgebied voor het vasthouden/bergen van water. Creëren van otter habitat
Hoogeveensche Vaart			
Hunze of Oosermoersche Vaart			
	1995-2015	3000 ha	Herinrichten van landschap: meanders, moerassen met voldoende voedselaanbod, vasthouden/bergen van water

	2010-2015	500 ha	Hunzedal Torenveen-Bonnerklap
	2016-2021	8 km	In de Veenkoloniën: aanleg 8 km aan NVO's
	2016-2021	17 km	Beekherstel Hunze (hermeandering)
	2016-2027	1000 ha	Herinrichten van landschap: meanders voor het vasthouden/bergen van 1.3 miljoen kubieke meter water.
	2021	450.000 m3	Water vasthouden in Hunze
	2021	1.7 km, 46 ha	Herinrichten van landschap (meanders) voor het vastouden/bergen van water in Paardetangen/Achterste Diep (stroomopwaarts van de Hunze)
	>2021	Verwijderen obstakels	Gemaal Oostermoer vlakbij De Groeve is vervangen om populatie vissen doorgang te geven, kan ook ten gunste zijn van de otter
	2022	240 ha	Landschapsherinrichting (meanders) in het gebied De Branden
	2022-2027	9 km	Aanleg NVO's in de Veenkoloniën, deels in Hunze
	2022-2027	18.2 km	Beekherstel Hunze (Voorste diep en Achterste Diep) + 5x vispassages
	2027	480.000 m3	Water vasthouden in Hunze
Noord Willemskanaal			
	2016-2021	3 km	Aanleg NVO's door WS Hunze en Aa's
	>2020	4-5x	Aanleg van FUP's bij Noord-Willems kanaal
	2022-2027	3 km	Aanleg NVO's door WS Hunze en Aa's
Onlanden (incl. Paterwolsemeer, Leekstermeer)			
	1998	Onbekend	Noordelijke polders onderwater gezet om dijkdoorbraak te voorkomen
	2005-2013	2500 ha	Herinrichten Onlanden-gebied voor het bergen van water
	2008-2013	Onderdeel van 2500 ha	Aanleg van een verbinding (corridor) tussen Leekstermeer en Paterwoldse meer
	2008-2013	Onderdeel van 2500 ha	Verbindingen d.m.v. slenken tussen Drentse beken en het Leekstermeer
	2008-2013	Onderdeel van 2500 ha	Herinrichten van het Leekstermeer voor het bergen/vasthouden van water.
	2008	from -1.1m NAP --> -0.5/-0.84m/0.1m NAP	verhoging waterpeil
	2008	Onbekend	Eelderdiepje herverbonden met wateren stroomopwaarts.
	2010-2013	part of the 2500 ha	Herinrichten van Peizermaden voor bergen/vasthouden van water.
	2022-2027	1 km	Leekstermeer: aanleg van NVO's
	2022-2027	1x	Leekstermeer: aanleg van kleine eilanden die golfslag and windwerking op het meer verminderen. Kunnen misschien ook fungeren als rustgebied.
Oranjekanaal			
	2009	24x over 17 km	Aanleg van Fauna Uittreedplaatsen (FUP's)
Oude Vaart			
	2016-2021	10km	Aanleg NVO's + 3 vispassages door WS Reest en Wieden
Peizerdiep/Oude Diep/Slokkert			
	2009-2015	3 km	Aanleg NVO's buiten EMS
	2010-2015	1.6 km	NVO's in Peizer/Eelder, stroomopwaarts buiten EMS
	2011-2013	900 ha	Herstel natuurgebied tussen Langelo en Een
	2016-2021	5km	Aanleg NVO's door WS Reest en Wieden

	2016-2021	4.5km	Natuurlijk inrichting door WS Reest en Wieden
	2016-2021	3 km	Herinrichting landschap in Oude Diep door WS Reest en Wieden
	2016-2021	2.6 km	Herinrichten landscap (meanders) bij Steenbergerloop, zijtak van Peizerdiep
	2016-2021	6 km	Herincrichten van landschap stroomopwaarts in Eelderdiep
	2016-2021	1.4 km	Herinricten van oevers: NVO's
	2016-2021	1.5 km	Herinrichten van landscap (meanders) in het Oostvoorsche diep, zijtak van Peizerdiep
	2021	13 km	Oude diep: verbreding watergang (13 km), aanleg NVO's, berging water
	>2021	5 km	Herinrichten van landschap (meanders) in het Witterdiep, zijtak van Peizerdiep
	2022-2027	50 ha	Bergen/vasthouden van water in watervaten ("capillaries") stroomopwaarts
	2022-2027	50 ha	Bergen/vasthouden van water in watervaten ("capillaries") stroomafwaarts
	2022-2027	22.8 km	Verbetering maaibeleid waarbij vegetatie op oevers blijft staan en alleen de stroomdraad/stroombaan wordt verwijderd
	2022-2027	8 km	Herinrichten van landschap (meanders) in Peizerdiep/Eelderdiep gebied
	2022-2027	12 km	Herinrichting van landschap (meanders) in Peizerdiep/Eelder stroomafwaarts
Reest			
	2013-2015	40 ha	Project: stadsrandzone Meppel-Reestdal. Waterberging als onderdeel van de gebruiksfunctie natuur
	2014	1250 ha	Onderdeel van het Gewenst Grond- en Oppervlaktewater Regime (GGOR) project, natuurontwikkeling: balans tussen landbouw en natuur
	2016-2021	1km	Aankoppelen stroomgebieden (Reest) door WS Reest en Wieden
	2017	60 ha	NNN: vlakbij Drogteropslagen: herinrichting van het watergebied (meanders) voor het verhogen van watertoevoer en het vasthouden/bergen van water
	2020	Unknown	Aanleg van verbinding (corridor) tussen Zuidwoldiger en Vogelzangsewijk die verbonden zijn met natuurgebieden zoals De Slagen en Het Zwarte Gat
Vledder Aa, Wapserveensche Aa			
	2016-2021	3km	Natuurlijk inrichting door WS Reest en Wieden
	2014		Herinrichting landschap (meanders), deel van NNN
	>2021	204 ha	Herinrichting landschap (meanders), deel van NNN
Wold Aa, Ruiner Aa			
	2016-2021	3.5km	Natuurlijk inrichting door WS Reest en Wieden (WS DOD)
	2016-2021	1km	Herinrichting landschap (meanders) in Wold Aa door WS Reest en Wieden (WS DOD)
Zuidlaardermeer			
	2021	?	Revitalisering rietoevers in het Zuidlaardermeer
	2024	1 km	Herinrichten van oeverzone in Zuidlaardermeer, meer luwtes
	2027	1.2 miljoen m3	Bergen van water
	2016-2021	2x	Inrichten van oeverzone in Zuidlaardermeer

Sources of the improvements in Drenthe:

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Appendix 9 Distribution of the otter in Drenthe.

Waterbody	Being monitored	Spraints found (since)	Population size	Offspring confirmed (since)
Bargerveen	Unclear	No, but likely	Unclear	Unknown
Beilerstroom, Beilervaart & Brunstinger Leek	Yes	2012	Unclear	Likely
Boerenveensche plassen en Gijssertelkoelen	>2022?	No, but likely	Unclear	Unknown
Coevorden Vecht canal/Stieltjes canal	Yes	2018-2020	Unclear	Unknown
Drentsche Aa (rivier en NP)	Yes	2012	Unclear	2018
Drentse Hoofdvaart	Yes	2012	Unclear	Unknown
Drents-Friese Wold & Leggelderveld + achtersteplas	Yes	2016	Unclear	Unknown
Dwingelderveld NP	Yes (but unreliable)	2016	Only sightings	Unknown
Fochteloërveen	Yes	2014	4-6	2016
Holtingerveld	Yes	2012	6-8	Likely
Hoogeveen Oude Diep	>2022?	2016	Unclear	Unknown
Hoogeveensche Vaart	Yes	2004	Unclear	Unknown
Hunze of Oosermoersche Vaart	Yes	2016	Unclear	Yes
Noord Willems canal	Yes	2012	Unclear	Unknown
Onlanden (incl. Leekstermeer, Friese Veen)	Yes	2013	~5	2015
Oranje canal	>2022?	2016	Unclear	Unknown
Oude Vaart	Yes	2011	Unclear	Unknown
Peizerdiep/Oude Diep/Slokkert	Yes	2014	Unclear	Yes
Reest	Yes	2013	Unclear	Unknown
Vledder Aa, Wapserveensche Aa	Yes	2013	Unclear	Likely
Wold Aa, Ruiner Aa	Yes	2013	Unclear	Unknown
Zuidlaardermeer	Yes	2011	5-7	2016

Appendix 10: Condition of remaining three factors affecting the otter population in Drenthe.

Waterbody	Existing traffic bottlenecks	Habitat function	Ecological status of the water body (GEP)
Bargerveen	No (nearby Hoogeveensche Vaart)	Nature area (Natura2000)	Low prey availability
Beilerstroom, Beilervaart & Brunstinger Leek	No	Polder	unknown
Boerenveensche plassen en Gijssertelkoelen	No	Nature reserve	Not many fish
Coevorden Vechtkanaal/Stieltjeskanaal	No	Infrastructure	Good/GEP (2009-2021)
Drentsche Aa (rivier en NP)	No	Nature	Insufficient to mediocre (2010-2018), exp GEP <2027
Drentse Hoofdvaart	N32 (Meppel-Steenwijk)	Infrastructure	unknown
Drents-Friese Wold & Leggelderveld + achtersteplas	No	Nature reserve	unknown
Dwingelderveld NP	No	Nature reserve	unknown
Fochteloërveen	N373 (Norgtervaart-Huis ter Heide)	Nature reserve	Low prey availability
Holtingerveld	No	Nature reserve	unknown
Hoogeveen Oude Diep	No	Polder	Insufficient (2009, 2014)
Hoogeveensche Vaart	A28 (Meppel-De Wijk), A37 (Hoogeveen-Veenoord)	Infrastructure	Good/GEP (2009-2021)
Hunze of Oosermoersche Vaart	No	Nature	Insufficient (2012-2015), exp mediocre (2021)
Noord Willems canal	A28 (Groningen-Tynaarlo)	Infrastructure	Mediocre (2013-2019) --> exp GEP (2022-2027)
Onlanden (incl. Leekstermeer, Friese Veen)	A28 (Groningen-Tynaarlo)	Nature reserve	Leekstermeer: Insufficient (2009), Bad (2013)
Oranje canal	No	Infrastructure (hardly)	Good/GEP (2009-2021)
Oude Vaart	N32 (Meppel-Steenwijk)	Infrastructure	Mediocre (2009, 2014)
Peizerdiep/Oude Diep/Slokkert	No	Nature	Insufficient (2009), Insufficient/Mediocre (2013)
Reest	No	Nature	Good/GEP (2009, 2014)
Vledder Aa, Wapserveensche Aa	No	Nature	Mediocre (V) and Insufficient (W) (2009, 2014)
Wold Aa, Ruiner Aa	No	Nature	Mediocre (W)(2009, 2014)
Zuidlaardermeer	No	Nature reserve	Bad (2018)

Appendix 11: Improvements in Overijssel

Naam waterlichaam	Jaar van verbetering of afronding	Groote van project	Omschrijving van verbetering
Almelo - Vroomsoop -De Haandrik			
	2013-2014	12 FUP's	Aanleg van 12 FUP's in Almelo-De Haandrik Kanaal
	>2021	Onbekend	Voorbereidingen voor beheer van biodiversiteit: verbeteren maaibeleid, NVO's, enz.
	2016-2021	3 km	Vlakbij, Buldersleiding bij Nieuweleuzen: aanleg NVO
	>2021	1 Holt	Provincie doneert 1 holt aan Waterschap Vechstromen in Dedemsvaart
	2022-2027	3 km	Aanleg NVO's bij Dedemsvaart
Dinkel			
	1996	12 km	Omleidingskanaal ten oosten van de Dinkel
	>2019 (moet nog starten)	Onbekend	Kloosterhuizenbeek: verminderen van stroomsterkte
	>2019 (moet nog starten)	Onbekend	Elsbeek: Veranderen van stroomsterkte om droogte te voorkomen
	>2020	Onbekend	Ruhenbergerbeek: voorbereiding verbeteren waterkwaliteit (WFD)
	>2020	5 km	Glanerbeek: landschapsherinrichting meanders en NVO's
	>2020	2 km	Zuidelijk Dinkeldal: landschapsherinrichting meanders en NVO's
Engbertsdijksvenen			
Gebied Vledders en Leijerhooilanden			
	2021	18 km, 4 ha	Verbreden watergang op een lengte van 18km met 4 ha aan natuur
	2021	verhoging waterpeil met 40 cm	Natuurlijke herinrichting.
IJssel			
	2015	10 km	Project Ruimte voor de Rivier: vergraven van uiterwaarde: Bolwerksplas, Worp en Ossenwaard• Keizers-, Stobben- en Olsterwaarden
	~2016	130 ha	Vergraven uiterwaarden Scheller en Oldeneler als onderdeel van Ruimte voor de Rivier
	2017	8 km	Hoogwatergeul Veessen-Wapenveld als onderdeel van Ruimte voor de Rivier.
	2017	300 m	Dijkverlegging Westerwolte als onderdeel van Ruimte voor de Rivier
	2019	566.5 ha	13 deelgebieden gekarteerd als rustgebied voor broedvogels, kan fungeren als rustgebied voor otter
	2019	350+40 ha	Nieuwe natuur rondom de nieuwe verbinding Reevediep tussen de IJssel en het Drontemeer als onderdeel van Ruimte Voor de Rivier
	2021	?	Vlakbij: Lierder- en Molenbroekerpolder Wijhe: verbeteren watergangen, vergroten berging van water.
	2022-2023	>5km	Vlakbij: Natuurlijke herinrichting van Nieuwe Wetering Broekland/Elshof/Laag Zuthem. Verbreden van natuurlijke oevers
	2022-2027	7 km	Aanleg NVO's in Soestwetering, naast de IJssel
Hoogeveense Vaart			
	>2021	Onbekend	Voorbereidingen voor beheer van biodiversiteit: verbeteren maaibeleid, NVO's, enz.
Kanaal Almelo-Nordhorn			
Ketelmeer + vossemeer			
	2009-2015	2 km	Aanleg NVO's in Buiten Reeve, zijtak van Vossemeer
	2016-2021	2 km	Zijtak Vossemeer bij Uitwateringskanaal: aanleg NVO
Lemelervelt-Deventer			

	2021	12 km	Zijtak: Soestwetering en Breebroeksleiding Heeten/Okkenbroek: aanleg NVOs en vis passeerbaarheid verbeteren
	2022 -2027	7 km	Aanleg NVO's in Soestwetering benedenloop
Olde Maten & Veerslootlanden			
	?	2x	Tussen Olde Maten-De Wieden en Olde Maten-Zwarte Water een faunapassage/FUP aangelegd
	?	80 ha	Extra open water gemaakt, deels weer dichtgegroeid: ideaal voor de otter
	2014	1000 ha	Aanleg nieuw natuurgebied van 1000 ha na ruilverkaveling met eigen waterhuishouding tot een totaal van 1500 ha
Ommer canal			
	>2021	Onbekend	Voorbereidingen voor beheer van biodiversiteit: verbeteren maaibeleid, NVO's, enz.
	2020-2021	6.5 km	Project Collendoornerveen: verbinding tussen verlengd Ommerkanaal en de Overijsselse Vecht
Overijsselse Vecht			
	?	500 m	Aanleg NVO's
	2009-2015	205 ha	Natuurlijke inrichting uiterwaarden weghalen oeverbescherming
	2009-2015	4km	Aanleg NVO's in vlakbije Emmertochsloot, plus 5 vispassages
	2016-2021	3 leefgebieden	Aanleg speciale leefgebieden voor flora & fauna in Overijsselse Vecht/Zwarte water
	2016-2021	2 meanders	Aanleg meanders bij herinrichting Vecht/Zwarte Water
	2017	600m	Grensmeander: enlargement of floodplains by relocating the winter dike
	>2020	12km	Lutterhoofdwijkkanaal: aanleg NVO's tussen Slagharen and Coevorden
	>2020	1 meander	Karshoek-Stegeren: Landschapsherinrichting met NVO's en vergroten van uiterwaarden
	2021	Onbekend	Herstel van slenken en verbinden van kolken bij de Vecht: Kranenkolk, Langenholte en Spiekpolder
	2021	Onbekend	Marswetering vlakbij Zwolle: vergroting berging water. Aanleg vispassages
	2021	39 ha	Baalder Uiterwaarden: NVO's met vegetatie in de uiterwaarden
	2022-2027	2 meanders	Aanleg meanders in de Vecht
	2022-2027	4 leefgebieden	Aanleg nevengeul tussen Overijsselse Vecht en Zwarte Water
	2022-2027	3x	Aanleg speciale leefgebieden voor flora & fauna in Overijsselse Vecht/Zwarte water
Regge beneden			
	2010-2021	Onbekend	Landschapsherinrichting met meanders
Regge midden			
	1989	6.5km	Verbeden en verdiepen van Midden Regge + gefaseerd maaibeleid
	2010 -2021	Onbekend	Landschapsherinrichting met meanders
Regge Boven			
	2010-2021	?	Landschapsherinrichting met meanders
	2015	13 km	Project Doorbraak: nieuw waterlichaam als verbinding tussen Loolee and Ekosche Aa (vlakbij de Boven regge): waterlichaam 6-7m breed) + oevers 70 m breed
	2017	~1-1.5 km	De Meene, gemeente Goor: Landschapsherinrichting met NVO's in Midden Regge
	2019	11.5 km, 115 ha	Project Reggendal vlakbij, Enter: landschap herinrichting (meanders): 11.5km aan NVO's en 115-200 ha aan nieuwe natuur. NVO's zijn 25 meter breed. 4000 ha landbouwgebied verbeterd.
Schipbeek + Buurserbeek			
	2016-2021	1x	Aanleg vispassage

Twentekanaal			
	2021-2023	tot 2.8m diep	Verdieping en verbreding van kanalen. Ook aanleg van NVO's.
Twickelervaart			
	2017	1.5	Terugbrengen van meanders in the Oelerbeek near Twickelervaart
Weerribben-Wieden and surroundings			
	2005	2200m	Aanleg NVO's (2.5m width) tussen Weerribben-Wieden and Rottige Meente.
	2010	109 ha	Uitbreiding van de Wieden met het gebied Beulaker Polder
	2016-2021	6 km	Aanleg NVO's door WS Reest en Wieden in Drentse Kanalen en Meppelerdiep, onder NP W-W
	>2020	?	Verbinding van Weerribben met Rottige Meenthe voor NNN
	>2020	108 ha	Inrichting van zomerdijk (A, B en C)
	>2020	?	Verbinding Wieden met Vollehovermeer
Zwarte Meer (+ kadoelermeer en vollehovemeer)			
	2020	first -0.83, now -0.76 NAP	Watertest bij waterschap WOD om eerder water het meer in te laten.
	2022-2027	5 km	Aanleg NVO's in Goot/Ganzendiep (tussen Zwarte Meer en IJssel)
Zwarte Water			
	1988-2021	150 ha	Uitbreiding beheergebied Staatsbosbeheer met geplagde rietlanden en gegraven poelen: van <100ha naar 250 ha.
	2009-2015	14km	Aanleg NVO's in Mastenbroekpolder, ten westen van het Zwarte Water
	2009-2015	3 km	Aanleg NVO's in Kloosterzielstreng, zijtak van Zwarte Water
	2009-2015	7 km	Aanleg NVO's in Kostverlorenstreng, zijtak van Zwarte Watter
	2016-2021	4 km	Zijtak De Steenwetering: aanleg NVO
	2016-2021	2 meanders	Zie Overijssele Vecht (herinrichting)
	2016-2021	3 leefgebieden	Zie Overijsselse Vecht (leefgebieden)
	2022-2027	2x	Zie Overijsselse Vecht (nevengeulen)
	2022-2027	4 leefgebieden	Zie Overijsselse Vecht (leefgebieden)
Zwolle - Lemelerveld - Vroomshoop			
	2009-2015	4 km	Aanleg NVO's in zijtak Noordzuidleiding, plus 4 vispassages
	2009-2015	5 km	Aanleg NVO's in zijtak Damholterwaterleiding, plus 4 vispassages
	2016-2021	8 km	Aanleg NVO's, plus 5 vispassages (2009-2021)
	2016-2021	2 km	Aanleg NVO in OK-kanaal vlakbij Zwolle

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Appendix 12: Distribution of the otter in Overijssel.

Waterbody	Being monitored	Spraints found (since)	Population size	Offspring confirmed (since)
Almelo - Vroomshoop - De Haandrik	Yes	Sighting	Unclear	No
Dedemsvaart	Yes	2017	Unclear	No
Dinkel	Yes	2014	2-3	Yes
Engbertsdijksvenen	Unclear	2019	Sightings	No
gebied Vledders en Leijerhooilanden	Unclear	Sightings	Sightings	No
Hoogeveense Vaart	Yes	2012	Unclear	No
IJssel	Yes	2009	Unclear	No
Kanaal Almelo-Nordhorn	Yes	2015	Sightings	No
Ketelmeer + Vossemeer	Yes	2005	2-4 (VM, KM, ZM,KM)	Yes
Lemelervelt-Deventer	Yes	2008	Unclear	No
Olde Maten & Veerslootlanden	Yes	2002-2008?	2-3	2014
Ommerkanaal (kanaal)	Yes	2016	Unclear	2019
Overijsselse Vecht	Yes	2012	3-4 (Zwarte water + Vecht)	2012
Regge Beneden	Yes	2012	4-6 (Regge)	Likely
Regge Boven	Yes	2012	4-6 (Regge)	Likely
Regge Midden	Yes	2012	4-6 (Regge)	Likely
Schipbeek + Buurserbeek	Unclear	None	NA	NA
Twentekanaal (Z -E)	Unclear	None	NA	NA
Twentekanaal (zijkanaal Almelo)	Unclear	None	NA	NA
Twickelervaart	No	Unclear	NA	NA
Weerribben-Wieden and surroundings	Yes	2002 (release)	108-119	2003
Zwarte Meer (+ kadoelermeer en vollehovemeer)	Yes	2008	2-4 (VM, KM, ZM,KM)	Yes
Zwarte Water	Yes	2012	3-4 (Zwarte water + Vecht)	Yes
Zwolle - Lemelerveld - Vroomshoop	Unclear	2015	Unclear	No

Appendix 13: Condition of remaining three factors affecting the otter population in Overijssel.

Waterbody	Existing traffic bottlenecks	Habitat function	Ecological status of the water body (GEP)
Almelo - Vroomshoop - De Haandrik	No	Infrastructure	Good/GEP (2009-2021)
Dedemsvaart	N377 (Nieuwleusen-Hasselt	Polder	Insufficient (2009-2015)
Dinkel	No	Nature reserve	Mediocre (2009-2015)
Engbertsdijksvenen	No	Nature reserve	hardly any fish
gebied Vledders en Leijerhooilanden	No	Polder	unknown
Hoogeveense Vaart	No	Infrastructure	Good/GEP (2009-2021)
IJssel	Meenteweg	Infrastructure	Insufficient (2006-2016)
Kanaal Almelo-Nordhorn	No	Infrastructure	unknown
Ketelmeer + Vossemeer	No	Nature reserve	Good/GEP (2008, 2011), Mediocre (2014)
Lemelervelt-Deventer	No	Infrastructure, Nature	unknown
Olde Maten & Veerslootlanden	No	Nature reserve	unknown
Ommerkanaal (kanaal)	(N762 Balkburg-Ommen)	Infrastructure/Polder	unknown
Overijsselse Vecht	A28 (Lichtmis-Zwolle)	Nature reserve	Insufficient (2011-2014)
Regge Beneden	No	Nature reserve	Mediore (2009), Insufficient (2015), Good/GEP (2021)
Regge Boven	No	Nature	Mediore (2009), Insufficient (2015), Good/GEP (2021)
Regge Midden	No	Nature	Mediore (2009), Bad (2015), Good/GEP (2021)
Schipbeek + Buurserbeek	No	Nature	Mediocre (2015)
Twentekanaal (Z -E)	No	Infrastructure	Good/GEP (2008)
Twentekanaal (zijkanaal Almelo)	No	Infrastructure	Good/GEP (2008)
Twickelervaart	No	Nature	unknown
Weerribben-Wieden and surroundings	N375 (Zomerdijk), N762 (Blauwe Hand - Vollehove), N334 (Zwartsluis-Beukersluis), N334 (Blauwe Hand-Giethoorn), N351 (near Kuinre), Lageweg to Ossenzijl	Nature reserve	unknown
Zwarte Meer (+ kadoelermeer en vollehovemeer)	No	Nature reserve	Good/GEP (2008, 2011, 2014)
Zwarte Water	No	Infrastructure	Insufficient (2011-2014)
Zwolle - Lemelerveld - Vroomshoop	No	Infrastructure, Nature	Good/GEP (2009-2021)

Appendix 14 Improvements in Gelderland.

Naam van waterlichaam	Jaar van afronding	Projectgrootte	Omschrijving van verbetering
Rivierenland			
	>2020	maaibeleid	A-watergangen: 50% op talud blijft staan in het voorjaar (WFD)
	>2020	maaibeleid	A-watergangen: 1 zijde van het droge talud blijft staan in de winter (wisselt om het jaar) (WFD)
Edensche Zeeg			
Linge beneden			
Linge boven			
	2015	1 km	Aanleg natuurvriendelijke oever
Linge kanaal			
Maas			
	~2016	350 m	Dijk verlegd bij Lent als onderdeel van Ruimte voor de Rivier
Maas-Waalkanaal (Neder)Rijn			
	1992-2010	120 ha	Plan Ooievaar: De Blauwe Kamer heringericht tot rivieroeverlandschap
	2002	?	Grebbeberg (zuidkant Utrechtse Heuvelrug) verbonden met Blauwe Kamer
	?	13 cm	Verwijderen van obstakels in de uiterwaarde Elst waardoor de uiterwaarde een grotere capaciteit van 13 cm heeft.
	2015	?	Project Ruimte voor de Rivier: Vergraven uiterwaarde Doorwerthsche Waarden
	2015	740 ha	Project Ruimte voor de Rivier: Huissensche Waard, vergraven van uiterwaarden
	2015	300 ha	Project Ruimte voor de Rivier: Vergraven uiterwaarde Meinerswijk
Pannerdensch kanaal			
Waal			
	1996	40 ha	Wetland Passewaaij ingericht
	2013-2015	4 km	Aanleg nevengeul (Spiegelwaal) bij Nijmegen
	2016	500-700 ha	Vergraven uiterwaarden Munnikenwaard en Brakelse Benedenwaard voor Ruimte voor de Rivier
Rijn en IJssel			
Baakse Beek			
	2016-2021	5km, 8	5km aan beekherstel in benedenloop en 8 (7 beneden-, 1 bovenloops) vispassages
	2022-2027	6km	6 km aan beekherstel in bovenloop
Berkel			
	2016-2021	13km, 1x	13km aan beekherstel en 1x vispassage
Bielheimerbeek			
	2022-2027	6x	Aanleg vispassages
Bolsbeek			
Boven Slinge			
	2016-2021	4km, 2x	Beekherstel en 2x aanleg vispassages
	2022-2027	7km,	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
Buurserbeek			
	2016-2021	4 km	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
	2022-2027	1 km	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
Groenlose Slinge			

	2022-2027	8x	Aanleg vispassages
Groote Beek			
	2016-2021	8km	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
	2022-2027	8km, 1x	Beekherstel en 1x aanleg vispassage
Hambroekplas			
	~1994	?	Aanleg recreatieplas
IJssel			
	1989	120 ha	Project Ooievaar: Duursche Waarde, herinrichting uiterwaarden
	2007	?	Uitbreiding van Duursche Waaarde: De Enk
	2012	250 m	Ruimte voor de Rivier: Dijkverlegging met 250 m landinwaarts bij Hondbroeksche Pleij
	2014	?	Project Ruimte voor de Rivier: nieuwe hoogwatergeul aangelegd
	2015	11 geulen, 17 oevers	Aanleggen van 11 geulen langs de IJssel en op 17 locaties oevers aangepast
	2016	290 ha + 200 ha	Project Ruimte voor de Rivier: vergraven van uiterwaarde: Cortenoever en Voorsteklei
	2016-2021	3 km	Zijtak de Stouwe: aanleg NVO
Keizerbeek			
	2022-2027	14km	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
Millingerwaard			
	1992	800 ha	Project Ooievaar: aanleg nieuw natuurgebied
	2013-2021	265 ha	Project Ruimte voor de Rivier: aanleg nieuwe natuur van 265 ha met 3.5 km NVO's
Ooijpolder			
	?	?	Aanleg van 3 a 4 otterholtes
Oosterwijkse vloed			
Oude IJssel			
	2016-2021	8.06km	Natuurvriendelijk onderhoud
	2016-2021	1x	Aanleg vispassage
	2022-2027	2km	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
Ratumse Beek			
	2016-2021	1km	Beekherstel (natuurlijker waterstysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
Rijnstrangen			
	2016-2021	2x	Aanleg van 2 vispassages
	2009->2021	28 ha	Herstel rietmoeras van 28 ha
Slinge (Meibeek en Gracht)			
Slingeplas			
Valeplas, Gieseplas, Lathumse plas			
Veengoot			
	2022-2027	3km	Beekherstel (natuurlijker watersysteem, aanpassen van lengte en dwarsprofiel en inbrengen van doodhout)
Waalse Water			
Vallei en Veluwe			

Algemeen	>2020		Overgegaan op maaibeleid waarbij zo vaak mogelijk 1 talud niet gemaaid wordt, in praktijk nog niet altijd het geval vanwege particuliere terreinbeheerders die toch maaien (aandachtspunt voor communicatie)
Apeldoorsch Kanaal			
	2016-2021	51.2km	Natuurvriendelijk ondehoud
	>2021	14 beken	Herstel van 14 beken in de stad Apeldoorn met onder andere vispassages
Barneveldse Beek			
	2016-2021	1.6km	Natuurvriendelijke inrichting
	2021	20 stuwen	20 stuwen worden vispasseerbaar gemaakt.
Bottenstrank			
Bussloo			
Fliert	2021	1.8 km	Beekherstel met natuurlijke inrichting van de Fliert en een ecologische verbinding van 1.8 km lang en 12m breed. Meer vegetatie langs oevers
	2016-2021	6.2km	6.2 km Natuurvriendelijke onderhoud, 3.1km natuurvriendelijke inrichting
Hierdense Beek (+ Leuvenumsebeek, staverdensebeek)			
	2013-2019	8 km, 10 ha	Beekherstel met natuurlijke inrichting voor het EMS
Kievitsveld			
Veluwemeer en Wolderwijd Voorsterbeek			
	>2021	>2.3 km	Aanleg van NVO's in voorsterbeek (in totaal 7.5 km?)
	2016-2021	7.4km	7.4 km NV onderhoud, 3.7km NV inrichting + optimalisatie
Wiel en Rassenbeek			
	2016-2021	6.3km en 3.15km	6.3 km aan NV onderhoud en 3.15km aan NV inrichting
	2021	?	Aanleg van NVO's.

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13. Interview Rivierenland
14. Interview Vallei and Veluwe

Appendix 15: Distribution of otters in Gelderland

Waterbody	Being monitored	Spraints found (since)	Population size	Offspring confirmed (since)
Rivierenland				
Edensche Zeeg	No	None	None	None
Linge beneden	No	None	None	None
Linge boven	No	None	None	None
Linge kanaal	No	None	None	None
Maas	No	None	None	None
Maas-Waalkanaal	No	None	None	None
(Neder)Rijn	No	None	None	None
Pannerdensch kanaal	No	None	None	None
Waal	No	None	None	None
Rijn en IJssel				
Baakse Beek	No	No	NA	NA
Beneden Slinge	Unclear	Likely	No	No
Berkel	Unclear	2017-2020	>2	NA
Bielheimerbeek	Yes	2012	Unclear	No
Bolsbeek	No	No	NA	NA
Boven Slinge	Yes	2013	Unclear	NA
Buurserbeek	Unclear	Sighting (OV)	Unclear	NA
Groenlose Slinge	No	No	NA	NA
Groote Beek	No	No	NA	NA
Hambroekplas	No	No	NA	NA
IJssel	Yes	2009	Unclear	No
Keizerbeek	No	No	NA	NA
Millingerwaard	Yes	2014	0-1	Unclear
Ooijpolder	Yes	2014	0-1	Unclear
Oosterwijkse vloed	No	No	NA	NA
Oude IJssel	Yes	2008	1-2	No
Ratumse Beek	No	No	NA	NA
Rijnstrangen	Yes	2014	2	2015
Slinge (Meibeek en Gracht)	No	No	NA	NA
Slingeplas	No	No	NA	NA
Valeplas, Gieseplas, Lathumse plas	Yes	2015	Unclear	No
Veengoot	No	No	NA	NA
Waalse Water	Yes	2016	Unclear	No
Vallei en Veluwe				
Apeldoornsch Kanaal	Yes	2015	unclear	unclear
Barneveldse Beek	No	No	NA	NA
Bottenstrank	Yes	2020	unclear	unclear

Bussloo	No	No	NA	NA
Drontermeer	Yes	2013	unclear	unclear
Fliert	No	No	NA	NA
Hierdense Beek (+ Leuvenumsebeek, staverdensebeek)	No	No	NA	NA
Kievitsveld	No	No	NA	NA
Veluwemeer en Wolderwijd	No	2013	unclear	unclear
Voorsterbeek	Yes	2018	unclear	unclear

Appendix 16: Condition of remaining three factors affecting the otter population in Gelderland.

Waterbody	Existing traffic bottlenecks	Habitat function	Ecological status of the water body (GEP)
Rivierenland			
Edensche Zeeg	No	Polder	GEP (2018)
Linge beneden	No	Polder	Bad and Insufficient (2018)
Linge boven	No	Polder	GEP (2018)
Linge kanaal	No	Polder	GEP (2018)
Maas	No	Infrastructure	unknown
Maas-Waalkanaal	No	Infrastructure	unknown
(Neder)Rijn	No	Infrastructure	Insufficient/Mediocre (2006-2016)
Pannerdensch kanaal	No	Infrastructure	unknown
Waal	No	Infrastructure	Bad/Insufficient (2006-2016)
Rijn en IJssel			
Baakse Beek	No	Polder	unknown
Beneden Slinge	No	Polder/Nature	unknown
Berkel	No	Polder	unknown
Bielheimerbeek	No	Polder	unknown
Bijland	No	Recreation	unknown
Bolsbeek	No	Polder	unknown
Boven Slinge	No	Polder/Nature	unknown
Buurserbeek	No	Polder/Nature	unknown
Groenlose Slinge	No	Polder	unknown
Groote Beek	No	Polder	unknown
Hambroekplas	No	Recreation	unknown
IJssel	No	Infrasctructure	Insufficient (2006-2016)
Keizerbeek	No	Polder	unknown
Millingerwaard	No	Nature reserve	unknown
Ooijpolder	N325 (2018-2019) near Beek-Ubbergen	Nature reserve	unknown
Oosterwijkse vloed	No	Polder	unknown
Oude IJssel	No	Uolder	unknown
Ratumse Beek	No	Polder	unknown
Rijnstrangen	No	Nature reserve	good/GEP (2015, 2018)
Slinge (Meibeek en Gracht)	No	Polder	unknown
Slingeplas	No	Recreation	unknown
Valeplas, Gieseplas, Lathumse plas	No	Polder	unknown
Veengoot	No	Polder	unknown
Waalse Water	No	Nature	unknown
Vallei en Veluwe			
Apeldoornsch Kanaal	No	Infrastructure (hardly)	unknown
Barneveldse Beek	No	Nature	unknown
Bottenstrank	No	Nature	unknown
Bussloo	No	Recreation	GEP (2018)

Drontermeer	No	Infrastructure	unknown
Fliert	No	Polder (very narrow)	Mediocre (2017)
Hierdense Beek (+ Leuvenumsebeek, staverdensebeek)	No	Nature	GEP (2017)
Kievitsveld	No	Recreation	unknown
Veluwemeer en Wolderwijd	No	Infrastructure	Good/GEP (V&W: 2007,2010,2013,2016), Mediocre (V) and insufficient (W) (2014),
Voorsterbeek	No	Nature	Mediocre (2018)

Appendix 17 Translation of key words from English to Dutch

English name	Dutch name
Eco-friendly bankside	Natuurvriendelijke oever (NVO)
Ecological main structure	Ecologische Hoofdstructuur
Estate owners	Landgoedeigenaren
Fences	Afrastering
Fish steps	Vispassages
Inlet	Fauna Uittreedplaats (FUP)
Land consolidation	Ruilverkaveling
Pumping stations	Gemalen
Riparian vegetation	Oevervegetatie
Room for the River (RftR)	Ruimte voor de Rivier
Side channels	Nevengeulen
Target Species	Doelsoorten
Tunnel	Wissel
Water board	Waterschap