A research paper on:

Presence of the Otter (Lutra lutra) influenced by habitat factors in the Gelderse Poort: A potential migration route.

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Research paper

Presence of the Otter (Lutra lutra) influenced by habitat factors in the Gelderse Poort: A potential migration route.
A research in cooperation with ARK Nature

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Abstract

Halfway through the previous century the otter population declined drastically in Europe, resulting in the complete disappearance of the otter in the Netherlands. Important factors that contributed to the decline of the population were water pollution with pesticides, (causing a collapse in fish stocks), hunting, habitat loss, and habitat fragmentation and isolation (Joint Nature Conservation Committee, 2010). These factors led to the official extinction of the otter in the Netherlands in 1988 (Nolet & Martens., 1989) In 2002, a six-year reintroduction project was started. This reintroduction led to the establishment of a core population in Friesland. To maintain an overall viable population of otters in the Netherlands and prevent inbreeding, connection between this core population and adjacent areas is crucial. An area which could serve as a potential migration route and habitat in the Netherlands is the Gelderse Poort., There is only limited information available on habitat preferences of otters in the Netherlands. Such data is however essential to judge which areas are suitable otter habitat. Therefore in this paper we focussed on establishing otter population distribution in the Gelderse Poort with the use of camera traps and spraints, and investigated how habitat factors influence presence of otters. 102 grid cells scored for habitat factors, 26 of them had otter presence. We found a positive correlation between the presence of otters and tree coverage along banks and a positive correlation between the presence of otters and houses in the area. The presence of trees in potential otter habitat corresponded with results from previous research in Spain and Denmark. The presence of houses contradicts with previous findings, as generally otters are found in undisturbed areas. However I argue that the Gelderse Poort could still serve as a migration route or even hold a permanent population.

1. Introduction

1.1. Estimates of population sizes, distribution and the use of habitat are a key elements in the world of wildlife conservation management (Cruz-García, et al., 2017). In general, a habitat provides for a population, this is determined by feeding, nestling sites, coverage and other factors. Establishing these habitat requirements for populations is an important part of understanding the ecological factors that determine use (Samuel, et al., 1985). Analysing factors like feeding and nestling sites also aids conservation programmes, these parameters help decision making and provide clarity for law making (Sutherland, 2016). However with the increasing habitat fragmentation in Western European countries, suitable habitat is shrinking (Tillmann, 2005). Fragmentation is usually defined as a process during which “a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original” (Wilcover, et al., 1986). Fragmentation, in general together with habitat loss, has been proposed to threaten the viability of populations and cause problem like inbreeding (Andersen, et al., 2004; Stow & Sunnucks, 2004). To overcome problems like inbreeding in fragmented populations, create migration routes and counteract pollution, it is essential to determine which habitat factors are limiting remaining populations of a species and constraining further consolidation in suitable habitats (Madsen & Prang, 2001). Good habitat creation, protection and migration routes helps the protection of species. Especially for species that are in need of protection, like to European otter (Kruuk, 2006).

1.2. *Lutra lutra*

The Eurasian otter has one of the widest distribution of all Palaearctic mammals (Ando & Corbet, 1966), but during the previous century, the population declined drastically through its current range. Factors contributing to the decline of otter were primarily pollution from pesticides, causing a collapse in fish stocks and secondly, hunting, habitat loss, fragmentation and isolation (Joint Nature Conservation Committee, 2010). Fortunately, due to new legislation, a ban on pesticides and with help of the reintroductions, otter populations across Europe started to recover again (Mitchell-Jones, et al., 1999). Still these measures could not prevent extinction of the otter in the Netherlands in 1988 (Nolet & Martens., 1989).

1.3. *The Netherlands*

Before the extinction of the otter in the Netherlands in 1988, the population numbers declined rapidly from 1900 until 1942 when a change in legislation, giving the otter a status as “fur game” and not “harmful game”, caused the population numbers to rise again (NDFF Verspreidingsatlas Zoogdieren, 2020). However, from the 60s the population started to decline again due to the pollution of water. Insecticides, fish traps, increasing traffic and construction in and around the aquatic environment, like canalisation (NDFF Verspreidingsatlas Zoogdieren, 2020) caused a further decrease of population numbers until the official extinction in 1988. Figure 1 shows the overall distribution of otters in the Netherlands from 1990-2020. Since the extinction in 1988 plans were initiated by the Ministry of Agriculture and Fishery to bring back the species. From 2002 a six year reintroduction project started (Niewold, et al., 2003), which resulted in the first offspring in the wild in 2004. From 2002 till 2009, 110 offspring were registered (Beekers, et al., 2012). In addition, the yearly genetic monitoring from the use of spraints (faeces specifically for the otter called spraints), shows a yearly increase of otters in the Netherlands (Kuiters, et al., 2015, 2016, 2017, 2018, 2019). Figure 2 shows the current distribution in 2018/2019. As the population is growing, there is a continuing linear trend of traffic victims proportional to the total population sizes of previous years (Kuiters, et al., 2019). Although the monitoring results in the beginning of the reintroduction project showed a small negative trend in the genetic variation of individuals, at the population level there was no further decrease in genetic variation since 2014-2015, (Kuiters et al., 2015). Genetic exchange with near otter populations in Germany, although very limited, could explain the now stabilising genetic variation at the population level. This indicates the importance of gene flow by natural migration or by reintroduction (Kuiters, et al., 2019).

1.4. *The Gelderse Poort*

To maintain an overall viable population of otters in the Netherlands, a connection between other populations is crucial (Kuiters, et al., 2015, 2016, 2017, 2018, 2019). One area which could serve as a connection between populations is the Gelderse Poort, which could potentially harbour at least 30 otters (Beekers, et al., 2012) (Kurstjens, et al., 2009 and could serve as a migration route to other areas in countries like Belgium (The Ardennes) and Germany (Eifel and Niedersachsen). To facilitate this migration and to reduce road kills, mitigating measures have been taken on two locations in Gelderland where otters were killed by traffic. The Gelderse Poort is described by Staatsbosbeheer as a natural, rugged, river landscape, part of a connected stretch of waterways, the size of 5000 ha. The floodplains made to compensate for the rising water level have been given back to nature. Additional channels where made to increase niches in the ecosystem and therefore diversity.

In the winter of 2019-2020 the Gelderse Poort probably harboured six individuals of which three around Doesburg and three in the Ooijpolder (ARK Nature, 2019). But this population is small and migration from Germany is needed to enhance genetic variation to prevent the disappearance of alleles. However, this gene flow from Germany is slow and it is desirable to introduce non related otters into the Gelderse Poort and surrounding areas (Kurstjens, et al., 2009). Therefore, ARK Nature has obtained a permit to give the Dutch otter population a genetic boost by reintroducing unrelated individuals in the population. With this exemption to reintroduce extra animals, comes mandatory responsibility to monitor the population of otters before and after the reintroduction. This research will therefore focus on otter monitoring in the Gelderse Poort and additionally habitat information will be collected during the field work as there is only limited information available on the habitat preferences of otters in the Netherlands. Habitat factors could also play a role in the movement of otters through the landscape (seasonal migration) and understanding these factors could facilitate migration between different areas (Kuiters & Lammertsma, 2014). Such data would be useful to point out specific areas qualified for otter habitat.

Research question:

To monitor the viability of the population, establish habitat preference and help facilitate future reintroduction, the following research questions were formulated:

- What is the distribution of the European otter in the Gelderse Poort (51° 52′ NB, 6° 0′ OL)?
- Which type of habitat and landscape features are associated with the presence of otters in the Gelderse Poort (51° 52′ NB, 6° 0′ OL) , Doesburg (52° 1′ NB, 6° 8′ OL) and Zutphen (52° 9′ NB, 6° 12′ OL, Netherlands?

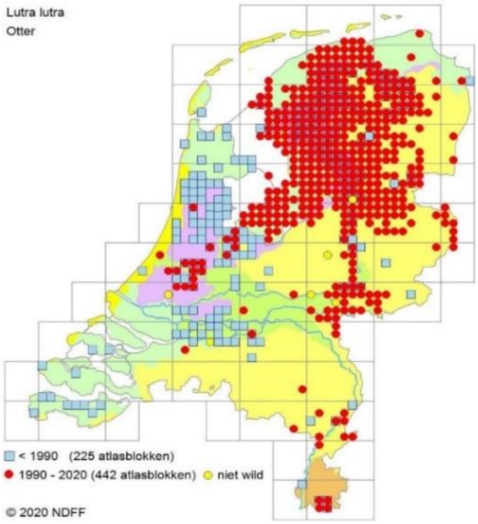

Fig 1. Distribution Otter (Lutra lutra) in the Netherlands,
showing population before 1990 (blue) and from 1990 till 2020 (in red)

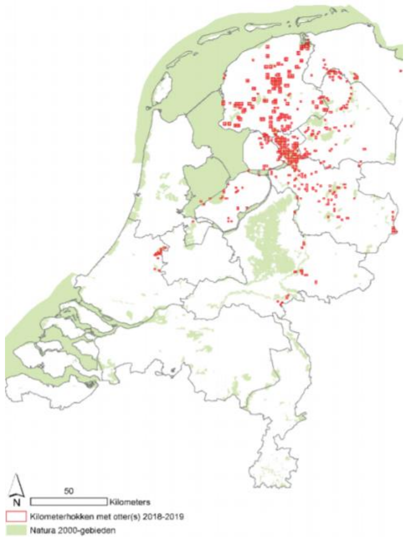

Fig 2. Distribution Otter (Lutra lutra) in the Netherland 2018/2019. Popualtion of otters around 360 individuals, based on DNA profiles recognized during the annual monitoring 2018/2019 by Kuiters et al. 2019 Copyright by (Kuiters, et al., 2019)

2 Material and Methods

2.1 *Research area*

The study took place from the 6th of April until the 15th of June, in the Gelderse Poort, Netherlands, around the rivers, Rijn, Waal, East of Nijmegen, containing the Rijnstrangen, the Oude Rijnstrangen, Oude Waal, Bijland and the floodplains from the IJsel around Doesburg and the Floodplains from the IJsel around Zuthpen are also included, as can be seen in Figure 3.

2.2 *Data Collection*

2.2.1 *Camera traps and spraints*

To monitor the population, 8 camera traps in the Ooijpolder, within the Gelderse Poort, (Figure 3, bottom right) were used. Camera traps are Bushnell Trophy Cams, set to video, 30-60 sec (max. length), 0-1 sec delay/interval, highest resolution, LED control: high and sensor level: high. In the Rijnstrangen two cameras are checked by a CaLutra (Calutra, sd) volunteer (Figure 3), who provides the data for this research. These cameras are used by the ARK year-round to constantly monitor the population (Figure 7). Otters cover most distances on land along the banks water bodies and prey is caught in the water (Kurstjens, et al., 2009). Therefore, the cameras are placed in areas known for otter activity, i.e. mostly under bridges and on the banks of body of waters (Figure 6) . Additionally, using the locations of spraints (2.2.3) and otters traces (2.2.4) a more detailed analysis of the distribution can be made. In all of the study areas (Figure 3) along the banks within 10 meters from the water were searched for spraints.

Waarneming.nl was used to increase overall count of otter presence, searching the study areas from 01-04-2019 until 15-06-2020, only verified sightings were used.

2.2.2 *Habitat and landscape features.*

To test if habitat and landscape features influence presence of otters and following the method of a research in Denmark (Madsen & Prang, 2001), a grid of 1 km^2 was used (Figure 4) and different types of habitat and landscape features were scored within each grid cell. To indicate correlation between presence of otters and landscape features grid cells containing a body of water will be scored on the following types of habitats and landscape features: Depth of water was obtained through Waterkwaliteitsportaal ((2.7.3), 2019). The bankside is defined as the land 10 meters from the body of water in de grid. As the otter mainly resides on land the territory or "home-range" is usually calculated as the length of the bank being used by an individual, on average containing 35 to 40 km (Kurstjens, et al., 2009). Besides camera traps, at each site the bank was searched for spraints Only spraints or clear footprints were accepted as evidence of otters. Beaver presence was measured though the presence of beaver on camera traps, on sight, traces: beaver dens (lodges) and clear bite markings on trees were accepted as evidence of beavers. The nature of the adjacent area was defined the most common type of land next to the bank, measuring at least 50m inland. Containing the categories: Agricultural land, Natural Wet Area, Residential Area, Recreational Area, and Other. Data of land use from ArcGis online (ArcGis, 2019) was used to overlay with the grid (Figure 4) to score the habitat (Table 1).

2.2.3 *Sprraints*

Spraints are the faeces of the otter (Figure 6), which contain specific scents from the anal glands and can be used for communication. From spraints otters can detect the sex as well as the reproductive status of the other individual. Spraints are placed on visible locations, under bridges, fallen or overhanging logs and crossings of roads-and water ways. Sometimes the otter can elevate the dirt to make the spraint more visible (Kruuk, 2006).

Spraints have a wide arranges of shapes and colours depending on the ingested foods (Dijkstra, et al., 2012)

2.2.4 *Otter marks*

Besides spraints, other marks can also be used when looking for activity looking for activity. Other marks include prints (Figure 5), wild animals trails from the water and or prey remains of fish or other vertebrates

2.3 Data Analysis

2.3.1 Data overview

The identified otters from the camera traps, spraints, other traces and habitat and landscape features were digitally logged online in excel per location and per grid (Appendix: Raw data)

2.3.2 *Visualisation of distribution*

QGIS (QGIS.org, 2019) was used to map the presence of the otter in the Gelderse Poort. Included in these maps are the individuals captured on camera traps, spraints found and clear footprints. Otters clearly visible on camera traps, spraints as described in 2.2.3 and other traces described in 2.2.4 were scored as present and were incorporated in the distribution maps.

2.3.3 *Statistical analysis*

Dplyr was used to load the data (Wickham, et al., 2020). Multiple logistic regression analysis (Marschner, 2011) was done in R (R Core Team, 2017) to estimate probabilities of the presence of otters as a function of one or more explanatory variables. Presence of otters as the dependent variable was set to 1, provided that the otter was clearly visible on camera traps, spraints as found in figure 6 and described in 2.2.3 and other traces described in 2.2.4 were scored as present and were incorporated in the analysis. Nine variables (pH, water depth, presence of trees, presence of reed, roads, houses, presence of dogs, presence of beavers, type of land use), were used. Using the function glm (Marschner, 2011) variables, if not significant on a 0.05 level in a stepwise selection were dropped subsequently from a model including all variables to be tested. Those variables that were selected by this procedure were ultimately used in the model development. Anova (Fox & Weisberg, 2019) was used to analyse the variance of the final model and SPSS to make the figures (Corp, 2017)

Fig 3. **Study area.** Highlighted areas are studied areas. On the top left, the floodplains from the IJsel around Doesburg. On the top middle, the floodplains from the IJsel around Doesburg. On the bottom left, The Gelderse Poort, containing the Oude Rijnstrangen, Oude Waal and Bijland. On the bottom right, the floodplains from the IJsel around Zuthphen. Top right research area located in the Netherlands.

Table 1. Different landscape habitats and landscape features.

Habitat, landscape feature	Variable description	Reference
Depth of water	<0.5–1 m, 1-2m and > 2m	(Madsen & Prang, 2001)
*Tree coverage along bank**	Presence/absence of trees on bankside	(Madsen & Prang, 2001)
*Reed coverage along bank (Phragmites) **	Presence/absence of shrubs on bankside	(Madsen & Prang, 2001)
Roads	Public road for motorized vehicles	ARK Nature
Houses	Presence/absence house within grid	ARK Nature
Dogs	Presence/ absence of a run-off area for dogs within grid	ARK Nature
Beaver presence	Presence/absence of beaver/ beaver traces within grid	ARK Nature
Otter presence	Presence/absence of otter/otter traces within grid	ARK Natue
Land use	Most common type of land use within grid, at least 50m of coverage adjacent to bank	(Madsen & Prang, 2001)
Water level	Seasonal changes in water level, <2m or >2m	(Madsen & Prang, 2001)

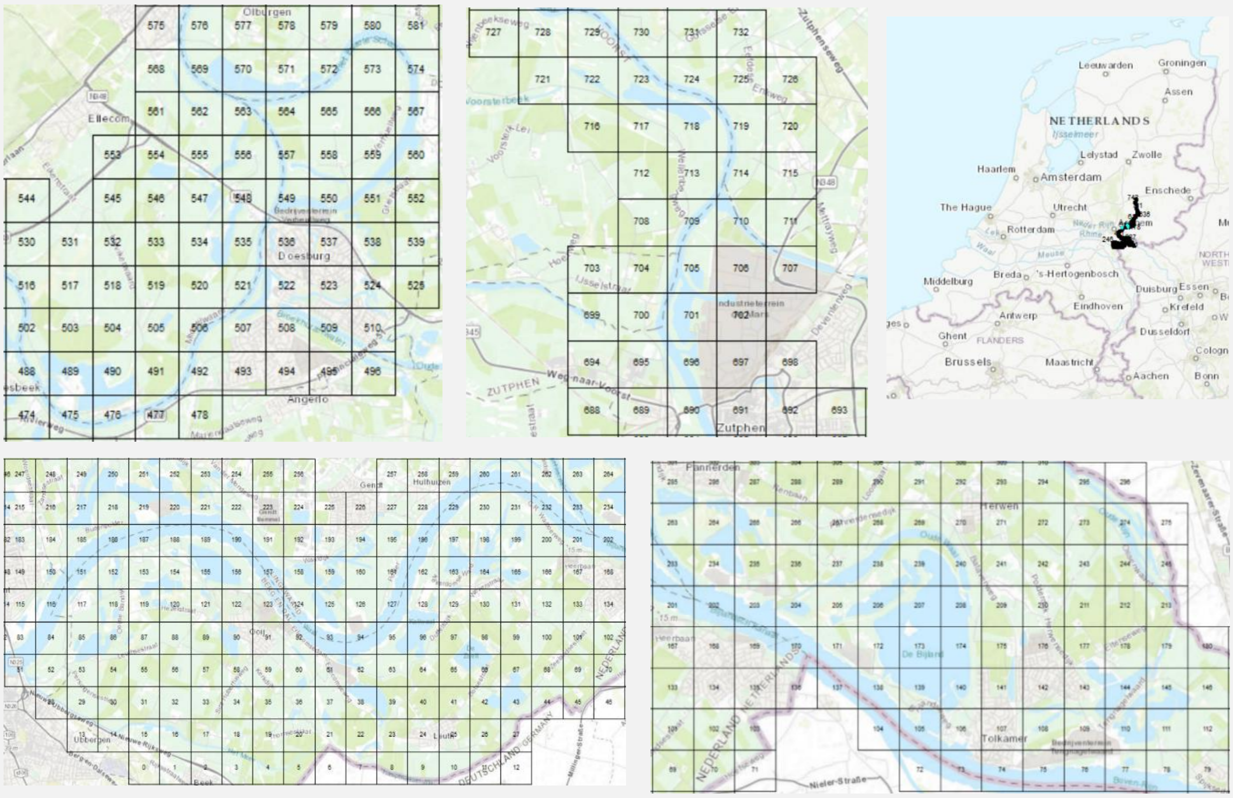

Figure 4. Research areas overlapped with a grid. On the top left, the floodplains from the IJsel around Doesburg. On the top middle, the floodplains from the IJsel around Zutphen. On the bottom right, the Oude Rijnstrangen, Oude Waal and Bijland. On the bottom left The Gelderse Poort. Top right research area located in the Netherlands.

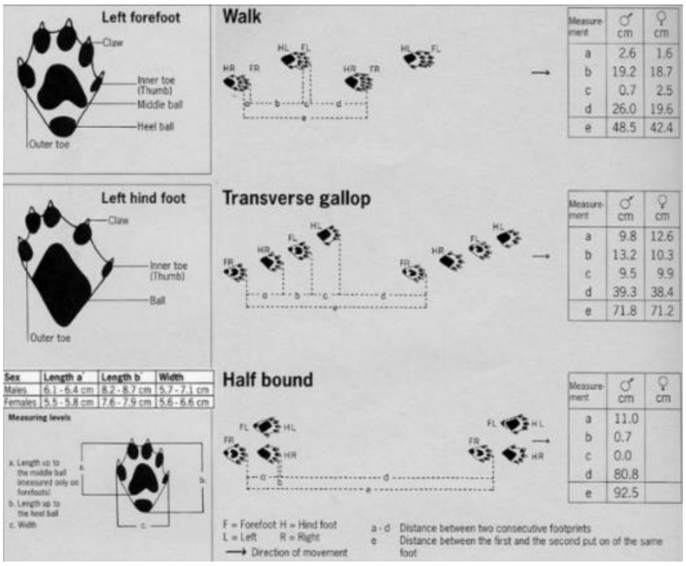

Fig 5. ***Prints of otters***. Different ways otters walk creates different types of prints. (Dijkstra, et al., 2012)

***Figure 6*. Otter spraint under bridge**

Fig 7. Camera traps. *Cameras are checked for otter activity. Camera placed near a fauna passage under the road. Photo by Amber Riley.*

3 Results

In 26 grid cells out a total of 102, otters were present. Figure 8 shows the locations where otter presence was found, with a total of 8 otters in The Gelderse Poort. 2 in the Rijnstrangen, 7 around Zutphen and 9 around Doesburg.

Using a stepwise selection, variables were dropped subsequently, resulting in two variables with a significant contribution: houses and tree coverage (Appendix: Anova 1). When the variable houses was implemented in the model with tree coverage both variables showed a significant contribution (p=0.0478 and p=0.040 respectively), which was confirmed by Anova in Table 2, creating the following formula; *Logit(p) = -4.37+2.28houses + 2.26tree_coverage*, were both variables contribute positively to the presence of the otter (Table 3). This final model significantly differed from the null model (p= 0.007, Appendix Anova 2). Furthermore, when interaction between the variables houses and tree coverage was implemented in a model, a higher AIC (78.56) was found then without the interaction (76.74) (Appendix: Summery Models). Therefore the model with the lowest AIC was adopted as a final result.

Presence of otters increased when houses were present within the grid-cell (p=0.048). When houses were present within the grid-cell the difference between absence or presence of otters increased as well (Figure 9). In addition, significantly higher percentages of trees (p=0.040) were present along the bank is areas with otters (Figure 10). Moreover an interesting trend can be seen in Figure 11 as otters are most present in areas dominated by agriculture, however by far the most land use scored was agriculture (58,82%).

A correlation matrix was made to get an overview of the relation of the dependant variable against the independent variables from Table 1. (Appendix: Figure S1)
Out of nine variables six variables showed correlation with another variable creating an overall of 8 different correlations. 1 variable, tree coverage, showed a significant correlation with the dependent variable, otters (Appendix Figure S1).

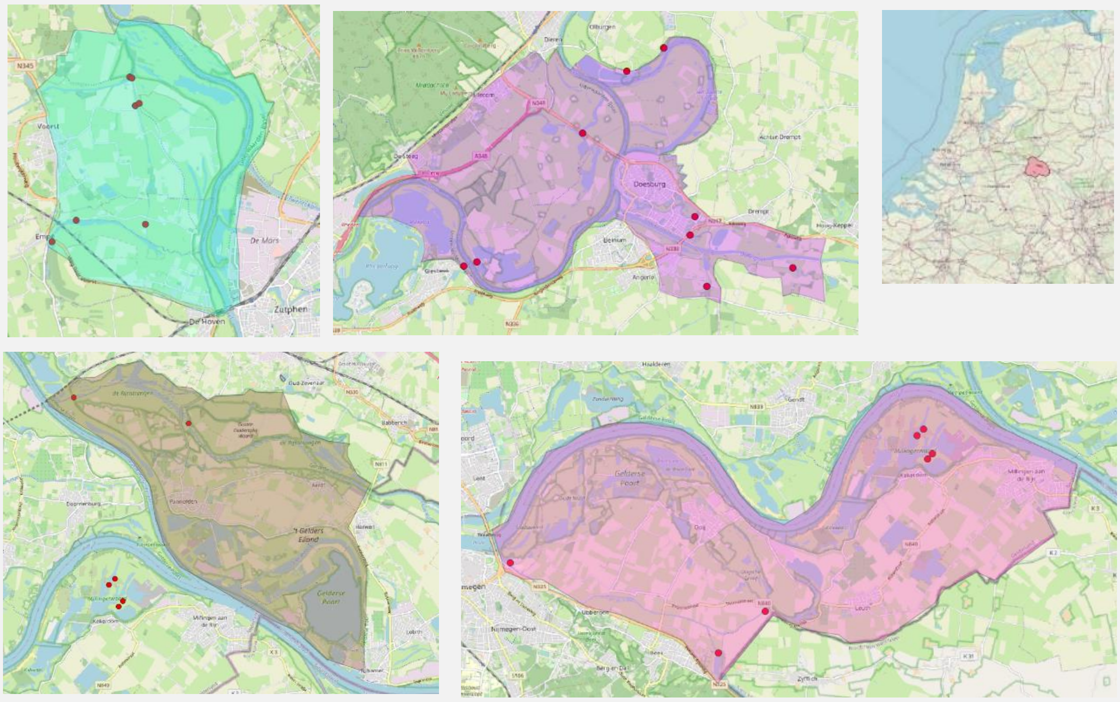

Fig 8 **Study area with otter presence.** Highlighted areas are studied areas, red dots indicate otter presence, either on sight or spraints.

Table 2. Analysis of Deviance Table (Type III tests)

Response:	**Otters**		
Predicter:	Df	Chisq	Pr(>Chisq)
(Intercept)	1	11.7459	0.00061
Houses	1	3.9156	0.04784
Tree coverage	1	4.2227	0.03989

Table 3. Coefficients Summery Final Model

Coefficients				
	Estimate Std	Error	z value	Pr(>|z|)
(Intercept)	-4.374	1.276	-3.427	0.00061
Houses	2.280	1.152	1.979	0.04784
Tree coverage	2.259	1.099	2.055	0.03989

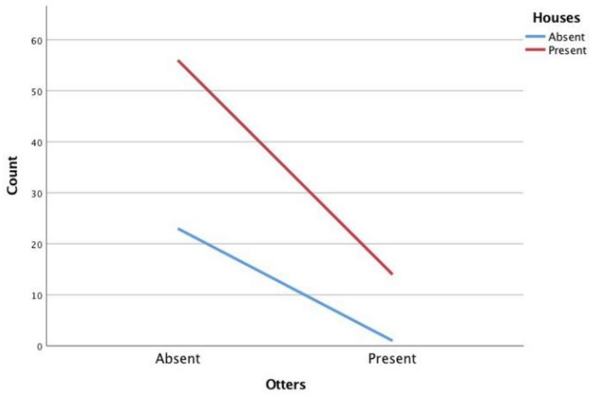

Figure 9. The amount (count) of presence of houses within each grid cell against otter presence. A higher presence of otters was found when houses were present within the grid, as well as the difference between absence or presence of otters (red line).

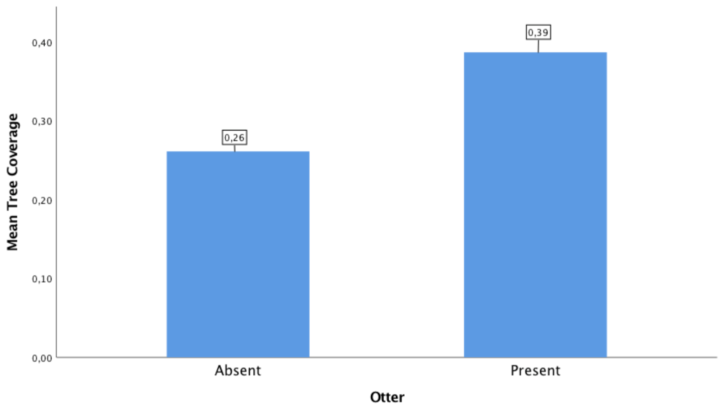

Figure 10. Tree coverage (%) within each cell against otter presence. A higher percentage of trees (39% then 26% average) correlates with more otters present in the area.

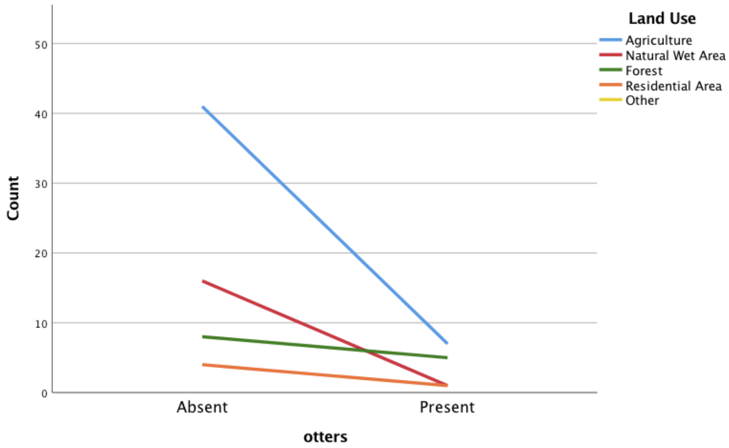

Figure 11. The amount (count) of the 4 different types of land use against the presence of otters. The difference between absent or presence of otters is the highest when agriculture is the most dominant land use.

4 Discussion

In conclusion this research showed a positive correlation between the presence of otters and tree coverage along banks and within a logistic regression model, tree coverage and the presence of houses seems to positively influence the presence of otters. Additionally, explainable correlations were found between habitat factors but were irrelevant for this research.

4.1 Sightings

The use of an online platform like waarneming.nl becoming more popular for research to gain more data points, using apps or online platforms. (source) however for more elusive species, like the otter, establishing presence on sight, is not favourable. Waarneming.nl was selected to increase the data set, as the otter is scarce and consequently the sightings as well, the search on the timeframe was first set for 01-04-2019 until 15-6-2019 corresponding with the field work for this research in 2020, but was then later adjusted to 01-04-2019 until 15-06-2020 to increase the amount of sightings for the statistical analyses. The identification of spraints found by non researchers can be difficult to validate, waarneming.nl counters this by using pictures to verify the sighting and for this research only verified sightings were used.

4.2 Spraints

The use of spraints has been widely used for the past decades to asses the presence of the species in a particular area or habitat (Mason & Macdonald, 1987,). Research, in particular on the use of this methodology has been used to back up this way of monitoring the distribution and other factors contributing to the presence of otters. Mason and Macdonald also showed in 1987 that with care, the density of signs can be used to make a broad comparison of populations, valuable for conservation programmes. However critics argue that the validity of such an indirect sampling method needs verification and the only appropriate evaluation is by comparing results between areas with known otter populations distributions to other areas with statistical techniques (Kruuk & Conroy, 1987)

However, it is my opinion that solely with the use of spraints habitat factors correlated with otter presence can be misleading. As the otter uses very specific places to defecate as can be seen in Figure 8 (Kruuk, 2006) the otter is definitely present in that specific area, but possibly not scored in surrounding areas which are probably potential habitat as well. To counter this problem Madsen & Prang (2001) used presence only data and argued that this way, and with the use of spraints, which are used as an indicator of otter presence in each surveyed stretch, the different habitat factors characterised the whole surveyed stretch. Therefore the presence of otters was related to habitat features rather than reflected the habitat types within each stretch favoured by otters for sprainting (Madsen & Prang, 2001). Because of the fragmented landscape, and therefore the fragmented habitat in the research area, this method by Madson and Prang was not used, as it was believed to give skewed results, as the different habitat factors did not characterised the whole stretch of surveyed bodies of water.

4.3 Absence of evidence is not evidence of absence

As previously stated the way spraints are placed are very specific. Hence the otter is present in that area but possibly not scored in surrounding habitat. Future research could use a similarity analysis and incorporate surrounding areas without otter spraints found, to compare the similarity of the habitat of those areas, to the areas were otters spraints were indeed found. Ideally, a large area know to contain a population is systematically and densely (ie a large amount of camera traps) monitored, to investigate how the species uses the habitat differently.

4.4 Population and conservation.

The positive correlation between houses and otters was an unexpected result. Previous research indicates that otters are shy and elusive animals, or at least, that is the current stigma (Leaniz, et al., 2006). However this image has come around. In 1987 a study in the UK concluded that the difficulties proposed, regarding otters living in urbanized areas or recreational areas after the reduction of the species during the 1900 century, were probably a bit exaggerated (Jefferies, 1987). If there is sufficient cover along the banks where the otter can move through undisturbed, otters can reside in areas together with human activity (Martin-Collado, et al., 2020). This is in line with research done in Denmark who argued that, as angling and canoeing are the most important recreational activities occurring along the Danish water courses, as measured by the number of people using these habitat ((Madsen & Prang, 2001), it would be possible to have a viable population of otters in an area which has a high human influence. Macdonald and Mason (1994) also stated that provided that an area containing sufficient and readily safe shelter, otters will tolerate significant levels of disturbance and can even be found in living in urban areas, provided that, there is an uncontaminated food supply, waterside shelter and corridors to other viable and protected populations (MacDonald & Mason, 1994). This is in line with the correlation of otter presence and the increase of tree coverage along banks, as otters, especially females, use the roots to rest and nestling sites to have cubs. With this in mind, The Gelderse Poort could be potential habitat.

As this research shows the distribution is limited. There are some sighting within the Gelderse Poort, however these sightings are mostly from 2019 and little activity has been measured in 2020. With migration from the core population in the Netherlands from the north and additional reintroduction, the Gelderse Poort and surroundings could hold a stable population and could serve as a migration route to other areas in countries like Belgium (The Ardennes) and Germany (Eifel and Niedersachsen). Migration from the north is supported by the activity found around Zutphen and further south in Doesburg, which could implicate that the species is migrating south to the Gelderse Poort. In addition, this migration is even more likely as this data implicates that otters can reside in fragmented habitats with human disturbance, providing there is sufficient cover, namely trees, along the banks.

5 Literature

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Appendix

1. Figures

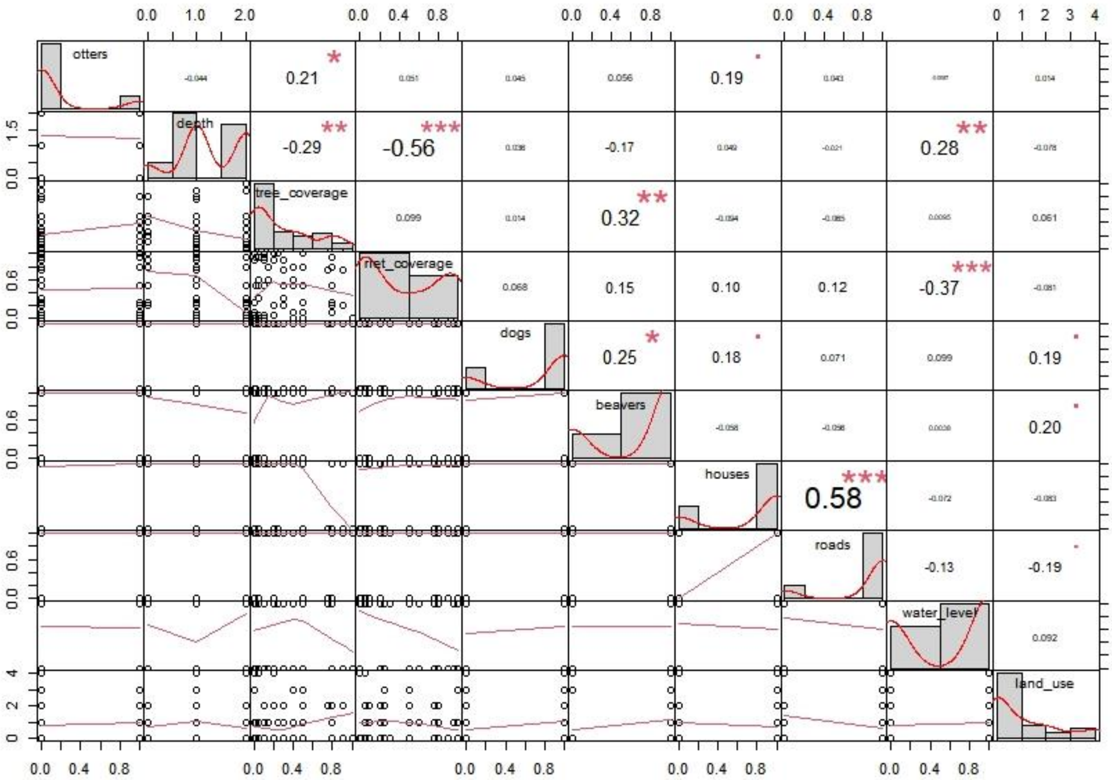

Figure S1. Correlation matrix. The dependent variable on the top left, against the independent variables.

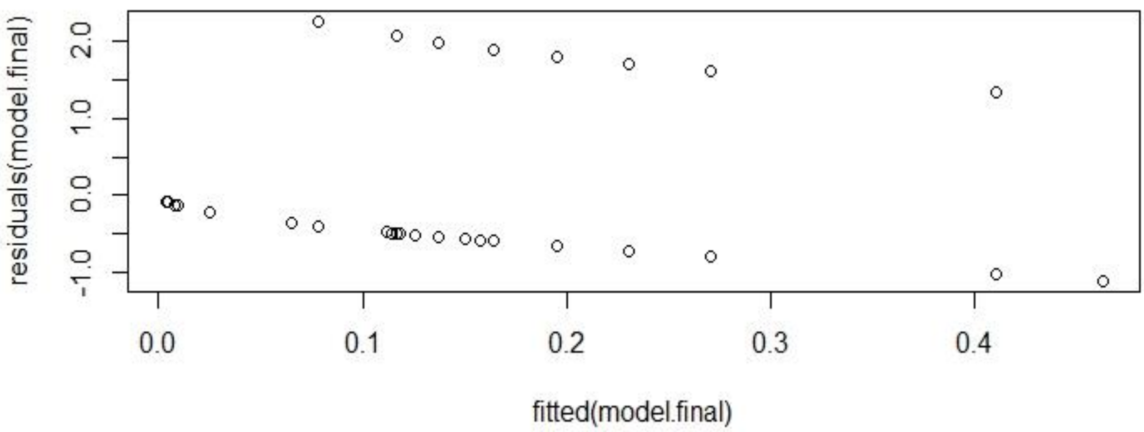

Figure S2. Residual plot of model.final otters - houses + tree_coverage

2. Anova

```
Anova 1. Analysis of Deviance Table (Type II tests)

Response: otters
              Df  Chisq Pr(>Chisq)
houses         1 3.9156    0.04784 *
tree_coverage  1 4.2227    0.03989 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Anova 2. Analysis of Deviance Table

Model 1: otters ~ 1
Model 2: otters ~ houses + tree_coverage
  Resid. Df Resid. Dev Df Deviance Pr(>Chi)
1        79     64.064
2        77     54.235  2   9.8284 0.007341 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

3. Summery models

Summery 1 interaction

```
Call:
glm(formula = otters ~ houses * tree_coverage, family = binomial(link = "logit"),
    data = Data, weights = na.action(na.omit))

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-1.11499  -0.58591  -0.49797  -0.09249   2.25903

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)            -5.651      4.071  -1.388    0.165
houses                  3.605      4.100   0.879    0.379
tree_coverage           3.976      4.964   0.801    0.423
houses:tree_coverage   -1.868      5.099  -0.366    0.714

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 78.797  on 92  degrees of freedom
Residual deviance: 70.558  on 89  degrees of freedom
  (1 observation deleted due to missingness)
AIC: 78.558
```

Summery 2

```
Call:
glm(formula = otters ~ houses + tree_coverage, family = binomial(link = "logit"),
    data = Data, weights = na.action(na.omit))

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.1517  -0.5648  -0.4872  -0.1674   2.2983

Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)     -4.374      1.276  -3.427  0.00061 ***
houses           2.280      1.152   1.979  0.04784 *
tree_coverage    2.259      1.099   2.055  0.03989 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 78.797  on 92  degrees of freedom
Residual deviance: 70.739  on 90  degrees of freedom
```

```
  (1 observation deleted due to missingness)
AIC: 76.739
```

Data Repository

DOI: 10.5281/zenodo.3982717

https://doi.org/10.5281/zenodo.3982717

```
<a href="https://doi.org/10.5281/zenodo.3982717"><img src="https://zenodo.org/badge/DOI/10.5281/zenodo.3982717.svg" alt="DOI"></a>
```

https://zenodo.org/badge/DOI/10.5281/zenodo.3982717.svg