MICA
Management of Invasive Coypu and muskrAt in Europe

NATURA 2000

D2.3 - Evaluation of the impact on protected species by monitoring numbers

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Summary

This report gives an overview of the biodiversity observations collected during the years 2021 to 2023 and analyses possible relations among the change in reed extent, IAS free area and the muskrat and coypu population sizes. It aims specifically to:

1. Provide an overview of changes in the endangered species LKPI
2. Evaluate if changes in the population size and/or clean area LKPIs can have led to changes in the endangered species LKPI
3. Evaluate if changes in the habitat LKPI (size of the reedbed extent) can have led to changes in the endangered species LKPI

The project areas contained a number of endangered species (also containing threatened species according to the IUCN red list). The changes in species richness an composition over the 3 years appear to be small within each project area, while there were large differences among project areas.

Similarly to the number of species, also the LKPIs (size of the clean area, (relative) reedbed extent, muskrat and coypu population sizes and catch per suitable habitat) did show little variation over the project duration within each project area for the project duration, while there were considerable differences among the project areas. Based on this we conducted the analysis between species richness and the three explanatory LKPIs (reed extent, IAS free area and the muskrat and coypu population sizes) across the project areas.

Based on these analyses we found there is an indication that the clean area LKPI might be related to endangered birds in our project, but no evidence that the clean area LKPI led directly to changes in the other endangered species LKPI in general. Furthermore we found a slight indication that the muskrat population size LKPI might be related to endangered birds in our project, but no evidence that the muskrat and coypu populations LKPIs led directly to changes in the other endangered species LKPI in general (see aim 2).

With regard to aim 3 we identified a meaningful positive relation between the habitat LKPI (reed extent) and the species richness in birds and odonata.

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1. Introduction

This provides an overview of the impact of muskrats and coypu on protected species in 6 LIFE Mica project areas. These two species have a significant effect on emergent and submerged aquatic vegetation, which can lead to the suppression or disappearance of plant species. This in turn has a more severe impact on bird, fish, amphibian, and insect species that rely on these habitats for survival.

This report includes a comprehensive analysis to evaluate how changes to the invasive and alien species (IAS) population sizes, clean areas, and reed bed areas impact the endangered species LIFE Key Project Indicators (LKPIs), particularly red list species richness.

The aim of this report is to:

1. Provide an overview of changes in the endangered species LKPI
2. Evaluate if changes in the population size and/or clean area LKPIs can have led to changes in the endangered species LKPI
3. Evaluate if changes in the habitat LKPI (size of the reedbed extent) can have led to changes in the endangered species LKPI

2. Methods

2.1 Monitoring protocol

Project areas 1 (Lake Dümmer), 2 (Aschau Teiche), 3 (Vechtegebiet), 4 (Sint-Laureins), 5 (Sint-Maartensheide - De Luysen), and 10 (Border Gelderse Poort / Kreis Kleve) were surveyed for birds, Odonata, and plants in Germany (areas 1, 2, 3), Belgium (areas 4, 5), and the Netherlands (area 10) in 2021, 2022 and 2023.

A complete overview of the monitoring protocol and a list of the survey dates can be found in the online Supplementary material.

2.2 Red list data

We obtained a list of red list species and their status (critically endangered, endangered, near threatened, and vulnerable, etc.) in Germany for birds (Grueneberg et al. 2015), Odonata (Ott et al. 2021), and plants (Metzing et al. 2018). We obtained similar lists for Belgium (Maes et al. 2020) and the Netherlands (Ministerie van Landbouw, Natuur en Voedselkwaliteit 2023). In all cases, the most updated red list was used. Only species found on the red list in the country where they were surveyed are included in the analysis. However, it is important to note that a species can be included on a red list in one country but not another and may have a different global red list status.

All analyses were conducted at the species level since this is the taxonomic rank of the red lists. Species were grouped into the main categories of birds, odonata, and plants.

2.3 Biodiversity indices

Biodiversity indices provide information on the variety and distribution of species within a community and are essential in assessing the health and functioning of ecosystems. By comparing the values of these metrics in different locations and at different times, we can gain insight into how biodiversity is changing and what impact this may have on the ecosystem and its ability to provide critical ecosystem services. We report the species richness of all species as well as the number of species per red list status as biodiversity metric. Species richness refers to the number of different species present in a given area or community. It ignores evenness (which is a measure of diversity), which is considered less relevant in this project.

2.4 Relation between biodiversity and size of clean area, relative reedbed extent, muskrat and coypu population sizes

We relate species richness to the size of the IAS-clean areas, relative reedbed extent as well as the muskrat and coypu population size and catch per suitable habitat. The relation is evaluated through scatter plots and the Spearman correlation coefficient to test relationships statistically. All data analyses were done in the R environment (R Core Team, 2023).

3. Results

3.1 Summary statistics

Between 2021 and 2023, we collected 5780 total observations of 202 total species. Of these 202 species, 70 are birds, 36 are Odonata, and 96 are plant species. An overview of the species richness results for each species group and project area can be found in Appendix 1 and an overview of the red list status of these species is given in Appendix 2.

3.2 Species Richness

Species richness varied among project areas and over time (see Figure 1). However, we found a very similar pattern across years, especially among plants. It was also striking that the variability among the sub-plots and different moments of field data collection was relatively high (as indicated by the standard errors in Figure 1). So, even though differences over the years in the Birds and Odonata species richness in e.g. Lake Dümmer, Aschau Teiche as well as Border Gelderse Poort/Kreis Kleve were seen, the variability within the surveys was also considerable and therefore these differences were not statistically significant. The overall interpretation of these patterns is that the species richness in the targeted species did not vary across time in these three years of study.

With respect to birds Lake Dümmer and Aschau Teiche stood out with a high species richness. With respect to odonata it were Lake Dümmer and Aschau Teiche and Sint Laureins. And with regard to plants Vechtegebiet, Sint Laureins and Sint-Maartensheide de Luysen showed a high species richness. So the areas were quite contrasting with regard to species composition in the groups that were surveyed in this project.

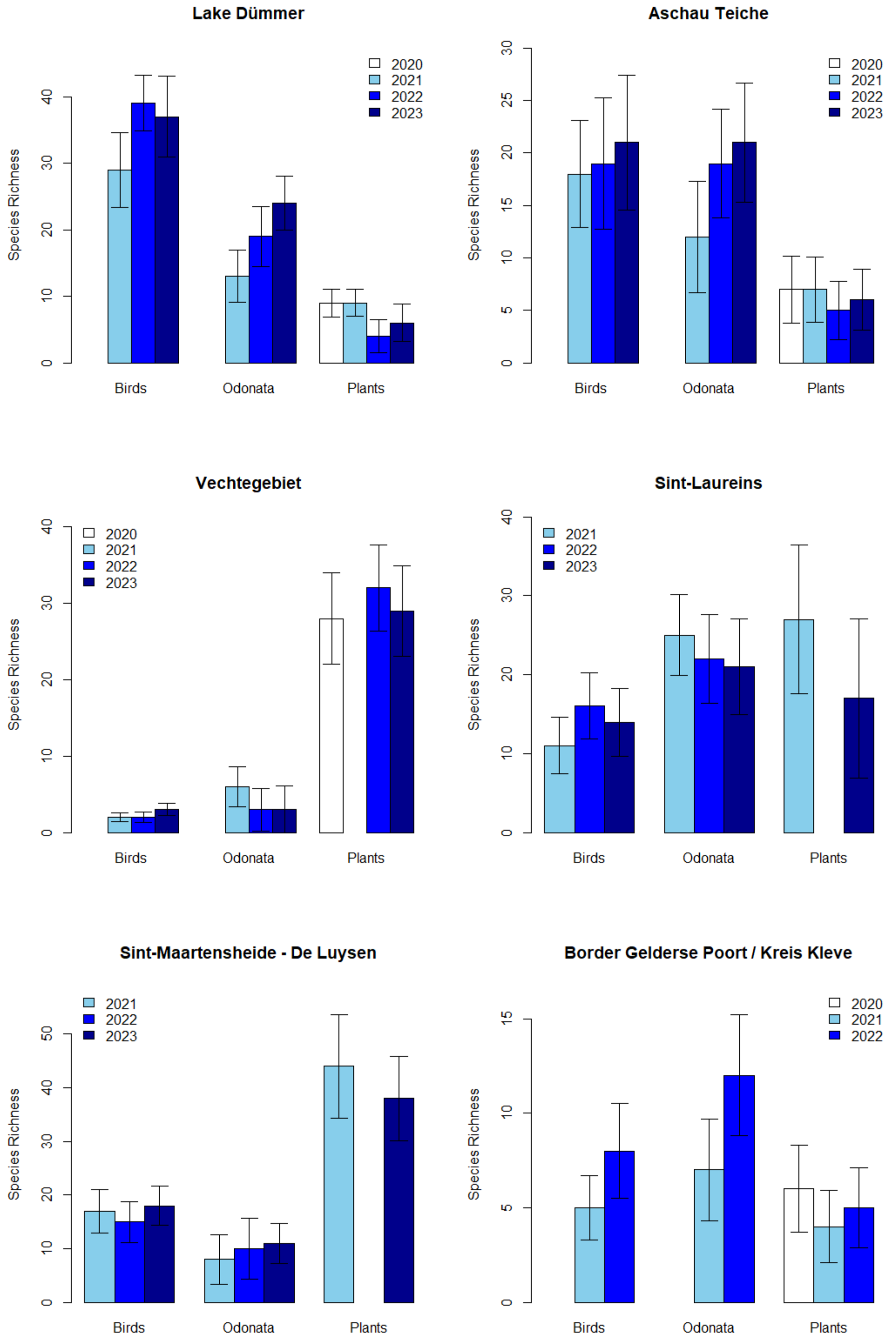

Figure 1. Species richness per project area, species group, over time. The error bars show the standard error calculated among the different sampling moments and sites within one year. Note that the y-axes are different per sub-plot.

3.3 Endangered Species LKPI

3.3.1 Overview of changes

First, we observed all species that were listed on the red list (within the same country as surveyed), including those listed as critically endangered, endangered, near threatened, or vulnerable. We did not observe large differences in species richness across years (Figure 2 and a tabular view in Appendix 2). However, we did see differences between project areas; we observed the highest number of red list species in areas 1 and 5 and the lowest number of red list species in areas 2 and 10 (Figure 2). There were up to 5 critically endangered, 4 endangered, 3 near threatened, and 4 vulnerable species found within a given year. The species richness of red list species surveyed for each project area, year, red list status, and species group can be found in Appendix 2.

Acquatic warblers (*Acrocephalus paludicola*) and little bitterns (*Ixobrvchus minutus*) were not observed during the surveys. Black terns (*Chlidonias niger*) were observed once (1 individual) in project area 10. Little bitterns (*Ixobrychus minutus*) were observed once (2 individuals in total) in project area 5. Reed buntings (*Emberiza schoeniclus*) were observed 101 times total in all years in project areas 1, 4, and 5 in both Belgium and Germany. Lesser bullrushes (*Typha latifolia*) were observed 24 times in all 3 countries at all project areas except 3 in all years.

As expected, the size of the project area (km^2) affects the red list species richness - an effect of observer bias. The fact that the larger project areas (especially area 10) contained fewer red list species is an illustration of this phenomenon.

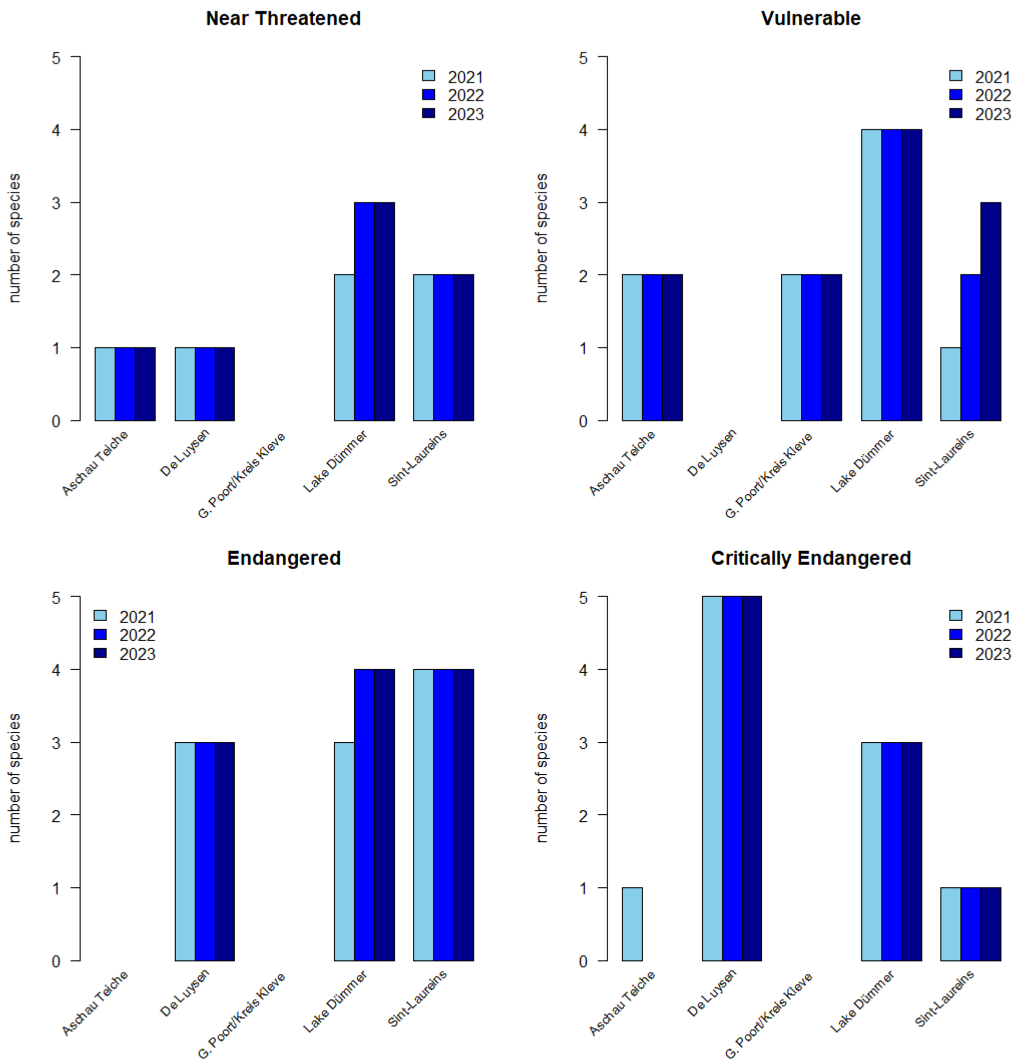

Figure 2. Number of species of all red list species observed in each project area and year, including all survey data collected by Life MICA parties. Only includes red list species from the country's red list where the survey was conducted.

3.4 Relation between species richness and reedbed extent, size of clean areas and muskrat and coypu population sizes and catch per suitable habitat.

3.4.1 relation between species richness and relative reedbed extent

The relation between relative reedbed extent (surface area covered by reedbeds divided by the total project area) and the species richness is shown per species group in Figure 3. It shows that the linear correlation for birds is low (the data for lake Dümmer in the upper-left of the figure deviate from the overall pattern) while for the Odonata it is moderate and for plants it is negative. The direction of these trends is expected: reed area is conditional as a core habitat for the birds and odonata species that were surveyed in this project. At the same time reed vegetations (especially when stretching over larger extents) tend to be species-poor and homogenous – hence for areas with a high reed cover, the plant species diversity is low as a consequence.
When considering the significance of these relationships, only the relation for the odonata is significant (when using a Pearson correlation coefficient to measure linear association as well as a Spearman correlation coefficient). However, this is only the case when calculating the association across all project areas. When the individual effects of the areas are taken into account as random factors (either as intercept or slope and intercept), none of the relationships are significant. This is mainly due to the relatively short project duration, compared to any changes that take place in occur species richness and reed area within each project area. To provide an indication of how the relative reedbed extent may relate to species richness within each of the species group of interest, still provide Figure 3 with linear trend lines.

In addition, to the relation between reed extent and diversity, the association among species richness and all KPLIs is given in Table 2. In this table, the Spearman correlation is reported as we are primarily interested in the direction of associations and not in linearity. It appears that there are only two significant relationships in addition to that between relative reed extent and odonata species richness: the size of the coypu clean area with bird species richness, and the muskrat population size with bird species richness. The directions of these relationships are also in accordance to what would be expected.

Given all the calculated correlations, one could argue that the significance values should be adjusted for multiple testing. This does however not make a difference in the result - it still leaves these correlation coefficients significant. From an ecological viewpoint however, the presence of these two relations and the absence (also deviations in trend) the results are inconclusive. It is clear that in these data, no systematic and large scale effect could be discerned. Our assessment is that each of the project areas have their own key characteristics (and related to that a unique community composition). Any relations between KPLI and species richness should therefore best be analysed per project area and, once robust relations are found between KPLIs and species richness in multiple project areas, a pooled analysis could be conducted. While there are trends in both the KPLIs and species richness of the focal species, these are not sufficiently pronounced over the duration of this project to allow such an analysis. That is why we limit ourselves here to an analysis with the information for project areas pooled.

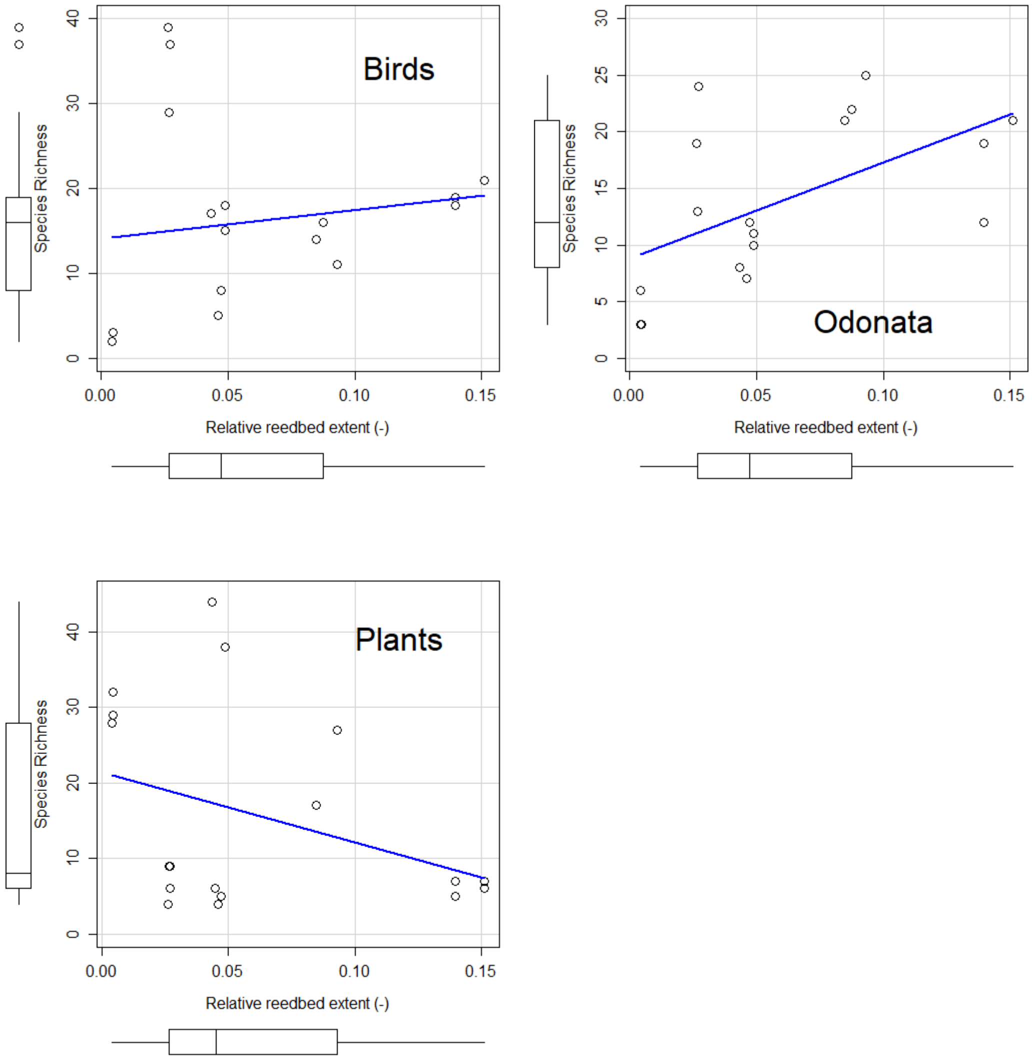

Figure 3. Relation between relative reed extent and diversity for the three species groups. Every circle represents a value for a project area in a single year.

Table 1. Spearman correlation coefficients between LKPIs and the species richness per species group (and calculated across all project areas). The significant correlation coefficients are highlighted.

LKPI	IAS	species group	correlation coefficient	p-value
relative reed extent	both	birds	0.32	0.21
	both	**odonata**	**0.59**	**0.01**
	both	plants	-0.28	0.26
clean area	muskrat	birds	-0.04	0.86
	coypu	**birds**	**-0.73**	**<0.00**
	muskrat	odonata	-0.48	0.05
	coypu	odonata	0.01	0.97
	muskrat	plants	0.20	0.42
	coypu	plants	0.27	0.27
population size	**muskrat**	**birds**	**-0.58**	**0.01**
	coypu	birds	-0.04	0.87
	muskrat	odonata	0.12	0.64
	coypu	odonata	-0.45	0.07
	muskrat	plants	0.17	0.50
	coypu	plants	-0.08	0.76
catch per suitable habitat	muskrat	birds	-0.45	0.08
	coypu	birds	0.15	0.56
	muskrat	odonata	0.25	0.34
	coypu	odonata	-0.24	0.36
	muskrat	plants	0.07	0.78
	coypu	plants	-0.20	0.43

4. Conclusions

4.1 General conclusions

The project areas contained a number of endangered species (also containing threatened species according to the IUCN red list), which did show relatively stable occurrence patterns over the years. The areas did differ considerably with regard to species composition and species richness among each other.

Similarly to the number of species, also the LKPIs (size of the clean area, (relative) reedbed extent, muskrat and coypu population sizes and catch per suitable habitat) did show little variation over the project duration within each project area for the project duration, while there were considerable differences among the project areas. We decided to evaluate the relation between the state of the endangered species with the LKPI by relating the yearly values species richness of the surveyed endangered species with the yearly LKPIs across all project areas.

A major conclusion following from these analyses that for a thorough evaluation of the relationship among the clean area, habitat and population size LKPIs with the endangered species LKPI one would have to collect monitoring data over a prolonged period. Based on an extrapolation of the data collected in this project we estimate that a period of 6 to 10 years would be required.

4.2 Evaluate if changes to the clean area LKPI can have led to changes in the endangered species LKPI

There was only a significant relationship between the clean area for coypu and bird species richness. For all the other species groups, no pattern was seen. Therefore we conclude that there is an indication that the clean area LKPI might be related to endangered birds in our project, but no evidence that the clean area LKPI led directly to changes in the other endangered species LKPI in general.

4.3 Evaluate if changes to the habitat LKPI (relative reed extent) can have led to changes in the endangered species LKPI

We observed a positive relationship between species richness and relative reed extent for birds and odonata, and a negative relation for plants. The relation with plants can be explained by the nature of reed vegetation (which is by definition not diverse) and is in this context less relevant.
Even though this trend could not be confirmed within each project area, we attribute this to the relative short duration of the observations compared to the rates of change and think that trend would exist within project areas as well if the observations would be continued over a longer period.
We conclude that there is an indication that the habitat LKPI is positively related to endangered birds and odonata in our project.

4.4 Evaluate if changes to the population size and catch per suitable area have led to changes in the endangered species LKPI

We observed a positive relation between muskrat population size and bird species richness only. There were no other relations between population size and catch per suitable habitat and species richness LKPI. Therefore we conclude that there is a slight indication that the muskrat population size LKPI might be related to endangered birds in our project, but no evidence that the muskrat and coypu populations LKPIs led directly to changes in the other endangered species LKPI in general.

5. References

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Appendix 1 – Species richness per project area per species group and year

area	*species group*	*year*	*species richness*	*species richness SE*
1	Birds	2021	29	5,6
1	Birds	2022	39	4,2
1	Birds	2023	37	6,1
1	Odonata	2021	13	3,9
1	Odonata	2022	19	4,5
1	Odonata	2023	24	4,1
1	Plants	2020	9	2,1
1	Plants	2021	9	2
1	Plants	2022	4	2,5
1	Plants	2023	6	2,8
2	Birds	2021	18	5,1
2	Birds	2022	19	6,3
2	Birds	2023	21	6,4
2	Odonata	2021	12	5,3
2	Odonata	2022	19	5,2
2	Odonata	2023	21	5,7
2	Plants	2020	7	3,2
2	Plants	2021	7	3,1
2	Plants	2022	5	2,8
2	Plants	2023	6	2,9
3	Birds	2021	2	0,6
3	Birds	2022	2	0,7
3	Birds	2023	3	0,8
3	Odonata	2021	6	2,6
3	Odonata	2022	3	2,8
3	Odonata	2023	3	3,1
3	Plants	2020	28	6
3	Plants	2022	32	5,6
3	Plants	2023	29	5,9
4	Birds	2021	11	3,6
4	Birds	2022	16	4,2
4	Birds	2023	14	4,3
4	Odonata	2021	25	5,1
4	Odonata	2022	22	5,6
4	Odonata	2023	21	6,1

4	Plants	2021	27	9,4
4	Plants	2023	17	10,1
5	Birds	2021	17	4,1
5	Birds	2022	15	3,8
5	Birds	2023	18	3,6
5	Odonata	2021	8	4,6
5	Odonata	2022	10	5,7
5	Odonata	2023	11	3,7
5	Plants	2021	44	9,6
5	Plants	2023	38	7,9
10	Birds	2021	5	1,7
10	Birds	2022	8	2,5
10	Odonata	2021	7	2,7
10	Odonata	2022	12	3,2
10	Plants	2020	6	2,3
10	Plants	2021	4	1,9
10	Plants	2022	5	2,1

Appendix 2 – Number of species per red list status by project area and year

project area	*year*	*nr of species*	*Red list status*
1	2021	3	Critically Endangered
1	2022	3	Critically Endangered
1	2023	3	Critically Endangered
2	2021	1	Critically Endangered
4	2021	1	Critically Endangered
4	2022	1	Critically Endangered
4	2023	1	Critically Endangered
5	2021	5	Critically Endangered
5	2022	5	Critically Endangered
5	2023	5	Critically Endangered
1	2021	3	Endangered
1	2022	4	Endangered
1	2023	4	Endangered
4	2021	4	Endangered
4	2022	4	Endangered
4	2023	4	Endangered
5	2021	3	Endangered
5	2022	3	Endangered
5	2023	3	Endangered
1	2021	2	Near Threatened
1	2022	3	Near Threatened
1	2023	3	Near Threatened
2	2021	1	Near Threatened
2	2022	1	Near Threatened
2	2023	1	Near Threatened
4	2021	2	Near Threatened
4	2022	2	Near Threatened
4	2023	2	Near Threatened
5	2021	1	Near Threatened
5	2022	1	Near Threatened
5	2023	1	Near Threatened
1	2021	4	Vulnerable
1	2022	4	Vulnerable

1	2023	4	Vulnerable
10	2021	2	Vulnerable
10	2022	2	Vulnerable
10	2023	2	Vulnerable
2	2021	2	Vulnerable
2	2022	2	Vulnerable
2	2023	2	Vulnerable
4	2021	1	Vulnerable
4	2022	2	Vulnerable
4	2023	3	Vulnerable