Management of Invasive Coypu and muskrAt in Europe

D2.1 - Evaluation of the numbers of muskrat and coypu in the project areas

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Summary

This report summarizes the Muskrat and Coypu numbers in the Life Mica Project.

The Muskrat and Coypu catches per project area show overall a variable but relatively constant pattern within project areas. Differences between project areas are large (not just in absolute values, but also in occurrence per suitable habitat).
The same can be said with respect to the AIS free areas and the estimated population sizes that are based on these catches.

While these values seem to correspond with the overall understanding of the population developments in the project areas, the yearly values that were used in this project do not offer sufficient detail for control activities in practice. A more fine-grained reporting of catches will be required for that.

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1. Introduction LIFE MICA project

Innovative methods for monitoring and management of coypu and muskrat
The LIFE MICA project (Management of Invasive Coypu and MuskrAt in Europe) is an EU LIFE project with the aim to develop management strategies for invasive coypus (*Myocastor coypus*) and muskrats (*Ondatra zibethicus*) in Europe. From 2019 to 2023, innovative methods for population control of these species have been developed and tested in a cooperation between German, Dutch and Belgium (Flemish) institutions.

Invasive alien species
Due to globalization, species are spreading around the globe and often establish outside their native range. When these species threaten biodiversity, human and animal health or cause economic damage in their new habitats, they are referred to as invasive alien species (IAS).

EU Regulation on invasive alien species
The EU Regulation No. 1143/2014 aims to mitigate negative impacts of invasive alien species on biodiversity. The regulation defines measures to prevent the introduction of invasive alien species and to manage established populations. Coypus and muskrats are on the 'Invasive Alien Species of Union Concern' list, therefore countries are required to take appropriate management actions.

Coypus and muskrats in Europe
Originally, coypus are native to South America and muskrats come from North America. They established in Europe after releases from fur farms in the early 20th century. Both species are semi-aquatic rodents, which mainly feed on riparian vegetation and burrow tunnels in dykes and riverbanks. As such, the main impacts of coypus and muskrats are threats to biodiversity in their new habitats, undermining of waterway infrastructure (dikes and dams) and damage to agricultural land.

Innovative methods developed by LIFE MICA
In the LIFE MICA project, five innovative methods for monitoring and management of coypus and muskrats were developed and tested in 11 project areas in Flanders, the Netherlands and Germany (DNA-Mapping, Environmental DNA (eDNA), Smart camera tracking, Smart life traps, Dashboard). The aim of LIFE MICA was to provide tools for coypu and muskrat management that can be employed in regions with coypu and muskrat occurrence. Generally, those methods can be also applied for the management of other invasive alien species or even protected species.

The role of monitoring occurrence, abundance and population estimates
In order to evaluate whether the applied methods in LIFE MICA are effective, it is crucial to monitor the coypu and muskrat occurrence and abundance over time. This can be done through observations (direct visual detections as well as through camera traps), as well as by recording the number of captured animals. These observations allows, in turn, to make an estimate of population sizes and other key indicator values like the size of the area where the animals are not present ('clean area'). In this report we list the number of catches, the size of the clean areas and the population sizes for the project areas.

2. Methods

As input for this analysis, the catches of Muskrat and Coypu in the Life MICA project areas are reported in the dashboard at https://mica.inbo.be/ and available for download through GBIF (https://www.gbif.org/).
All available data on Muskrat and Coypu observations and catches that were available at 1 September 2023 were considered – the URLs to these data are provided in Appendix 1.

The data were combined in calculations to determine Muskrat and Coypu catches, and the clean area (sections 3.1 and 3.2). They also form the basis for population estimates (reported in section 3.3).

In this report, reference is made to the 11 project areas, which are numbered for brevity. As a reference, Table 2.1 and Figure 2.1 give names, and other attributes for the project areas.

Table 2.1 Names and sizes of the project areas in km^2.

Area	Name	Surfaces area (km^2)	Suitable habitat (length water ways, km)
1	Lake Dümmer	46	4.1
2	Aschau Teiche	0.86	4.2
3	Vechtegebiet	149	5.1
4	Sint-Laureins	3.66	2.7
5	Sint-Maartensheide - De Luysen	1.84	5.9
6	Mark Valley Herne Galmaarden	1.87	3.2
7	Hoogstraten	7.57	4.8
8	Wetterskyp Fryslan	3460	12.2
9	Noord-Holland North from Alkmaar	1000	10.2
10	Border Gelderse Poort / Kreis Kleve	74	5.4
11	Border Hunze en Aa's	1000	5.3

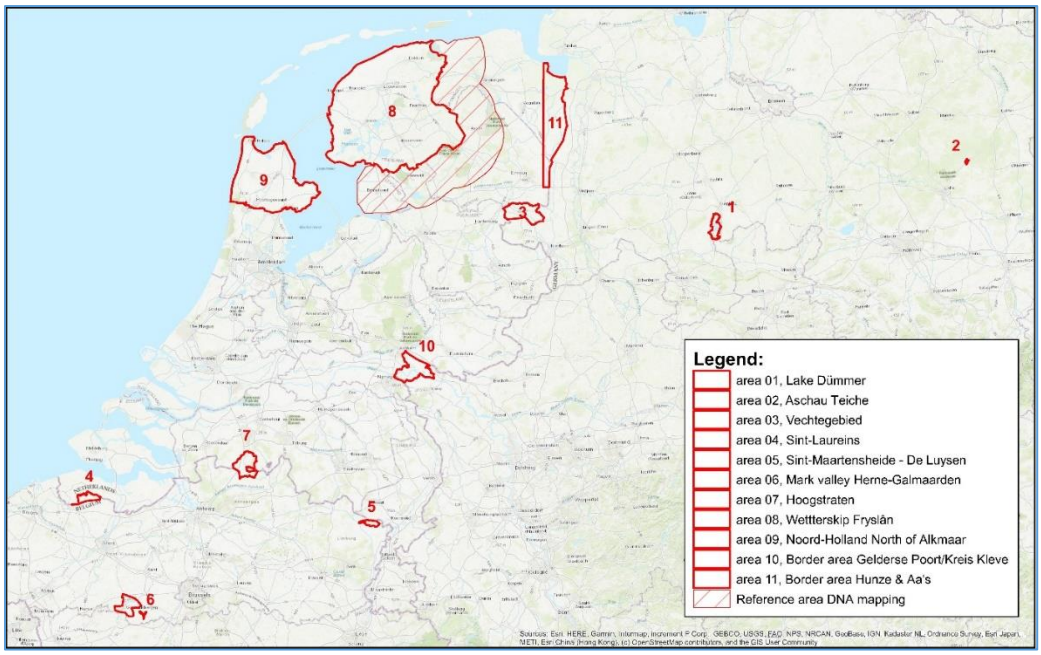

Figure 2.1. Project areas

Determining catch and catch per suitable habitat (KPLI D2.1.2)
The catch was established per project area, based on the best available records. For some areas these were hunting-reports (total numbers per year), for others these comprised records from the control organization (with recordings of every individual capture). Using the estimated length of waterways, these values were converted to catch per suitable habitat.
The estimated length of waterways were calculated by using the method used in LIFE MICA (developed by Nicolas Noé and described here: https://github.com/inbo/mica-dashboard/blob/main/source_data/RATS_PER_KM_WATERWAY.md)

Determining the size of IAS free areas (KPLI D2.1.3)
The surface area where no IAS is present (= IAS free areas, or 'clean area') are estimated as those areas in which no individuals are observed or captured over a complete year. For this analysis, a 5 by 5 km grid is used. With muskrat and coypu camera trap observations in Belgium, the Netherlands and Germany and the occurrence data by UVW, RATO and VVM in combination. All cells that are not occupied and overlapping with the project areas are included in the total clean area per project area.

Estimating population size (KPLI D2.1.4)
Using a simple population model, parameterized per project area, the catches and observations are translated into estimated population sizes within the project areas. The population models use yearly time-steps and progress by making estimates of birth, death and survival by taking information from literature into account.
The entire population model can be captured in a single equation:

$$N_t = MAX(0; (N_{t-1}*BR) - C_t)*(SR_p+YS_t) \quad \text{(eq. 1)}$$

Where N_t is the size of the population in year t, C_t is the number of catches in year t. BR is a birth rate (taken constant over time, and the same for all project areas). SR_p is a survival rate which is constant over time but varying between project areas and YS_t is a yearly component of the survival rate which is constant for the project areas. The parameter values for BR, SR_p and YS_t are listed in Appendix 2.

3. Results

3.1 Number of coypu and muskrat caught (KPLI D2.1.1 & D2.1.2)

The catches of Muskrat and Coypu per project area are given in respectively Tables 3.1 and 3.2.

The values show a mixed pattern over time. In most project areas the catches have been stable (with a considerable variation from year to year). Only in Area 9 there is an upward trend for Muskrats and in Area 3 there is a downward trend for Coypu.

Table 3.1 Muskrat catches. A dash means that data for the respective year and project area is not available. The values for 2023 refer to a half a year (January until July) so these cannot be compared directly with the values in the preceding years.

nr	2018	2019	2020	2021	2022	2023 (1st half)
1	-	-	20	57	27	-
2	0	0	0	0	0	0
3	-	73	388	319	242	87
4	215	429	447	676	683	512
5	0	0	0	0	0	0
6	28	77	33	37	89	45
7	0	0	0	0	0	0
8	560	571	277	282	449	191
9	406	353	331	322	2357	983
10	190	102	156	100	103	34
11	926	2010	1308	1273	1327	713

Table 3.2 Coypu catches. A dash means that data for the respective year and project area is not available. The values for 2023 refer to a half a year (January until August) so these cannot be compared directly with the values in the preceding years.

nr	2018	2019	2020	2021	2022	2023 (1st half)
1	-	-	69	41	44	-
2	19	32	34	29	26	26
3	-	491	700	450	230	-
4	0	0	0	0	0	0
5	41	0	7	0	1	1
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	2	0	0	0	0	0
9	0	0	0	0	0	0
10	36	29	50	28	54	14
11	90	84	147	148	103	89

Since the length of waterways is constant over time (see Table 2.1), the tables with these values are not provided here (they would show the same patterns as Tables 3.1 and 3.2).

3.2 Size of IAS free areas (D.2.1.3)

The development of clean areas over time are given in Tables 3.3 (Muskrat) and 3.4 (Coypu). The numbers are somewhat related to the catches (Tables 3.1 and 3.2) but in general, the size of clean areas varies less. Only in project areas 8 and 9 (Wetterskip Fryslan and North Holland North from Alkmaar) the Muskrat clean areas vary importantly. In the first it increases slightly over time, where in the latter there is a considerable drop, especially in 2021 to 2023.

Table 3.3. Size of clean areas over time for Muskrat, as fraction of total surface area (See Table 2.1 for surface area).

Project area (nr)	2018	2019	2020	2021	2022	2023
1	0	0	0	0	0	0
2	1	1	1	1	1	1
3	0.13	0.10	0.08	0.08	0.06	0.09
4	0	0	0	0	0	0
5	1	1	1	1	1	1
6	0	0	0	0	0	0
7	1	1	1	1	1	1
8	0.64	0.65	0.68	0.69	0.71	0.70
9	0.87	0.86	0.76	0.72	0.59	0.57
10	0.02	0.03	0.03	0.04	0.03	0.03
11	0.07	0.08	0.09	0.08	0.09	0.08

Table 3.4. Size of clean areas over time for Coypu, as fraction of total surface area (See Table 2.1 for surface area).

nr	2018	2019	2020	2021	2022	2023
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0.15	0.12	0.12	0.15	0.18	0.18
4	1	1	1	1	1	1
5	41	0	7	0	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	0.01	1	1	1	1	1
9	1	1	1	1	1	1
10	0.06	0.07	0.05	0.04	0.04	0.06
11	0.12	0.15	0.14	0.13	0.12	0.12

3.3 Estimated population sizes of Muskrat and Coypu (D.2.1.4)

The estimated Muskrat and Coypu population sizes per project area are given in Tables 3.5 and 3.6. Most of the areas show a stable trend for both Muskrat and Coypu. Exceptions are areas 3 and 8, which show a slight decline in Muskrat population size, while area 9 shows a strong increase. For Coypu, areas 5 and 11 show a declining trend.

The estimates from the population model refer to the number of individuals that are present in an area so they don't refer to individuals that are actual breeding and it is also theoretically possible to have more individuals caught in a given year, than the estimated population size (as the captures include offspring as well as individuals passing through an area).

Table 3.5. Estimated muskrat population size per project area. The numbers refer to the expected number of reproductive individuals at the start of the breeding season.

nr	2018	2019	2020	2021	2022	2023
1	63	67	85	73	75	77
2	0	0	0	0	0	0
3	512	602	569	482	424	441
4	1078	1156	1346	1248	1124	1072
5	0	0	0	0	0	0
6	115	108	138	154	144	156
7	0	0	0	0	0	0
8	653	529	592	586	476	494
9	1752	2162	2947	3520	3021	3217
10	174	171	142	119	88	90
11	2706	2460	2778	2828	2859	3280

Table 3.6. Estimated coypu population size per project area. The numbers refer to the expected number reproductive individuals at the start of the breeding season.

Nr	2018	2019	2020	2021	2022	2023
1	67	82	84	100	115	138
2	44	46	50	56	64	74
3	590	589	464	417	467	542
4	0	0	0	0	0	0
5	10	10	7	7	6	5
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	48	54	52	61	52	65
11	154	165	152	121	97	75

Conclusions

The Muskrat and Coypu catches per project area show overall a variable but relatively constant pattern within project areas. Differences between project areas are large (not just in absolute values, but also in occurrence per suitable habitat).
The same can be said with respect to the AIS free areas and the estimated population sizes that are based on these catches.

While these values seem to correspond with the overall understanding of the population developments in the project areas, they do not offer sufficient detail for control activities in practice. For this (and more generally, to gain insight in more detail regarding the effectivity of population control measures), a more detailed data record as well as effort would be required. This would include exact recording of the date of catches or a temporal resolution of months, and a fine spatial resolution, e.g. at a 5x5 km grid.

Appendix 1 - list of data sources on observations and catches

Title (and GitHub directory)	IPT	GBIF
Muskrat captures in Flanders, Belgium	mica-legacy-occurrences	https://doi.org/10.15468/pequ4z
MICA - Muskrat occurrences collected by RATO in East Flanders, Belgium	mica-rato-occurrences	https://doi.org/10.15468/5fps96
MICA - Muskrat and coypu occurrences collected by UVW in The Netherlands	mica-uvw-occurrences	https://doi.org/10.15468/qjds4c
MICA - Muskrat and coypu camera trap observations in Belgium, the Netherlands and Germany	mica-agouti-occurrences	https://doi.org/10.15468/5tb6ze
MICA - Muskrat occurrences collected by VMM in Flanders, Belgium	mica-vmm-occurrences	https://doi.org/10.15468/gwzwk4
RATO - daily operations commissioned by the province East Flanders, Belgium	rato-occurrences	https://doi.org/10.15468/fw2rbx
Mica - Muskrat, Raccoon and Coypu occurrences collected by ITAW in Germany	mica-itaw-occurrences	https://doi.org/10.15468/qzcu4s

Appendix 2 – Parameter values used in population estimates of Muskrat and Coypu

Here we list the parameter values used for the Muskrat and Coypu population models:

$$N_t = MAX(0; (N_{t-1}*BR) - C_t)*(SR_p+YS_t) \quad \text{(eq. 1)}$$

Where N_t is the size of the population in year t, C_t is the number of catches in year t. BR is a birth rate (taken constant over time, and the same for all project areas). SR_p is a survival rate which is constant over time but varying between project areas and YS_t is a yearly component of the survival rate which is constant for the project areas.

The value for BR was 2.1 for muskrat and 2.2 for coypu. It should be noted that this value is somewhat colinear with the SR+YS parameters in the model, so that it should be seen as an effective birth and (young) survival rate.

The values for the parameters SR_p and YS_t are given in Tables A2.1 and A2.2.

Table A2.1 Values for the parameter SR_p (survival per project area, see equation 1)

nr	name	muskrat	coypu
1	Lake Dümmer	0.50	0.55
2	Aschau Teiche		0.55
3	Vechtegebiet	0.45	0.58
4	Sint-Laureins	0.48	
5	Sint-Maartensheide - De Luysen		0,30
6	Mark Valley Herne Galmaarden	0.51	
7	Hoogstraten		
8	Wetterskyp Fryslan	0.51	
9	Noord-Holland North from Alkmaar	0.50	0.50
10	Border Gelderse Poort / Kreis Kleve	0.50	0.55
11	Border Hunze en Aa's	0.52	0.50

Table A2.2 Values for the parameter SY_t (survival component per year, see equation 1)

Year	muskrat	coypu
2018	0.10	0.10
2019	0.15	0.15
2020	0.20	0.20
2021	0.10	0.15
2022	0.10	0.10
2023	0.10	0.10