LIFE Project Number

LIFE18 NAT/NL/001047

Final Report

Covering the project activities from 01/09/2019 to 01/09/2023

Reporting Date[1]

01/12/2023

LIFE MICA

Data Project

Project location:	The Netherlands, Germany, Belgium
Project start date:	01/09/2019
Project end date:	01/09/2023
Total budget:	€ 3.030.869
EU contribution:	€ 1.658.234
(%) of eligible costs:	54,98%

Data Beneficiary

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[1] Include the reporting date as foreseen in part C2 of Annex II of the Grant Agreement

This table comprises an essential part of the report and should be filled in before submission

Please note that the evaluation of your report may only commence if the package complies with all the elements in this receivability check. The evaluation will be stopped if any obligatory elements are missing.

Package completeness and correctness check	
Obligatory elements	**✓ or N/A**
Technical report	
The correct latest template for the type of project (*e.g.,* traditional) has been followed and all sections have been filled in, in English *In electronic version only*	✓
Index of deliverables with short description annexed, in English *In electronic version only*	✓
Mid-term report: Deliverables due in the reporting period (from project start) annexed Deliverables in language(s) other than English include a summary in English *In electronic version only*	N/A
Financial report	
The reporting period in the financial report (consolidated financial statement **and** financial statement of each Individual Beneficiary) is the same as in the technical report with the exception of any terminated beneficiary for which the end period should be the date of the termination.	✓
Consolidated Financial Statement with all 5 forms duly filled in and signed and dated *Electronically Q-signed or if paper submission signed and dated originals* and in electronic version (pdfs of signed sheets + full Excel file)*	✓
Financial Statement(s) of the Coordinating Beneficiary, of each Associated Beneficiary and of each affiliate (if involved), with all forms duly filled in (signed and dated). The Financial Statement(s) of Beneficiaries with affiliate(s) include the total cost of each affiliate in 1 line per cost category. *In electronic version (pdfs of signed sheets + full Excel files) + in the case of the Final report the overall summary forms of each beneficiary electronically Q-signed or if paper submission signed and dated originals**	✓
Amounts, names, and other data (*e.g.,* bank account) are correct and consistent with the Grant Agreement / across the different forms (*e.g.,* figures from the individual statements are the same as those reported in the consolidated statement)	✓
Mid-term report (for all projects except IPs): the threshold for the second pre-financing payment has been reached	N/A
Beneficiary's certificate for Durable Goods included (if required, *i.e*., beneficiaries claiming 100% cost for durable goods) *Electronically Q-signed or if paper submission signed and dated originals* and in electronic version (pdfs of signed sheets)*	N/A
Certificate on financial statements (if required, *i.e*., for beneficiaries with EU contribution ≥750,000 € in the budget) *Electronically Q-signed or if paper submission signed original and in electronic version (pdf)*	✓
Other checks	
Additional information / clarifications and supporting documents requested in previous EASME letters (unless already submitted or not yet due) *In electronic version only*	✓
This table, page 2 of the Mid-term / Final report, is completed - each tick box is filled in *In electronic version only*	✓

**signature by a legal or statutory representative of the beneficiary / affiliate concerned*

Version	date	Changes by	Comments
1.0	01/09/2023	P. Rossignol L. Molinary	Adaptation of the template to LIFE MICA, mid-term report information added
2.0	11/09/2023	P. Rossignol L. Molinary	Templates made for each consortium partner to fill in
3.0	13/09/2023	L. Tiggelman	Templates checked and adjusted, sent to all consortium partners to fill in and update
4.0	12/10/2023	P. Rossignol L. Molinary	Received updated templates compiled into one document
5.0	09/11/2023	L. Tiggelman	Technical part of the report checked and adjusted
6.0	21/11/2023	L. Tiggelman	All chapters updated, feedback and input from consortium partners added, sent to consortium partners for feedback
7.0	22/11/2023	P. Rossignol, L. Molinary	Chapter 8 'Comments on the financial report' updated
8.0	24/11/2023	L. Tiggelman	Small adjustments and updates throughout the report, sent to consortium partners for validation
9.0	30/11/2023	L. Tiggelman	Final check and adjustments

Final Version	date	Approved and signed by beneficiary
9.0	30/11/2023	Waterschap Rivierenland Mrs M. van Willegen Head of the Department Muskrat & Coypu

1. Table of contents

2. List of key-words and abbreviations

Agouti	-	application for standardized processing of photo and video collected with motion-sensitive camera traps
BE	-	Belgium
BUTLER	-	System to deliver documents for LIFE projects
EASME	-	Executive Agency for Small and Medium-sized Enterprises
ELO	-	European Landowners Organisation
ERP	-	Enterprise Resource Planning
EU	-	European Union
(EV)INBO	-	(Eigen Vermogen van het) Instituut voor Natuur en Bosonderzoek
IAS	-	Invasive Alien Species
ITAW	-	Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Foundation
IUCN	-	International Union for Conservation of Nature
GA	-	Grant Agreement
GBIF	-	Global Biodiversity Information Facility
GER	-	Germany
KPLI	-	Key Project-level Indicators
LIFE MICA	-	LIFE Management of Invasive Coypu and MuskrAt in Europe
LWK-NDS	-	Landwirtschaftskammer Niedersachsen
Neemo/ElmenEEIG	–	LIFE monitoring organisations
NGO	-	Non-Governmental Organisation
NL	-	Netherlands
PB	-	Project Board
RATO	-	Rattenbestrijding Oost-Vlaanderen
ROBOR	-	Robor Electronics B.V.
SAP	-	Enterprise resource planning system
UvA	-	Universiteit van Amsterdam
UvW	-	Unie van Waterschappen
VAT	-	Value Added Tax
(VLAGEW) INBO	-	Instituut voor Natuur- en Bosonderzoek
VMM	-	Vlaamse Milieumaatschappij
VWJD	-	Vereinigung der Wildbiologen und Jagdwissenschaftler Deutschlands
WENR	-	Wageningen Environmental Research
WSRL	-	Waterschap Rivierenland

3. Executive Summary

Background:

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. The objective of the project is to develop a transnational plan for the management of coypu and muskrat populations in Europe and to test innovative technologies used in population control. In the LIFE MICA project five different innovative methods for monitoring and management of coypu and muskrat have been developed and tested: DNA-mapping, environmental DNA (eDNA), smart camera tracking, smart life traps, dashboard.

Key deliverables

Action nr.	Name of the action
A.	**Preparatory actions, elaboration of management plans and/or of action plans**
A.1	Writing of the "Management of Invasive Coypus and Muskrats Plan"
A.2	Coypu and Muskrat dashboards
A.3	Fine tuning of camera tracking and smart life traps
A.4	Fine tuning of DNA approaches
C.	**Conservation actions**
C.1	Implementation of the field systems and operations developed in the pilot areas
C.2	Implementation of DNA approaches and linked catch activities
D.	**Monitoring of the impact of the project actions (obligatory)**
D.1	Assessment and improvement of the quality of the equipment and methodology and improvements
D.2	Evaluation of the environmental impact
D.3	Evaluation of the socio-economic aspect
E.	**Public awareness and dissemination of results (obligatory)**
E.1	Awareness raising and dissemination material
E.2	Communication and dissemination actions
E.3	Transfer and replicability
F.	**Project management (obligatory)**
F.1	Overall project management
F.2	After-LIFE plan

All actions and deliverables have been finished and delivered. For more information see chapter 6.1 and the tables in Appendix I and II.

Output: (planned) activities, progress and achievements

A-activities:

- A1: Writing of the "Management of Invasive Coypus and Muskrats Plan": WSRL wrote the plan, UvW made a map of areas of intervention.
- A 2 Coypu and Muskrat dashboards: A first online prototype of the dashboard was finished January 2021. All planned features were finished March 2023. The creation of the dashboard was delayed significantly because building the dashboard was more complex than anticipated and there were some difficulties with regard to collecting and transforming the data from Germany. All issues were solved.
- A.3 Fine tuning of camera tracking and smart life traps: For smart camera tracking an algorithm was developed but several limitation were encountered. Concurrent with this

Agouti launched its own classification model that performed markedly well. It was decided to collaborate with Agouti. Our data was used to further train the classification software of Agouti, with special attention for muskrat, coypu and brown rat. This resulted in a database of over 150.000 annotated images. The database of all images containing animals is accessible via GBIF. Agouti is publically available and free to use. 50 cameras were foreseen to collect the image material, but due to increased costs only 43 cameras were bought. The software and hardware of the smart life traps was developed and deployed in the field for testing and to collect image material. The recognition software was updated several times using the collected image material. The software updates were immediately implemented in the smart life traps. Originally 50 smart life traps were foreseen, due to increased costs 25 smart life traps were developed. This action was significantly delayed but all goals and deliverables have been reached.

- A.4 Fine tuning of DNA approaches: This action includes DNA-mapping and eDNA. For eDNA the field strategies and laboratory protocols have been developed. For DNA-mapping the protocols were written and a subcontractor (WENR) was arranged to conduct the DNA-mapping and sequencing. This action was finished according to plan.

C-activities:

- C.1 Implementation of the field systems and operations developed in the pilot areas: For smart camera tracking 43 cameras were deployed in the field (instead of 50). They were deployed February 2020 as foreseen and remained in the field till April 2023. A field protocol for camera tracking at waterways was developed. 25 smart life traps were deployed in the field (instead of 50). The smart life traps were deployed a year later than planned, at November 2021 and remained in the field till July 2023. The collected images were added to the database and used to improve the recognition software. During the deployment sufficient feedback from trappers was collected to evaluate and improve the systems.
- C.2 Implementation of DNA approaches and linked catch activities: Both DNA-mapping and eDNA implementation went according to plan. An eDNA monitoring guideline was written. An autosampler was developed to take the water samples for eDNA. Three water laboratories processed the eDNA samples. For DNA-mapping samples were collected and analysed using DNA-mapping. Migration routes of muskrats were determined. Recommendations for trapping efforts in Friesland were presented which lead to additional catching efforts at the recommended sites.

D-activities:

- D.1 Assessment and improvement of the quality of the equipment and methodology and improvements: The project managers have had regular (weekly to monthly) contact with the people working with the methods in the project areas and the laboratories, to receive feedback, suggestions for improvements and determine issues. Two surveys were held. A report was written on the quality and usability of the deployed equipment. The methods and equipment were improved during the project using the gained feedback.
- D.2 Evaluation of the environmental impact: Three reports were written ‘the evolution of the numbers of muskrat and/or coypu in the project, ‘vegetation change by decreasing numbers of muskrat and/or Coypu’ and ‘impact of coypu/muskrat decrease on protected species’. For this, a model has been developed. For the report on protected species field work has been conducted. This action was severely delayed throughout the project, however the reports were delivered before the deadline.
- D.3 Evaluation of the socio-economic aspect: Tables were drafted and information on the socio-economic impact was supplied by the project partners in 2020 and 2023. Two reports

were written ‘Evaluation of LIFE MICA's social impact’ and ‘Evaluation of LIFE MICA's economic impact’. Everything went according to schedule.

E-activities:

- E.1 Awareness raising and dissemination material: An awareness raising and dissemination plan was drafted and awareness and dissemination material was created, among others: the LIFE MICA website, notice boards, Laymans report, leaflet and informative video.
- E.2 Communication and dissemination actions: Due to Covid, the first two years of the project many events were hosted and attended virtually. The last two years on site events could be held again. Two advisory board were held, eight open days were organised, workshops were held and conferences were attended. Several articles have been published on the project and the techniques developed. More details can be found in the report on communication and dissemination and report on networking activities.
- E.3 Transfer and replicability: LIFE MICA has cooperated with other LIFE projects (e.g. Rapid LIFE, ALIENAR, Reeds for LIFE). External organisation have shown an interest in the LIFE MICA methods. Several of the methods have been transferred and replicated. For more details see the reports on replication and transfer. The transfer activities were taken over by ITAW since this is entwined with replication, communication and dissemination, for which they were already the main responsible.

F-activities:

- F.1 Overall project management: The project was managed by a coordinator of WSRL. Management tool have been developed. Monthly (online) meetings between the coordinator and project partners have taken place to discuss tasks and progress. Project Board meetings were organised every 6 months, of which one PB meeting was combined with the yearly monitor visit. The cooperation between the partners and the contacts with the monitor were good.
- F.2 After-LIFE plan: An online brainstorm was held to discuss the after LIFE and exploitation plan. The after LIFE plan and exploitation plan have been written.

<u>Main deviations</u>

- Equipment and software: Less cameras and smart life traps were bought due to increased costs. The smart life traps were deployed a year later than planned. However, sufficient image material could be collected and they were deployed in the field long enough to test and make improvements. For smart camera tracking originally developed the image recognition ourselves, but it was decided to cooperate with Agouti to improve their image recognition software since it performed better.
- Administration and costs: Some costs were higher than anticipated, while other costs were lower. The hours of the trappers of the regional water authorities which were part of the own contribution of UvW were not considered eligible. This issue could not be solved even after consulting with the monitor. Therefore, those costs were not added. Overall, LIFE MICA has remained (far) below budget.
- Events: Due to Covid, the first two years events were cancelled or hosted online. The last two years on site events were held again.
- Project management: Due to changes within Neemo/Elmen EEIG this project had three different monitors. Furthermore, the methods of delivering documents has changed (BUTLER).

4. Introduction

Background, problems and objectives

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. The objective of the project is to develop a transnational plan for the management of coypu and muskrat populations in Europe and to test innovative technologies used in population control. By combating the presence and the spreading of those species, LIFE MICA helps to protect waterway infrastructure, integrity of riparian vegetation and prevents loss of crops. The project ran from September 2019 to September 2023 Innovative methods for population control of these species have been developed and tested in a cooperation between German, Dutch and Belgian (Flemish) institutions.

Project partners LIFE MICA

The following institutions are involved in the LIFE MICA project.

- Unie van Waterschappen (UvW) - *Dutch Water Authorities (NL)*
- Universiteit van Amsterdam (UvA) - *University of Amsterdam (NL)*
- Waterschap Rivierenland (WSRL) - *Regional Water Authority Rivierenland (NL)*
- Vlaamse Milieumaatschappij (VMM) - *Flanders Environment Agency (BE)*
- Instituut voor Natuur- en Bosonderzoek (INBO) - *Research Institute for Nature and Forest (BE)*
- Landwirtschaftskammer Niedersachsen (LWK NDS) - *Agricultural Chamber of Lower Saxony (GER)*
- Stiftung Tierärztliche Hochschule Hannover (TiHo), Institut für Terrestrische und Aquatische Wildtierforschung (ITAW) - *University of Veterinary Medicine Hannover Foundation, Institute for Terrestrial and Aquatic Wildlife Research (GER)*

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

On January 1st 2015, an EU regulation (No. 1143/2014) has entered into force, which focusses on the prevention and control of damage to biodiversity and ecosystem services caused by invasive alien species (European Commission 2014). The regulation defines measures to prevent the introduction of invasive alien species and to manage established populations. In this regulation, an invasive alien species is defined as “an alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services.” The Regulation includes a list of Invasive Alien Species of Union concern (Union list) and defines restrictions and obligations for member states for dealing with the listed species.

Coypus and muskrats in Europe

Coypu and muskrats are considered invasive alien species (IAS) in the European Union. 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 burrow extensive tunnels in dykes and riverbanks. They feed mainly on riparian vegetation and in limited extent on field crops. As they do not face the threat of natural predators in most European countries, an explosive growth of their populations can be observed. 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. Thus, coypu and muskrat represent economic and ecological threats to European countries.

Innovative methods developed by LIFE MICA

In the LIFE MICA project, innovative methods for monitoring and management of coypus and muskrats were developed and tested in 11 project areas in Flanders, the Netherlands and Germany. 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 also be applied for the management of other invasive alien species or even protected species.

The innovative methods

In the LIFE MICA project five different innovative methods for monitoring and management of coypu and muskrat have been developed and tested.

- DNA-Mapping:
- Environmental DNA (eDNA)
- Smart camera tracking
- Smart life traps
- Dashboard

DNA-Mapping allows identification of relationships between different muskrat populations to determine migration routes so that trapping efforts can be deployed more efficiently. Low density populations of muskrat and coypu can be efficiently detected through environmental DNA (eDNA). Smart camera tracking, monitors muskrats and coypu using cameras, to reduce the workload of image analysis, the Agouti (AI) algorithm was developed. The implementation of smart life traps prevents bycatch of protected species as traps only close for target species coypu and muskrats. A dashboard visualizing data on the monitoring and trapping of coypus and muskrats was made.

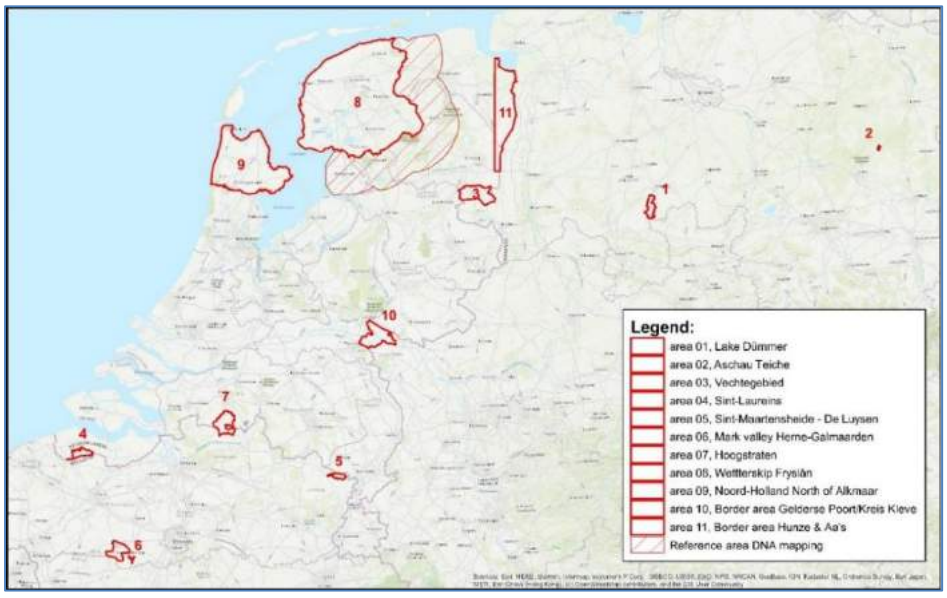

Figure 1: Project areas

Table 1: Methods used in the different project areas

Project area	Methods used
1. Lake "Dümmer", Germany	smart life traps
2. Aschau Teiche, Germany	eDNA, smart life traps
3. Vechtegebiet, Germany	smart camera tracking, smart life traps
4. Sint-Laureins, Belgium	smart camera tracking
5. Sint-Maartensheide - De Luysen, Belgium	smart camera tracking, smart life traps
6. Mark valley Herne/Galmaarden, Belgium	eDNA, smart camera tracking
7. Hoogstraten, Belgium	eDNA, smart camera tracking
8. Wetterskip Fryslân, Netherlands	DNA-Mapping, eDNA, smart camera tracking
9. Noord-Holland North of Alkmaar, Netherlands	eDNA
10. Border area Gelderse Poort/Kreis Kleve, Netherlands	Smart life traps
11. Border area Hunze & Aa's, Netherlands	eDNA

**Dashboard is an online platform, data collected in the project areas was added to the dashboard.*

Expected longer term results

Invasive alien species such as the coypu and muskrat pose the second greatest threat to biodiversity and cost millions of euros on a yearly basis. As these species live on roots of rushes and reed, they cause serious damage to their own habitat and that of endangered species. By digging in dykes and feeding on riparian reed vegetation, coypu and muskrat represent a safety risk for the inhabitants of lowlands because the danger of flooding increases.

The objective of the LIFE MICA project was to serve as a pilot study, testing `best practise` techniques and developing new strategies for coypu and muskrat population control. LIFE MICA aims to improve transnational coypu and muskrat control in Europe and thus protects infrastructure of waterways and biodiversity and crops from damage.

Organisations from Belgium, Germany and the Netherlands are involved in the realisation of the project, which means that this project stimulates the international cooperation and knowledge sharing regarding muskrat and coypu control.

With this project, the following goals have been pursued:

- Development of a transnational plan for management of coypu and muskrat populations in Europe and implementation of innovative technologies used in population control. The project focuses on:
    - The prevention of further spreading of the muskrat and coypu.
    - The detection of small populations of muskrats and coypus and the application of swift control measures.
    - The control of the current populations of muskrats and coypus.
- By combating coypu and muskrat populations, the LIFE MICA projects aims to:
    - Protect the lowlands against the danger of flooding,
    - Protect vulnerable species and enable recovery of the degraded ecosystem,
    - Protect field crops.
- The developed innovative methods contribute to more efficient monitoring and management of coypu and muskrats, leading to an decrease in management costs.

5. Administrative part

Management process

The project was managed by a coordinator of WSRL. At first this work was handled by a policy manager and two of the team leaders of the muskrat department of WSRL. From 2022 onwards a full time coordinator was hired for LIFE MICA. The coordinator was assisted by an external expert (Euroquality) that has experience with grant projects.

Monthly (online) meetings between the coordinators and the different project leaders of the project partners have taken place. During these meetings the coordinator was kept up to date with regards to the progress of all project partners and relevant topics and tasks were discussed. Prior to reporting moments, meetings were organised, information and templates were supplied, and questions were addressed. Project Board meetings took place every 6 months, of which one PB meeting was combined with the yearly monitor visit.

The cooperation between the partners and the contacts with the monitor were good.

Changes and issues during the project

Within the project, there have been the following changes and issues.

Project management:
Due to changes within Neemo and Elmen EEIG there have been three different monitors. Furthermore, the methods of delivering documents has changed to the BUTLER system.

Administration:
Hours by trappers (UvW) are provided by affiliates of the Union of Water Boards (Regional Water Boards) and are formally not own staff of the UvW, contrary to what was stated in the application. However, the Union's own contribution was based on this. We were planning a request to the monitor and the commission with an official amendment request, asking to take up the affiliates in the contract. After several consultations with the monitor, it was decided not to declare the hours of the trappers from the Regional Water Boards. The field hours made by the trappers were therefore not part of the LIFE MICA project. This reduced the own contribution of the UvW.

Costs:
Costs for organizing (virtual) events, including open days and PB an monitoring visits were not budgeted in the Grant Agreement (GA). For this budget was transferred between categories.

6. Technical progress, per Action

6.1.1. A1 – Writing of the "Management of Invasive Coypus and Muskrats Plan" (WSRL)

6.1.1.1. Administrative information

Lead partner	WSRL
Involved partners	VMM, LWK, UvW, ITAW
Location(s)	Not applicable
Start	Foreseen: 31/08/2019
	Actual: 31/10/2019
End	Foreseen: 29/02/2020
	Actual: 02/04/2020
Status	Finished

6.1.1.2. Technical progress

Undertaken activities and outputs:

- A1.1 Precision of the areas of intervention: Map of areas of intervention was delivered by UvW. Document with a table of activities for each area and accurate maps of the project areas.

- A1.2 Organization of field activities and MICA Plan: Writing of the Mica plan done by WSRL. The MICA plan was delivered on 02-04-2020, with a small delay, and accepted by all partners.

6.1.1.3. Deviation, main problems, and corrective measures (if any)

- The plan was finished a month later than planned, due to not having sufficient capacity at that time.

6.1.2. A2 – Coypu and Muskrat dashboards (EV INBO)

6.1.2.1. Administrative information

Lead partner	EV INBO
Involved partners	VLAGEWINBO, UvW, ITAW
Location(s)	Not applicable
Start	Foreseen: 09/2019
	Actual: 10/2019
End	Foreseen: 12/2019
	Actual: 01/2021 (first prototype) 03/2023 (all features)
Status	Finished

6.1.2.2. Technical progress

A2.1 Automation and open-sourcinq of the Coypu and Muskrat dashboards
A2 Source code and database map
A2.1 Guidelines for the data harmonisation

Data
To unify and store/access the data coming from the different applications used by the partners we decided to use an international data standard, Darwin Core and open-source platform, GBIF. All partners datasets were reviewed to see if they could easily be transformed to Darwin Core standards (https://dwc.tdwg.org/terms/). This standard is used on the Global Biodiversity Information Facility (GBIF) where the data have been uploaded. The necessary variables are species, location in coordinates and date. In the Netherlands catch data is aggregated by the Unie van Waterschappen. This aggregated dataset contains all the necessary variables. In Flanders catches are aggregated by VMM, RATO vzw and the province of West Flanders. Only VMM is a partner in Life MICA and their dataset contains all the necessary variables. The dataset from RATO vzw also contains all the necessary variables and will also be included for completeness. German data was only available in pdf format and did not contain the necessary variables. To remedy this an app was made using AppSheet and the dataset that results from this contains all the necessary variables.

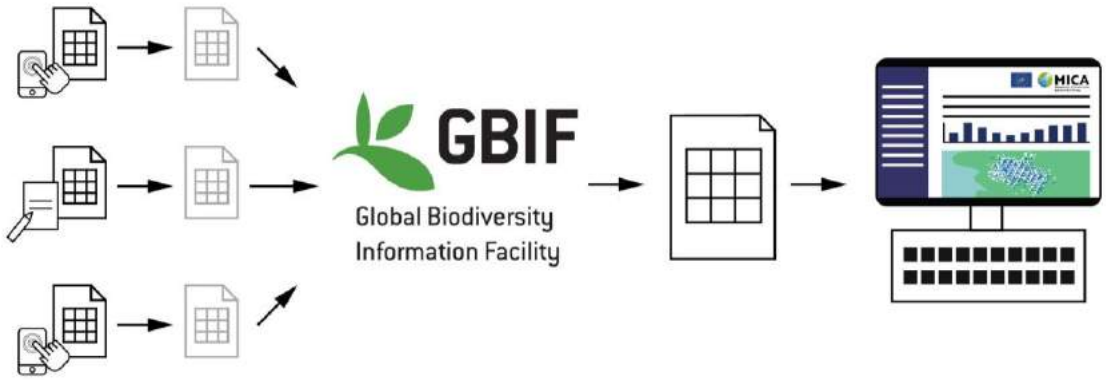

Figure 2: Visualisation of the data flow to the dashboard

A data pre-processing script was written for 9 data sets: the legacy data in Flanders (1991-2018), the legacy data in the Netherlands (1987-2014), the data collected by VMM (2 separate datasets), UvW, ITAW and RATO vzw (2 separate datasets) and the data collected by the

camera traps. These datasets have been published to GBIF, you can find all the links as well as the standardisation scripts here: https://github.com/inbo/mica-occurrences

Dashboard
A first online prototype of the dashboard was finished January 2021. All planned features were finished March 2023.

The dashboard can be accessed here: http://mica.inbo.be/
The underlying code is fully open source and can be accessed through GitHub: https://github.com/inbo/mica-dashboard

The dashboard includes all available data from GBIF and allows users to filter for source dataset, species, catches or observations, MICA area and date. Data can be visualized in two ways. In the first data are aggregated in hexagons and when zooming in, the aggregated view is replaced by individual points, allowing precise localisation of each individual. A pop-up also provides more details and a link to this specific observation on GBIF. The second way to visualize the data is as a 1km grid that shows the rats per km waterway for each grid cell. Lastly, the biodiversity information from the surveys performed in 2020 and 2021 can also be toggled on or off.

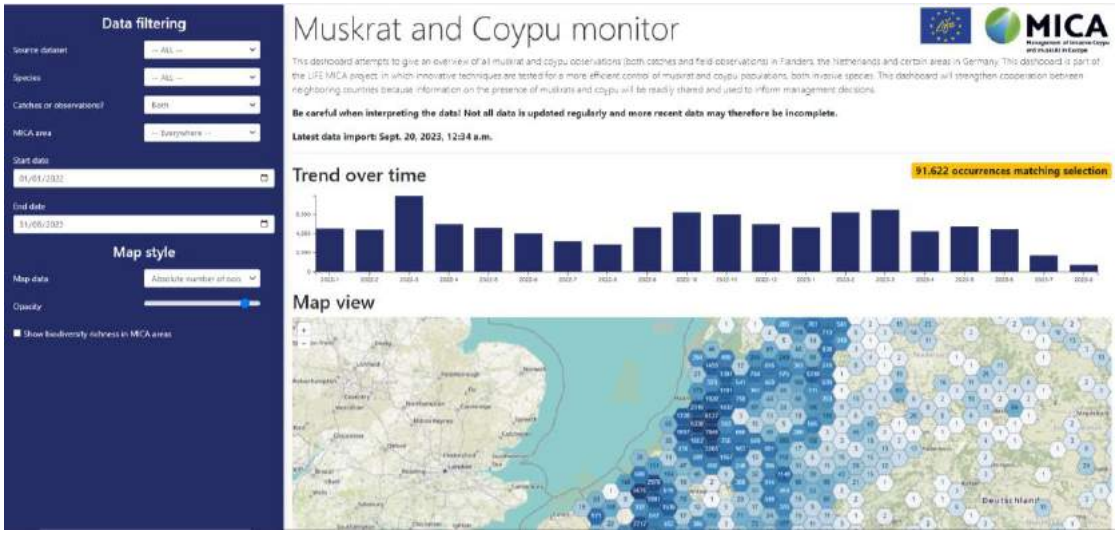

Figure 3: Screenshot of the dashboard

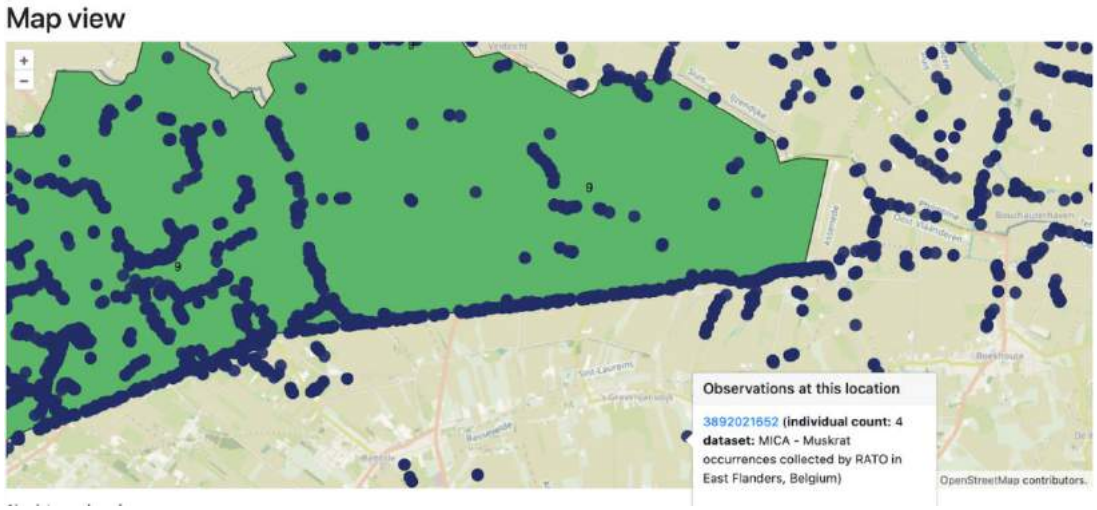

Figure 4: example of the zooming in functionality of the dashboard

6.1.2.3. Deviation, main problems, and corrective measures (if any)

There were two main hurdles with mobilizing the data and building the dashboard. The first one was collecting the data in Germany. In Germany most coypu and muskrat catches are done by volunteer hunters. These hunters do not register their catches or register them with very little detail (e.g. no coordinates or date). The initial idea was to adapt an app from one of the other partners and convince the hunters to use this. In the meantime we developed a simple app using AppSheet that could be used by the project partners in the project areas. Since the Dutch app was being upgraded we landed on the app from VMM. However instead of it being a small project of simply translating the app this turned out to be a more complex programming project. Eventually it was decided to just keeping using the simple app devised in AppSheet.

The second hurdle was the proposed timing and personnel changes at EVINBO. We needed to go through several different steps before we could start building the dashboard:

- Decide on a strategy for collecting and storing the data
- Exploring all the available data
- Transforming the data
- Publishing the data on GitHub

Taking all these steps with international partners and building a dashboard was not feasible in the proposed four months. Besides this we also had to hire someone to build the dashboard since we didn't have the technical expertise in-house at the start of the project. After this and all the previous steps were done we did get started on the dashboard. However the person hired did not stay on long enough to finish all features of the dashboard, leading to again needing to hire external help to finish the dashboard.

Though the dashboard was delayed, all issues were solved. The dashboard has been available online from January 2021 onwards. All planned features were finished March 2023.

6.1.3. A3 – Fine tuning of camera tracking and smart life traps (WSRL)

6.1.3.1. Administrative information

Lead partner	WSRL
Involved partners	UvW, ITAW, EV INBO
Location(s)	Project areas 3-8 and 10 (smart camera tracking) Project areas 1, 2, 3, 5, 10 (smart life traps)
Start	Foreseen: 09/2019
	Actual: 09/2019 (smart camera tracking), 11/2019 (smart life traps)
End	Foreseen: 09/2020
	Actual: 07/2021 (smart camera tracking), 7/2021 (first prototype smart life traps)
Status	Finished

6.1.3.2. Technical progress

A3.1 Adaptation of image-based recognition of coypu and muskrat for intelligent camera tracking

A3.1.1 Database with images of detected animals

A3.1.2 Script of image recognition

Figure 5: Initial setup in area 6

Collecting camera trap images

An initial setup using three different camera types was used to determine the best camera type and the best way to position the camera. The position is chosen to maximize muskrat and coypu observations and minimize unintentional triggering. More details can be found in the **Protocol camera traps** on the LIFE MICA website.

Table 2: Test setup to develop the camera trap protocol and collect data to train the AI

	Start camera trapping	End camera trapping
Area 6 Mark Valley	2019-09-18	2020-04-21
Area 4 Sint Laureins	2019-11-06	2020-02-12

This protocol was demonstrated to the other partners during a demonstration event organized in project area 5 (Sint-Maartensheide – De Luysen) where the use of Agouti, the platform used to host and annotate the pictures was explained as well. After these event cameras were placed in all project areas in Flanders and in area 3 (Vechtegebiet). Use of cameras in area 8 was started later because they wanted this to coincide with the DNA mapping detection.

This resulted in a database of over 150.000 annotated images. The database of all images containing animals is accessible via GBIF: https://www.gbif.org/dataset/8a5cbaec-2839-4471-9e1d-98df301095dd.

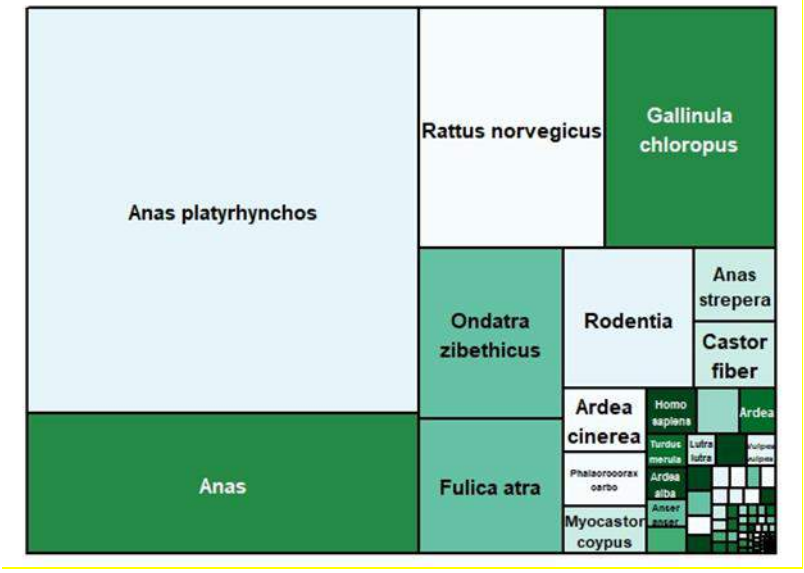

Figure 6: distribution of species observed by the camera traps

Developing the algorithm
The initial intention was to further develop the algorithm developed by Laura Hoebeke (https://libstore.ugent.be/fulltxt/RUG01/002/482/206/RUG01-002482206_2018_0001_AC.pdf). The algorithm was developed to discern woodland species from camera trap images. However, when testing the original implementation, several limitations were encountered. Concurrent with this Agouti launched its own classification model that performed markedly well.

Based on these findings, it was decided to:
- Use our data to further train the new model developed by Agouti
- Update the original implementation of L. Hoebeke to make sure it supports the usage of different pre-processing methods (to extract 'regions of interest'), the ability to switch the classification model (to predict up to species level), uses tensorflow 2.x and the integration with the current data standard for camera trap data, camptrap-dp.

By combining the newly trained model using the infrastructure of Agouti and the updated Python implementation, the project provides an interface for both interactive usages with Agouti as well as a Python implementation for research oriented applications and automation.

The new implementation is available on the MICA Github repository and can be used and installed as a Python Package camera trap. See the tutorial in the `notebooks` folder for more details on how to load the data and apply the classification model.

Collaboration with Agouti (WUR)
Based on the positive first review of the AI developed by Agouti we decided to collaborate with them and allocate some of the MICA funds (€ 15.000) towards further development of the AI. With these funds the Agouti team doubled the training data, with special attention for muskrat, coypu and brown rat. Due to this added data, the neural network was greatly improved and the success rate of the validation data set went from 45% to 63% and the error rate dropped from 10% to 5%. Next to this they also introduced new functionality that allows easy revision of the labelled images.

A3.2 Improvement of the selectivity of smart life traps

Development smart life traps
WSRL worked together with ROBOR Electronics B.V. to develop the smart life traps. On 16 August 2021 ROBOR delivered 2 smart life traps to WSRL for testing, which were placed in the project area November 2021 and the first catch took place January 2022. Begin 2022 a total of 25 smart life traps were delivered, deployed and tested. Originally 50 traps were planned, but due to several reasons it was decided to only produce 25 smart life traps. See the deviations for the explanation.

Image recognition software
About a thousand photos per animal are needed for the recognition software. At the start of the project there were few usable pictures. Footage taken by the smart life traps that were deployed in the project areas was used to update the recognition software. Traps have also been placed at Dierenrijk Eindhoven, Gaia Zoo and Otter-Zentrum Hankensbüttel to collect pictures of otters, raccoons and beavers. Furthermore, footage was collected online and supplied by animal organisations. It was investigated if the Agouti's footage database could be used, unfortunately this was not possible due to technical problems. At the end of the project a total of 350.000 pictures were taken by the smart life traps. Sufficient footage has been collected to improve the

recognition software several times. The first version of the smart life traps was finished August 2021, but the improvement and fine tuning of both the hardware and software continued till the end of the project.

6.1.3.3. Deviation, main problems, and corrective measures (if any)

A3.1 Camera tracking

The timing for collecting the database was not ideal since muskrats are most active during their spring migration from February to April. During the first few months we only collected seven image sequences from muskrats. After this we decided to place the camera's in a more muskrat dense area resulting in 388 images of muskrats. Coypu however are only present in low numbers in Flanders and it was therefore necessary to have the cameras operating in the partners' areas as well. This resulted in the database of images being sufficiently large to start training the algorithm in the summer of 2020.

The proposed budget did not cover the costs for 50 cameras as intended. This may be due to the need to also buy casings, locks and batteries. We opted to use 40 cameras instead of 50 instead of extending the budget. This did not influence the results since some additional cameras from INBO were used and some low density areas do not need as many cameras.

The aim of this sub-action was to fine tune an already existing image recognition algorithm. The colleague that helped build the original image recognition algorithm, was no longer employed at VLAGEWINBO when the project started. This led to a serious delay while trying to find the right expertise. After it became clear that there was no in-house expertise for building these particular algorithms we decided to allocate some of our personnel budget to subcontracting this work.

During the time our subcontractor was working on fine tuning the original algorithm we were made aware that Agouti, the platform used to host and annotate camera trap images, was working on an algorithm as well. Since INBO is a partner in Agouti we could test the beta version of this algorithm. The results were quite impressive and much further advanced than those from our own algorithm. We therefore decided, after discussing this with EASME, to no longer invest in fine-tuning our own algorithm but instead provide our data to Agouti to help them develop their algorithm. That is why fine tuning camera tracking was finished later than planned.

A3.2 Smart life traps

The development of the smart life trap had been delayed due to problems in developing the recognition software. In addition, necessary components (computer chips) had longer delivery times due to COVID and some components were no longer available, the design had to be modified, resulting in further delays. The total delay for the deployment of the smart life trap became over a year.

A total of 25 smart life traps were developed, while in the Grant Agreement a total of 50 traps were planned. This was due to several reasons. The development of the smart life traps costed more than budgeted (too low estimation of the costs, delays and parts becoming more expensive). Furthermore, updating and improving the traps takes time and costs which are higher when there are more traps. It was decided to focus on quality and not on quantity, so the available smart life traps could be developed further. Therefore, it was decided to only produce and test 25 smart life traps.

6.1.4. A4 – Fine tuning of DNA approaches (UvW)

6.1.4.1. Administrative information

Lead partner	UvW
Involved partners	UvA
Location(s)	Project area 8 (DNA-mapping) Project areas 2, 6-9 and 11 (eDNA)
Start	Foreseen: 09/2019
	Actual: 09/2019 (both DNA-mapping and eDNA)
End	Foreseen: 9/2020
	Actual: 9/2019 (DNA-mapping), 2/2020 (eDNA)
Status	Finished

6.1.4.2. Technical progress

A4.1 Finalisation of eDNA approach (UvA)

A4.1.2 Established field strategies for eDNA sampling of water areas 02/2020
A4.1.1 Optimized eDNA laboratory protocols 02/2020

Optimized eDNA protocols for isolation of eDNA from pooled samples, point samples and for qPCR were developed and delivered on 29-02-2020. A field strategy for eDNA sampling in the test areas was developed and delivered on 29-02-2020.

A4.2 Optimizing a sampling strategy for DNA mapping (UvW)
A4.2.1 call for tenders done for DNA mapping
A4.2.2 Protocol for DNA mapping

- Organize subcontractor: Done, WENR (Wageningen Environmental Research)
- Development of protocols for collection, storage and transport: Done, protocols are uploaded in Sharepoint and Life MICA website. The sampling strategy is specified as follows in this phase: a DNA sample is taken from all animals per 5x5 km area until 1 adult male, 1 adult female and 1 juvenile (male or female) is sampled.

The DNA mapping protocol has been sent to Wallonia as an example for a project that revolves there about the family relationships between coypu. The protocol can be used for other genetic purposes. Instruction video sampling: https://youtu.be/C44mPXCUNU4
Protocol DNA mapping: https://lifemica.eu/wp-content/uploads/2021/05/Protocol-DNA-sampling-muskrat-tail.pdf

6.1.4.3. Deviation, main problems, and corrective measures (if any)

eDNA
Despite slight delays in field tests due to the COVID pandemic, overall, the eDNA approach was on track to meet the deadlines. No significant changes to the baseline implementation of the eDNA part of the project have occurred.

C1 – Implementation of the field systems and operations developed in the pilot (VMM)

6.1.4.4. Administrative information

Lead partner	VMM
Involved partners	WSRL, LWK-LDS, UvW, ITAW, VLAGEWINBO, EV INBO
Location(s)	Project areas 3-8 and 10 (smart camera tracking) Project areas 1, 2, 3, 5, 10 (smart life traps)
Start	Foreseen: 2/2020
	Actual: 2/2020 (camera tracking); 11/2021 (smart life trap)
End	Foreseen: June 2023
	Actual: 4/2023 (camera tracking); 7/2023 (smart life trap)
Status	Finished

6.1.4.5. Technical progress

C1.1 Implementation of intelligent camera tracking

Cl.1.1: Database of images

Cl.1.2 Database of animal observations (species, time, location) from camera trapping Sessions

A network of camera traps on bottleneck locations can be used as a warning system for trappers to complement other techniques such as standard field prospections and eDNA.

- Research on camera trapping
    - INBO tested traps and trap setup with VMM.
    - 40 camera traps (reconyx Surefire) were bought and distributed. An additional 3 traps courtesy of INBO are deployed as well.
    - A field protocol was drafted by INBO, further explained on a meeting in Area 5: Sint-Maartensheide-De Luysen in Belgium.
- Image recognition
    - INBO has created a database, facilitated by the use of agouti (www.agouti.eu) as data platform.
    - Field agents have screened thousands of images. The image recognition system was trained with these identified pictures.
    - Deliverable C1.1.1 has been achieved. There is a solid base of screened images for the image recognition software to build upon.
    - Image recognition software has been operational but has been developed. One algorithm is available on the MICA Github repository and can be used and installed as a Python Package camera trap. The Agouti AI (which performs the best) can be used trough the Agouti website. Agouti also allows users to review observations.
- Fieldwork
    - LWK & ITAW & VMM all have timely put up camera traps in areas 3 to 7. These traps are working, checked upon regularly according to protocol and are feeding the image database.

- UVW & Wetterskip Fryslân installed 10 traps in area 8 after obtaining the DNA mapping results for said area in order to deploy the camera trap network as efficiently as possible. This went according to planning.
- Field personnel are responsible for the upkeep of the traps and the maintenance of their view on the water.
- A total of 43 cameras have been operational in the project areas

Table 3: Setup smart camera tracking

	Start camera tracking	End camera tracking	Number of camera traps
Area 3 Vechtgebied	2020-04-28	2023-04	7
Area 4 Sint Laureins	2020-04-27	2023-04	10
Area 5 De Luysen	2020-02-24	2023-04	5
Area 6 Mark Valley	2020-04-21	2023-04	5
Area 7 Hoogstraten	2020-04-30	2023-04	6
Area 8 Wetterskip Fryslân	2021-09-29	2023-04	10

Table 4: Overview of all collected images showing an animal. Lumped species are unidentified species that have been lumped in their respective higher tier taxonomic groups.

	Native species	Lumped species	IAS	Total
images	117.806	29.229	12.163	159.198
species	80	12	9	101

Table 5: Number of images showing at least one specimen of the target species (bold) and or other IAS in all relevant areas. Data full project up to August 2023.

	Area 3: Vechtege-biet	Area 4: Sint-Laureins	Area 5: De Luysen	Area 6: Mark valley	Area 7: Hoog-straten	Area 8: Wetter-skyp Fryslân	Total
Myocastor coypus	**1497**		25				1522
Ondatra zibethicus	**5254**	4199	9	38	112	49	9661
Aix galericulata	603	3	114	24	16		760
Alopochen aegyptiaca	26	6		2	2	2	38
Branta canadensis		3	40		3	10	56
Cairina moschata					1		1
Phasianus colchicus	108			1			109
Procyon lotor			6		1		7
Tadorna ferruginea	9						9

C1.2 Implementation and use of smart life traps at key locations and related catch activities

A total of 25 smart life traps were developed. The first two were placed in the field November 2021, April 2022 all traps were deployed in the project areas. From November 2021 until July 2023 the smart life traps were tested in the different project areas.

The main goals for testing in the field are:

1. Collecting good and sufficient footage to further improve the recognition software
2. Testing the smart life traps, receive feedback from trappers and improve both hardware and software

Development and training of the intelligent selectivity of the trap
The footage which was taken by the smart life traps was collected four times during the project and delivered to ROBOR, so they could use the images to further develop and fine-tune the recognition software. Each time the updated software was immediately implemented. Traps have also been placed at Dierenrijk Eindhoven, Gaia Zoo and Otter-Zentrum Hankensbüttel to collect pictures of otters, raccoons and beavers. A total of 350.000 pictures were taken by the smart life traps.

Feedback from trappers
The traps were placed in the project areas so the trappers could test them. WSRL contacted the trappers regularly (at least monthly). The trappers gave feedback, reported issues and gave suggestions for improvements with regard to both the hardware and software. All feedback from the trappers was also communicated to ROBOR so they could improve the smart life traps.

Improvements
From October 2022 till January 2023 the smart life traps were improved by ROBOR, both the hardware and software were improved based on the given feedback and issues were solved. All improvements are listed in the after life plan and the report on the quality and usability of the deployed equipment.

Conclusion
At the end of the project the smart life traps have proven to work, muskrats and coypu were caught and bycatch was avoided. However it was concluded that more development is needed. ROBOR will continue with the development after LIFE MICA has ended.

6.1.4.6. Deviation, main problems, and corrective measures (if any)

The smart life traps were deployed in the field over a year later than planned, due to issues with the development (see deviation 6.1.3.3). However there was sufficient time to test the smart life traps, collect pictures, make improvements and confirm that the smart life traps work.

C2 – Implementation of DNA approaches and linked catch activities (UvW)

6.1.4.7. Administrative information

Lead partner	UvW
Involved partners	VMM, UvW, UvA, WSRL
Other parties	Hoogheemraadschap de Stichtse Rijnlanden, Wetterskip Fryslân, Waterschap Hunze en Aa's, Stichting Waterproef and Aqualysis
Location(s)	Project area 8 (DNA-mapping) Project areas 2, 6-9 and 11 (eDNA)
Start	Foreseen: 01-09-2019 (eDNA); 01-01-2020 (DNA mapping),
	Actual: 01-09-2019 (eDNA); 01-02-2020 (DNA mapping)
End	Foreseen: 01-09-2023 (eDNA); 06-2023 (DNA mapping),
	Actual : 01-09-2023 (eDNA); 01-09-2023 (DNA mapping),
Status	Finished

6.1.4.8. Technical progress

C2.1 Scaling-up and real-life implementation of eDNA approach

C2.1.1 Standardized eDNA-based monitoring protocols for early prevention of re-population 04/2023

C2.1.2. 3 water laboratories that are able to routinely process high volumes of eDNA samples 04/2023

Scaling up and real-life implementation of eDNA approach

- The first version of the field "protocol" was developed at the start of the project, and went through multiple iterations based on test results and feedback from trappers. The final version of the field guideline was ready before the deadline of 04/2023
- The final eDNA method consists of two guidelines (previously protocols): Semi-Randomized sampling, with guidelines for interpretation and the follow up guideline of eDNA positive tracks.
- Testing of the field protocol in 2021 led to changes in the Field Approach changing the follow-up of positive 3-5 km monitoring tracks with 30-50 point samples to a follow-up with 1 km tracks. If necessary, burrows can be more accurately localised on positive 1 km tracks using point samples. Reduction of the number of point samples results in a substantial cost reduction.
- The autosampler was developed by the UvA to sample the tracks of 1-5 km and was funded by the UvW. In 2021, the e-DNA autosampler was shortlisted for a water innovation price (waterinnovatieprijs).
- In 2022, the sampled region of the Polder in area 9 had 831 catches compared to 139 in the previous year. In total, the number of catches in area 9 was 2.369 catches compared to 324 in 2021. Not all catches were in the sampled regions, as the unexpected number of catches in the polder partially led to increased efforts in other areas. The percentage of eDNA containing tracks was 39%. In Area 8, the number of catches in 2022 was 435 compared to 212. Most of these catches were in polders which were not sampled for eDNA, although eDNA signal in waterways surrounding these polders did give an indication of the higher population in these areas. The total number of eDNA positive tracks was 4%
- Results of large-scale sampling in 2022 led to a change from full-coverage sampling of areas, to semi-randomised sampling using 40-80 tracks. This results in a significant cost

reduction and is accurate enough to determine the presence of muskrats in a defined area. Details of the approach can be found in report: results C.2.1.1 eDNA method. Semi-randomised sampling with 40-80 3-5 km tracks is the standardised part of the method.

- Semi-randomised sampling in the first half of 2023 gave similar results to 2022 with 42% of tracks containing eDNA in area 9 and 3% of tracks containing eDNA in area 8. More information can be found in report C.2.1.1 eDNA method.
- In area 11 monitoring of preferential area for coypu (nature reserves) showed that elimination and subsequent re-colonisation can be detected using eDNA. Details in report C.2.1.1 eDNA method.
- In Area 8 there will be a continuation of sampling outside the LIFE MICA project for the entire management area.
- About half of the Dutch water authorities have indicated that they will implement the eDNA method in their muskrat management within the next year.
- Belgium has shown interest in the autosamplers as has the Danish environmental agency.
- A conservative estimate of the anticipated cost reduction for muskrat management by implementation of the eDNA method in low population areas, is ~50%. Details on the estimation can be found in results C.2.1.1 eDNA method.
- Conclusion: The eDNA method works, and will be implemented by multiple water authorities in low population areas.

Routine processing of samples by water laboratories

- From 2022 till April 2023, the processing of the water samples was fully transferred to the water laboratories. Details on the transfer can be found in report results C.2.1.2 transfer to water laboratories.
- Two more water laboratories are in the process of implementing processing of muskrat and coypu eDNA samples. In 2024 all 5 Dutch water laboratories will be able to analyse muskrat and coypu eDNA.

C2.2 Implementation of DNA mapping for a near-eradication area and linked catch activities

- Sampling was started in February 2020 until January 2021. The samples were send to WENR in February-March 2021.
- Sampling was done in Wetterskip Fryslân (main area) and in a strip of 20 kilometres around Fryslân (Hoogheemraadschap Hollands Noorderkwartier, Waterschap Noorderzijlvest, Waterschap Drents Overijsselse Delta and Waterschap Zuiderzeeland. Reference samples have been taken in other Life MICA Project Areas: Area 3, Vechtegebiet; Area 4, Sint-Laureins; Area 6, Mark valley; Area 10, border area Gelderse Poort.
- The samples were sequenced in Spain.
- Our trap registration system was slightly modified to be able to record the sample numbers in the field by the trappers.
- More samples have been taken for two specific reasons:
    - To investigate whether the regional presence of albino muskrats in Tiengemeten is genetically determined.
    - To investigate whether there is a genetic relationship between muskrats trapped in Noord-Holland and Flevoland (both sides of the IJsselmeer and Markermeer).
- If the DNA mapping can provide good predictions about migratory routes, then it is considered to:
    - use it for coypu found scattered inland.

- to be deployed in other regions to further understand the migration of muskrats.

- On 27 January 2022, an online workshop was organized:
  - the results of the 1st sample round have been fed back to the trappers who collected samples
  - the assumed migration routes were presented
  - working agreements were made for the 2nd round of sampling in project area 8
- Based on the assumed migration routes, Wetterskip Fryslân has placed additional traps along the inflow and throughflow routes.
- Wetterskip Fryslân placed 159 extra catching means at the advised locations, with which 65 muskrats were caught. Catches in these additional trapping devices are accounted for in Appendix 2 of the DNA-mapping report.
- The final report on DNA-mapping, 'Bronherkenning voor muskusratten op basis van ruimtelijke genetica' became available on November 10, 2023. It will be published on the LIFE MICA website https://lifemica.nl/research-innovaties/dsf/

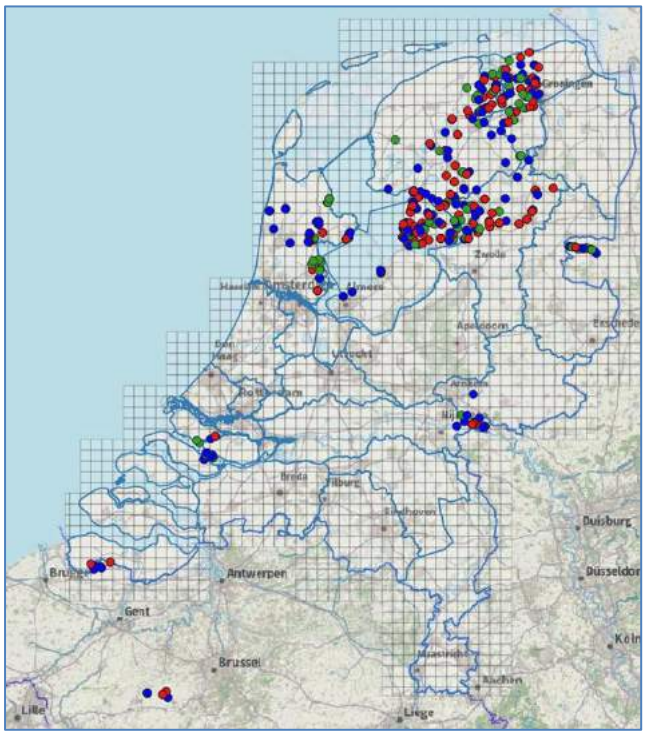

Figure 7 Locations of the DNA mapping samples: red = female, blue = male and green = juvenile

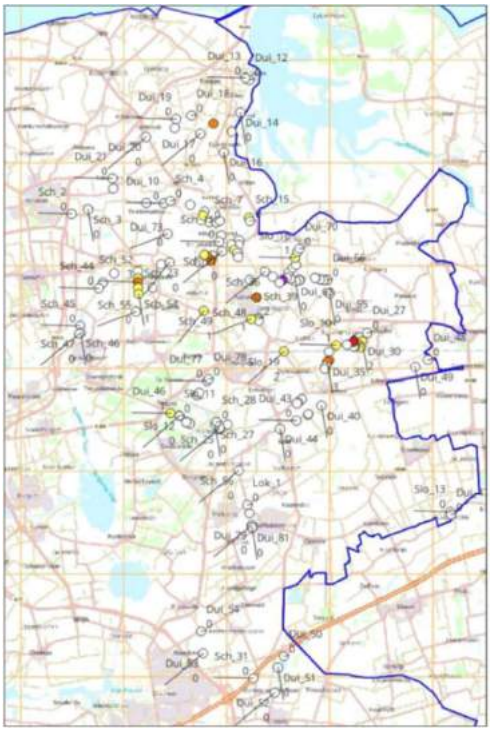

Figure 8: Catches additionally placed traps (white = 0 catches, yellow = 1 or 2 catches, orange = 3 or 4 catches, red = 5 or 6 catches)

6.1.4.9. Deviation, main problems, and corrective measures (if any)

<u>eDNA</u>

The deadlines for both deliverables were met. However to gain even more data for C2.1.1, sampling was continued until mid-June 2023 for area 9 and the end of June 2023 for area 8.

<u>DNA mapping</u>

- Due to COVID we had a slightly longer lead time for DNA sequencing (2 months delay), since laboratory capacity was needed for COVID.
- Raw data was delivered mid-December (3 months delay)
- 1st results were available at the end of January 2022 (1 month delay)

- Traps put at key-locations pre-determined by DNA mapping started from February 2022 (1 month delay)
- Start of 2nd round of sampling started 1 month later.

6.1.5. D1 – Assessment and improvement of the quality of the equipment and methodology (WSRL)

6.1.5.1. Administrative information

Lead partner	WSRL
Involved partners	UvW, UvA, ITAW, LWK-LDS, EV INBO, VLAGEWINBO, VMM
Location(s)	All project areas
Start	Foreseen: 09-2020
	Actual: 09-2019 (first equipment) 4-2022 (all equipment)
End	Foreseen: 08-2023 (was extended to 09-2023)
	Actual: 09-2023
Status	Finished

6.1.5.2. Technical progress

- The project managers have had regular (weekly to monthly) contact with the people working with the methods in the project areas and the laboratories, to receive feedback, suggestions for improvements and determine issues. This has proven the fasted and most effective way to assess the equipment and methods.
- For all methods improvements were implemented using the feedback from field experiences.
- Two surveys were held. The surveys were sent out on 25-4-2022 and 2-3-2023. On 22-7-2022 a preliminary report was written with the survey results of 2022. In 2023 the surveys were updated based on recent developments.
- WSRL wrote the report on the quality and usability of the deployed equipment. For this information was collected using the results, surveys and feedback from people working on the methods. All consortium partners contributed to this report, UvA aided with analysis. On 21-9-2023 a draft version of the report was sent to all consortium partners for feedback, on 30-9-2023 the final version of the report was sent to the consortium partners for validation.

6.1.5.3. Deviation, main problems, and corrective measures (if any)

- Due to delays the smart life traps were placed in the field later than planned. However, there was still sufficient time for feedback and several (software and hardware) improvements.
- It was decided to focus mostly on direct contact with the people working on the methods instead of surveys each half year. The surveys were not preferred. By having regular contact problems and improvement suggestions are fed back by trappers directly to the project leaders. This works faster and is more effective.
- The deadline of the report on the quality and usability of the deployed equipment was extended from 1-8-2023 to 30-9-2023 so all final results could be added to the report. The extension of the deadline was approved by CINEA/Elmen EEIG.

6.1.6. D2 – Evaluation of the environmental impact (UvA)

6.1.6.1. *Administrative information*

Lead partner	UvA
Involved partners	VMM, UvW, WSRL, ITAW, EV INBO LWK-NDS, VLAGEWINBO
Location(s)	Project areas: 1-5 and 10 (biodiversity surveys)
Start	Foreseen: February 2019
	Actual (or anticipated): August 2020
End	Foreseen: August 2023
	Actual: August 2023
Status	Finished

6.1.6.2. *Technical progress*

D2.1 Evaluate the evolution of the numbers of muskrat and / or coypu in the project areas

D2.1 Report on the evolution of the numbers of muskrat and / or coypu in the project Areas

The teams of WSRL (supported by their trappers), VLAGEWINBO (supported by the trappers of VMM), LWK- NDS (supported by their trappers) and ITAW (supported by hunters associations) have registered the number of catches with location information within the open-source dashboard and smartphone application of LIFE MICA. UvA members (. Emiel van Loon and Caitlin Black) have combined and analysed this information, starting in 2021 with an existing population model to estimate population sizes of muskrat and coypu (in number of individuals) and the size of IAS-free areas (in ha) in order to deliver the data reports and fact sheets on the relevant KPLIs by the planned deadline of 09/2023. This information on IAS population sizes and IAS-free areas was then placed on the LIFE MICA dashboard as well and is accessible to all beneficiaries in beneficiary's countries. In the course of the project the models appeared to be unsuitable for the tasks since the available information varied per area. As a result the initial population and IAS-free area was erroneous at the start.
Therefore the planned reporting of estimated population sizes of muskrat and coypu (in nr. of individuals) and the size of IAS-free areas (in ha) could not be done on a yearly basis in the first half of the project. The period 09/2021-10/2022 was used to try constructing new models, which eventually resulted in the current version (shown in the final version of the report on evolution of numbers of muskrats and coypu). At 02/2023 the preliminary results were reported for this model (still lacking final data). Another hurdle for the final result was to acquire the catch data in Germany. In Germany most coypu and muskrat catches are done by volunteer hunters. These hunters do not register their catches or register them with very little detail – but eventually we have obtained a data series of sufficient detail. The final version of the report on evolution of numbers of muskrats and coypu was delivered 9/2023.

D2.2 Evaluate riparian vegetation change by decreasing numbers of muskrat and / or coypu

D2.2 Report on vegetation change by decreasing numbers of muskrat and / or Coypu

Beginning in August 2020 (Areas 1, 2, and 3), the reedbed extent has been measured in the field at fixed sampling points by the field staff from UvW, UvA, EV-INBO, ITAW, WSRL and LWK-NDS, see Appendix III. The target species were determined by an expert field

biologist (Jeroen Gruijters) and are also shown in Appendix III. This list of target species was established October 2021, once all 2021 field observations were complete.

Starting from 01/2022, Sentinel-1 satellite-data has been collected in the Google Earth Engine platform for all the project areas. The identified project vegetation plots have been used with these images as validation sites for the reed classification model. To acquire additional validation sites, reed extent has also been identified manually on aerial photographs from various sources in projects by MSc students at UvA over the years 2020-2022 in various classes and individual projects. From 09/2022 onwards, an existing method to calibrate derive a classification model and estimate reed extent from Sentinel-1 data was applied and calibrated using the validation areas (method is reported in the final report). The preliminary outcome results of this were reported at the project board meeting of 16/02/2023. The classification results were however not yet complete (the years 2019 and 2020 were not yet included) and not very accurate. From 02/2023 until 08/2023 the model was extended to include 2019 an 2020 and a re-calibration was done. At 09/2023 the final estimates of the reed extent were provided in the final version of the report on vegetation change.

D2.3 Evaluation of the impact on protected species by monitoring numbers
D2.3 Report on the impact of coypu/muskrat decrease on protected species

The target species were determined by an expert field biologist (Jeroen Gruijters) and are listed in Appendix III. The teams of WSRL (supported by their trappers and Uhlelo), EV-INBO (supported by UvW), LWK-NDS (supported by their trappers) and ITAW (supported by hunters' associations) were trained by the UvA-expert (Dr. Caitlin Black) to use the species lists for observation while they are in the field. UvA was unfortunately not able to participate in visiting all field observations sites, in 2021 due to COVID. For 2022 onwards it appeared that the personnel conducting the field data collection was well trained (to follow the protocol and for species identification) so that no additional field training was required. The field data was collected every year until 2023. These field observations have been uploaded to GBIF and are stored in the LIFE MICA dashboard. Citizen science networks that conduct field monitoring in the area have been contacted to contribute existing citizen science data (waarneming.nl and GBIF), which was analysed by a UvA Master's student (Klaas Land) October 2021. The UvA expert (Dr. Caitlin Black) has interpreted the data and made a fact-sheet per project, which were presented at project board meetings. A preliminary draft report (not including the results of 2023) was presented at the project board meeting of 16/02/2023 and the final version of the report of the impact on the protected species was delivered at 09/2023.

6.1.6.3. Deviation, main problems, and corrective measures (if any)

The progress of the reports, factsheets and the model was significantly delayed. A back up plan was made in case UvA would not be able to deliver in time. However, everything was finished before the deadline of 9/2023. UvA was regularly contacted by the coordinator of WSRL to make sure everything would be finished in time. The delays were also discussed during (online) meetings and PB meetings. The fact sheets and draft versions of the reports were sent February and April 2023 to project partners for feedback. A back up plan was devised in case UvA could not deliver.

D2.1 Evaluate the evolution of the numbers of muskrat and / or coypu in the project areas
In the first half of the project it appeared to be infeasible to produce accurate estimates of the numbers of muskrat and coypu (along with IAS free areas), but as of 2022 these estimates were made. Unfortunately the population estimates were still not complete until the end of the project, when reliable catch records for Germany became available. In the final version of the report the evaluation of muskrat and coypu were made, for all project areas.

D2.2 Evaluate riparian vegetation change by decreasing numbers of muskrat and / or coypu
Based on available satellite and field-data, a classification model was developed and trained. There were no deviations from the planned output.

D2.3 Evaluation of the impact on protected species by monitoring numbers
UvA (Dr. Caitlin Black) was unfortunately not able to participate in field observations as planned, however the monitoring was conducted well by the project partners. The quality was checked and the data processing was conducted by UvA after the field visits. The results of this monitoring were uploaded to GBIF and presented via fact sheets at project-board meetings. There were no deviations from the planned output.

6.1.7. D3 – Evaluation of the socio-economic aspect (UvW)

6.1.7.1. Administrative information

Lead partner	UvW
Involved partners	VMM, ITAW, LWK-NDS
Location(s)	Not applicable
Start	Foreseen: 06-2020
	Actual: 05-2020
End	Foreseen: 09-2023
	Actual: 09-2023
Status	Finished

6.1.7.2. Technical progress

D3.1 Evaluation of LIFE MICA'S social impact
D3.2 Evaluation of LIFE MICA's economic impact

- The following steps have been taken for the deadline 09/2020:
  - 08-05-2020: UvW has drawn up draft tables to which the partners could comment.
  - 17-07-2020: The final tables where sent to all partners with the request to fill in the fields relevant to them.
  - 10-09-2020: The final tables where sent to all partners for validation.
  - 29-09-2020: Final tables finished
- From October 2022-February 2023 the partners are again asked to provide the data.
  - 24-10-2022: UvW has drawn up (updated) draft tables to which the partners could respond.
  - 02-01-2023: The final tables where sent to all partners with the request to fill in the fields relevant to them.
  - 09-06-2023: The draft reports where sent to all partners for validation.

- 28-09-2023: Final version reports ‘Evaluation of LIFE MICA'S social impact’ and ‘Evaluation of LIFE MICA's economic impact’ finished.

In chapter 6.4.2 and 6.4.3 for the economic and social benefits are shown. See Appendix IV and V for the tables with the KPI indicators for the social and economic impact. See the reports Evaluation of LIFE MICA'S social impact’ and ‘Evaluation of LIFE MICA's economic impact’ for more details on the social-economic aspect.

6.1.7.3. Deviation, main problems, and corrective measures (if any)

None.

6.1.8. E1 – Awareness raising and dissemination material (UvW)

6.1.8.1. Administrative information

Lead partner	UvW
Involved partners	All partners
Location(s)	Project areas and numerous locations
Start	Foreseen: 02-2019
	Actual: 02-2019
End	Foreseen: 09-2023
	Actual: 09-2023
Status	Finished

6.1.8.2. Technical progress

E1.1: Development of an awareness raising and dissemination plan

In the beginning of the LIFE MICA project, a “communication and dissemination plan” was written by ITAW and UvW. The plan identified the target audience of foreseen LIFE MICA communication activities and determined the means and channels that were used (project website, social media, email newsletter).

E1.2: Creation of the awareness raising and dissemination material

- El.2.1: Creation of a public website and a private area
- El.2.1 Operating website in beneficiaries languages + English

A LIFE MICA project website is available in English, Dutch and German: https://lifemica.eu/, https://lifemica.nl/ and https://lifemica.de/
The website informs about the general aims of the LIFE MICA project, presents the project areas and informs about the progress. Furthermore, a private Sharepoint area was set up for internal communication and sharing of documentation between the project partners.

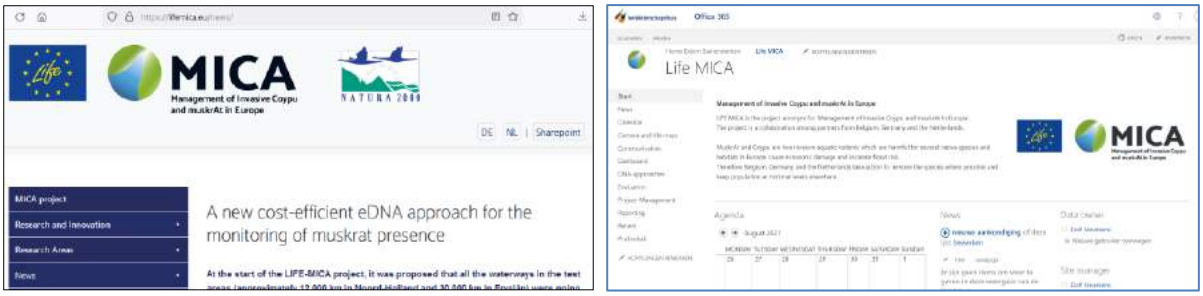

Figure 9:Screenshots of the LIFE MICA project website (left) and the LIFE MICA Sharepoint management page

- El.2.2: Creation of a notice board

In the beginning of 2020, noticeboards with information on the LIFE MICA project were placed in all project areas to raise awareness among local residents and visitors.

Figure 10: Noticeboards in the project areas

- E1.2.3: Creation of a Layman's report

A Layman´s report was written, summarizing the outcomes of the LIFE MICA project.. First version 04/2023, updated version finished 08/2023.

First page of the Layman´s report

- El.2.4: Creation of additional dissemination material

Additional awareness raising material was created: a one page flyer and a foldable leaflet. Furthermore, informative videos about the LIFE MICA project were produced, presenting either the project in general or certain aspects like a project area or one of the developed methods

LIFE MICA Video: https://www.youtube.com/watch?v=WY5-__1UItI

Figure 11: Flyer

Figure 12: Screenshot of informative video

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6.1.8.3. Deviation, main problems, and corrective measures (if any)

None.

6.1.9. E2 – Communication and dissemination actions (ITAW)

6.1.9.1. Administrative information

Lead partner	UvW
Involved partners	All partners
Location(s)	Project areas and numerous locations
Start	Foreseen: 09/2019
	Actual: 09/2019
End	Foreseen: 08/2023
	Actual: 08/2023
Status	Finished

6.1.9.2. Technical progress

E2.1 Communication and dissemination campaigns

The target audience was defined in the communication plan and comprises collaborators of the LIFE MICA project, environmental and water authorities, hunter's associations, policy makers, nature conservation organizations, research institutions and the general public. Communication and dissemination events consisted of open days, workshops, and conferences. Numerous communication and dissemination activities have been conducted during the course of the project. In Appendix VI a list of the communication and dissemination actions can be found For more details see report 'E2.1 Report on Communication and Dissemination Actions LIFE MICA project'.

Table 6: List of open days in LIFE MICA project areas

Location	Date	Nr. of participants	Type of event
Aschauteiche	02-07-2021	Ca. 15*	Online
Lake Dümmer	05-11-2021	Ca. 16*	Online
Vechte region	19-11-2021	Ca. 16*	Online
Friesoyther Wasseracht	14-08-2022	not documented	In-person
Gelderse Poort (Gendt)	16-09-2022	23	In-person
Huntloserr Wasseracht	02-10-2022	not documented	In-person
Hoogstraten (Wortel)	01-12-2022	26	In-person
Wetterskip Fryslân (Lemmer)	12-12-2022	53	In-person

**Approximate, mean number of participants is due to difference in numbers from beginning to end of the event*

Events and presentations

From 2020 till 2023, the LIFE MICA project partners attended and presented LIFE MICA at more than thirty in-person and online events with attendants varying from 10 to 100.000 people. These events and presentations took place all over Europe and comprised virtual or in-person fairs, conferences, seminars, various meetings and workshops. Regional and national institutions, interested public, scientific experts, regional Water and Agricultural Authorities and environmental policy makers, depending on the type of event, were involved. A complete list can be found in Appendix VII and the report 'E2.1 Report on Communication and Dissemination Actions LIFE MICA project'.

Publications
Publications regarding the LIFE MICA project and its developed methods as well as its results have been issued in different institutional magazines and in the general press. Moreover, LIFE MICA was presented in yearly newsletters, contents at the project website as well as in radio, television and social media/video platforms. All project partners contributed to publish and spread information materials in every possible format. The target recipients were: scientific and research institutions, general public, hunters' associations, Water and Environmental Authorities, and nature conservation organisations. Many publications are linked to or are available on the LIFE MICA website, which improved the spread of information and was a good tool to reach a broader audience, as proven by the increasing number of website visitors during the project.

The goal of publishing at least 3 articles each in institutional magazines, general press and scientific journals/conference books has been met.

E2.1 Report on communication and dissemination activities

The information on communication and dissemination activities was collected throughout the project from all partners and regularly updated. The report on communication and dissemination activities was written in 08/2023 and finished by 09/2023.

E2.2: Networking with other projects

Advisory Board
The LIFE MICA project is assisted by an Advisory Board comprising stakeholders ranging from hunter's associations, representatives of water authorities to policy makers. A first Advisory Board meeting was held in 2021 in a virtual talk show format, including presentations on the project progress, interviews, a guest lecture and discussion rounds. A second Advisory Board was organized by ITAW on the 6th of July 2023.

Networking activities during events, conferences and seminars
During conferences, open days or other meetings, which aimed at communication and dissemination of the project, LIFE MICA established an important network of contacts with different stakeholders such as environmental and water authorities, hunter's associations, policy makers, nature conservation organizations, and research institutions. Contacts with other LIFE projects were established, joint workshops were organized and the dashboard data was shared with LIFE RIPERIAS.
The opportunity to exchange information and learn about different management strategies, comparing and discussing methods for population control of invasive species and to share LIFE MICA methods were the main themes that brought the different projects and institutions together. Maintaining contact and networking with different organizations involved in management and research has been fundamental to the good progress of the LIFE MICA project itself and especially to the future development of the innovative methods.
A list with details on networking activities can be found in Appendix VII the report on Networking Activities.

E2.2 Report on networking activities
The information on networking activities was collected throughout the project from all partners and regularly updated. The report on networking activities was written in 08/2023 and finished by 09/2023.

6.1.9.3. Deviation, main problems, and corrective measures (if any)

In the first two years of the LIFE MICA project (2020 and 2021), physical meetings were restricted, completely banned or limited in number of participants due to the coronavirus pandemic. Therefore, several public outreach events had to be cancelled or postponed (fairs, congresses, meetings on local basis). However, meetings were transferred to virtual environments and even complex events like the first Advisory Board meeting and digital open days were successfully implemented.

6.1.10. E3 – Transfer and replicability (ITAW)

6.1.10.1. Administrative information

Lead partner	ITAW took over the lead of this action, originally LWK-NDS was lead
Involved partners	All partners
Location(s)	Numerous locations
Start	Foreseen: 01-10-2019
	Actual (or anticipated): 01-10-2019
End	Foreseen: 12-2019
	Actual (or anticipated): 12-2019
Status	Finished

6.1.10.2. Technical progress

A fundamental part of the EU LIFE program is to disseminate the results of the funded projects. The gathered experiences and the methods that were developed and tested throughout a LIFE project should be shared with relevant stakeholders beyond the beneficiaries and the project areas. The goal is to enable Replication and Transfer of the developed methods and approaches. In the grant agreement it was foreseen to contact institutions potentially interested in replication and transfer of the MICA methods with informative material and gather feedback with a questionnaire. It was also planned to organize workshops to distribute knowledge on the MICA methods and finally write guidelines on transfer and replication.

Replication: refers to the implementation of the developed coypu and muskrat management tools for management of coypu and muskrat in geographical regions beyond the LIFE MICA project areas.

Transfer: refers to the adaptation of the developed coypu and muskrat management tools for the management of other species (e.g. other IAS or even protected species).

E3.1 Replicability & E3.2 Transfer

All goals foreseen in the grant agreement were met.
A booklet with detailed information on the management methods developed during the LIFE MICA project was published in 2023 in English, German and Dutch on the LIFE MICA website. It was additionally sent by email to numerous stakeholders, ranging from management

authorities and hunters associations to nature conservation organizations in the beneficiary countries and beyond. Along with the booklet, a link to an informative film about the LIFE MICA project and a link to a short questionnaire on possible interest in Replication and Transfer of the developed management methods was included. The aim was to raise interest in the LIFE MICA methods and to gather feedback on whether stakeholders involved with management of IAS would consider replicating or transferring the management methods.
From 2022 to 2023, three workshops were organized in which numerous stakeholder groups participated: IAS management authorities, nature conservation agencies, nature conservation organizations, the hunters´ community, research institutions and interested public. During the workshops, the LIFE MICA methods were presented in detail and the attendees were invited to ask questions and discuss the potential application and limitations of the developed management methods. Finally, transfer and replication guidelines were written and are available at the LIFE MICA website.

Report on replicability activities
The information on replicability activities was collected throughout the project from all partners and regularly updated. The report on replicability activities was written in 08/2023 and finished by 09/2023.

Report on transferability activities
The information on transferability activities was collected throughout the project from all partners and regularly updated. The report on transferability activities was written in 08/2023 and finished by 09/2023.

6.1.10.3. *Deviation, main problems, and corrective measures (if any)*

Some Replication and Transfer activities were delayed in consequence of restrictions due to the coronavirus pandemic in 2020/21. However, in the end of the LIFE MICA project, all goals were met.

When planning the strategy for dissemination and replication/transfer of the developed management methods, it quickly got apparent that communication, dissemination, replication and transfer are intertwined and can hardly be separated. The stakeholders potentially willing to replicate the developed coypu and muskrat management methods in further regions are the same stakeholders that might also transfer the methods to other species than coypu and muskrat. The project beneficiary ITAW, leading communication as well as the replication activities took over the lead in Action E3.2 (transfer) as well. LWK, the originally responsible partner for Action E3.2, was always informed about the progress and included in all outreach activities (e. g. the workshops on replication/transfer).

6.1.11. F1 – Overall project management

6.1.11.1. *Administrative information*

Lead partner	WSRL
Involved partners	All partners
Location(s)	Not applicable
Start	Foreseen: 1-09-2019
	Actual: 1-09-2019
End	Foreseen: 12-2023
	Actual: 12-2023
Status	Finished

6.1.11.2. *Technical progress*

F1.1 Management tools
F1.2 Project management by WSRL

- Management tools: Have been developed, among others: financial template, deliverable template, layout guidelines for reporting and an online SharePoint
- Project management: WSRL has had project managers and coordinators during the entire LIFE MICA project. An external party (Euroquality) was hired to aid with the project management. Coordination between project leaders, coordinators, external support and monitor went well.
- Project board meetings, Advisory board meetings and monthly online meetings with all consortium partners have been running smoothly.
- The mid-term report was delivered 12-8-2021.

6.1.11.3. *Deviation, main problems, and corrective measures (if any)*

- Administrations hours trappers of Regional Water Authorities could not be added to the financial overview of the Dutch Water Authority (UvW). Though multiple meeting have taken place with the monitor this issue could not be solved, therefore the own contribution of UvW is lower than budgeted.
- Due to COVID in 2020 and 2021 PB meetings, advisory board and open days were held online, field visits could not take place. From 2022 onwards in-person events on location and field visits were orchestrated again.
- During this project we had three different monitors, this occurred due to changes within Neemo/Elmen EEIG. Furthermore, the methods of delivering documents has changed (BUTLER).

6.1.12. F2 – After-LIFE plan (WSRL)

6.1.12.1. *Administrative information*

Lead partner	WSRL
Involved partners	All partners
Location(s)	Not applicable
Start	Foreseen: 12-2022
	Actual: 12-2022
End	Foreseen: 6-2023
	Actual: 6-2023
Status	Delivered

6.1.12.2. *Technical progress*

F2.1 Establishment of the After-LIFE plan
F2.2 Exploitation plan

During online monthly meetings with the consortium partners possibilities for after LIFE and exploitation were discussed. It was a topic in the project board meeting on 16-2-2023, during this meeting it was decided to host an online brainstorm. The online brainstorm about the after LIFE and exploitation plan was held on 6-3-2023 with all consortium partners. Furthermore, after LIFE possibilities and exploitation were also discussed with external partners like ROBOR and Wetterskip Fryslân.

WSRL wrote the after LIFE plan and exploitation plan using received input and feedback from all consortium partners. March 2023 a first draft was written using the feedback gained through the brainstorm and meetings. Till June 2023 all partners supplied input and texts for the plans. On 14-6-2023 and 15-6-2023 the final draft versions of the after LIFE plan and exploitation plans were send to all consortium partners for feedback and validation. The finished after LIFE plan and exploitation plan were sent 30-6-2023 to all consortium partners.

Discussions on continuing the LIFE MICA methods were held. From June 2023 onwards multiple online meetings have been held to discuss continuing the methods and possibilities for a new project (with a follow-up grant). In the meetings joined both consortium partners and external partners. The eDNA method has already been replicated throughout the Netherlands and will also be used in Belgium. ROBOR will continue developing the smart life traps. The Agouti software of smart camera tracking is publically available.

6.1.12.3. *Deviation, main problems, and corrective measures (if any)*

- None

6.2. Main deviations, problems and corrective actions implemented

6.2.1. Deviation n°1 Dashboard

Description of the main problems or difficulties
There were two main hurdles with mobilizing the data and building the dashboard. The first one was collecting the data in Germany. In Germany most coypu and muskrat catches are done by volunteer hunters. These hunters do not register their catches or register them with very little detail (e.g. no coordinates or date). The second hurdle was the proposed timing and personnel changes at EVINBO. We needed to go through several different steps before we could start building the dashboard: • Decide on a strategy for collecting and storing the data • Exploring all the available data • Transforming the data • Publishing the data on GitHub Taking all these steps with international partners and building a dashboard was not feasible in the proposed four months. Besides this we also had to hire someone to build the dashboard since we didn't have the technical expertise in-house at the start of the project. However the person hired did not stay on long enough to finish all features of the dashboard, leading to again needing to hire external help to finish the dashboard.
Assessment of the impact on the outcomes of the project
No impact on the outcome. Though the dashboard was delayed, all issues were solved. The dashboard with all planned features was delivered. The dashboard has been available online from January 2021 onwards. All planned features were finished March 2023.
Measures taken / to be taken to overcome or alleviate the problems
Collecting the data in Germany: The initial idea was to adapt an app from one of the other partners and convince the hunters to use this. In the meantime we developed a simple app using AppSheet that could be used by the project partners in the project areas. Since the Dutch app was being upgraded we landed on the app from VMM. However instead of it being a small project of simply translating the app this turned out to be a more complex programming project. Eventually it was decided to just keeping using the simple app devised in AppSheet. Building the dashboard: Funds were transferred to hire personal to develop the dashboard.

6.2.2. Deviation n°2 Smart camera tracking

Description of the main problems or difficulties
Collecting image material for the database: At the beginning of the project not sufficient image material was available for the database. Recognition software: The development of recognition software (A3) was more complex than anticipated. The aim of this sub-action was to fine tune an already existing image recognition algorithm. The colleague that helped build the original image recognition algorithm, was no longer employed at VLAGEWINBO when the project started. This led to a serious delay while trying to find the right expertise.

Cameras: The proposed budget did not cover the costs for 50 cameras as intended. This may be due to the need to also buy casings, locks and batteries.
Assessment of the impact on the outcomes of the project
There was no impact on the outcome of smart camera tracking. Instead of developing our own recognition software we cooperated to develop the Agouti recognition software
Measures taken / to be taken to overcome or alleviate the problems
Collecting image material for the database: Cameras were placed in a more muskrat dense area. Coypu however are only present in low numbers in Flanders and it was therefore necessary to have the cameras operating in the partners' areas as well. This resulted in a sufficiently large image database to start training the algorithm in the summer of 2020. Recognition software: After it became clear that there was no in-house expertise for building these particular algorithms we decided to allocate some of our personnel budget to subcontracting this work. During the time our subcontractor was working on fine tuning the original algorithm we were made aware that Agouti, the platform used to host and annotate camera trap images, was working on an algorithm as well. Since INBO is a partner in Agouti we could test the beta version of this algorithm. The results were quite impressive and much further advanced than those from our own algorithm. We therefore decided, after discussing this with EASME, to no longer invest in fine-tuning our own algorithm but instead provide our data to Agouti to help them develop their algorithm. The Agouti algorithm was used for smart camera tracking Cameras: We decided to buy 40 cameras instead of 50 instead of extending the budget. This did not influence the results since three additional cameras from INBO were used. Furthermore, some low density areas do not need as many cameras. The wildlife cameras have been operational in the field from February 2020 until April 2023.

6.2.3. Deviation n°3 Smart life traps

Description of the main problems or difficulties
Development smart life traps: The development of the smart life trap had been delayed due to problems in developing the recognition software. In addition, necessary components (computer chips) had longer delivery times due to COVID and some components were no longer available, the design had to be modified, resulting in further delays. The total delay for the deployment of the smart life trap became over a year. Number of smart life traps: A total of 25 smart life traps were developed, while in the GA a total of 50 traps was planned. This was due to several reasons. The development of the smart life traps costed more than budgeted (too low estimation of the costs, delays and parts becoming more expensive). Furthermore updating and improving the traps takes time and costs, which are higher when there are more traps. Updating image recognition software: Due to shorter deployment time and fewer smart life traps fewer images could be collected.
Assessment of the impact on the outcomes of the project
Even though fewer traps were deployed and they were deployed later than planned, it was proven that smart life traps work. The hardware and (recognition) software have been improved several times. Therefore the outcome of the project was not impacted.
Measures taken / to be taken to overcome or alleviate the problems

Development smart life traps: The traps were deployed from 11/2021 till 7/2023 to make sure there was sufficient time to test and improve the smart life traps. Furthermore, trappers were contacted regularly for feedback. This was communicated to Robor (developer) and they improved both the hardware and software. Improvements were immediately implemented so further testing and improvement could be conducted. Number of traps: It was decided to focus on quality and not on quantity, so the available traps could be developed further. Therefore it was decided to only produce and test 25 smart life traps. Updating image recognition software: Since the traps were deployed later than planned there was less time to collect image material to improve the recognition software. Traps were placed in zoos to collect more pictures and extra image material was supplied by animal organisations. Over 35.000 pictures were taken by the smart life traps, which was used to update the recognition software four times.

6.2.4. Deviation n°4 Implementation of DNA approaches

Description of the main problems or difficulties
The sequencing of DNA-mapping samples was delayed a few months due to COVID, since the necessary materials for sequencing were used for COVID tests worldwide so less was available.
Assessment of the impact on the outcomes of the project
No impact on the outcome.
Measures taken / to be taken to overcome or alleviate the problems
The tasks that were scheduled after the sequencing were completed and executed in a shorter time frame to reduce the delay.

6.2.5. Deviation n°5 Assessment and improvement of the quality of the equipment and methodology

Description of the main problems or difficulties
Equipment and methods assessed in the field: Due to delays the smart life traps were placed in the field later than planned. All other equipment and methods were deployed in time. Surveys: The surveys were not preferred so there was little response. Especially during the first survey round. Direct contact was preferred. Deadline: The final results of the methods were due end of August while the report was due begin August.
Assessment of the impact on the outcomes of the project
No impact on the outcome.
Measures taken / to be taken to overcome or alleviate the problems
Equipment and methods assessed in the field: Contact with the people working on the methods was intensified. Improvements were immediately implemented. There was still sufficient time for feedback and several (software and hardware) improvements.

Surveys: The surveys were updated and sent to more people. It was decided to focus mostly on direct contact with the people working on the methods instead of surveys each half year. By having regular contact problems and improvement suggestions from trappers are fed back directly to the project leaders. This works faster and is more effective. Deadline: The deadline of the report on the quality and usability of the deployed equipment was extended from 1-8-2023 to 30-9-2023 so all final results could be added to the report. The extension of the deadline was approved by CINEA/Elmen EEIG.

6.2.6. Deviation n°6 Evaluation of the environmental impact

Description of the main problems or difficulties
Delays: The progress of the reports, factsheets and the model was significantly delayed, however everything was finished before the deadline of 9/2023 Population estimates: To Evaluate the evolution of the numbers of muskrat and / or coypu in the project areas (D2.1) population estimates needed to be made. In the first half of the project it appeared to be infeasible to produce accurate estimates of the numbers of muskrat and coypu (along with IAS free areas). Field visits: For the evaluation of the impact on protected species (D2.3), field visits were planned to monitor protected species. Due to Covid, UvA (Dr. Caitlin Black) was not able to participate in field observations as planned
Assessment of the impact on the outcomes of the project
No impact on the outcome, everything was delivered before the deadline
Measures taken / to be taken to overcome or alleviate the problems
Delays: UvA was regularly contacted by the coordinator of WSRL to make sure everything would be finished in time. The delays were also discussed during (online) meetings and PB meetings. The fact sheets and draft versions of the reports were sent February and April 2023 to project partners for feedback. A back up plan was devised in case UvA could not deliver. Population estimates: As of 2022 the population estimates were made, though not all data was complete yet. The project partners supplied the missing data in 2023. In the final version of the report the evaluation of muskrat and coypu were made for all project areas. Field visits: The monitoring in the field was conducted well by the project partners. The quality was checked and the data processing was conducted by UvA after the field visits. The results of this monitoring were uploaded to GBIF and presented via fact sheets at project-board meetings.

6.2.7. Deviation n°7 Communication and events

Description of the main problems or difficulties
In the first two years of the LIFE MICA project (2020 and 2021), physical meetings were restricted, completely banned or limited in number of participants due to the coronavirus pandemic. Therefore, several public outreach events had to be cancelled or postponed (fairs, congresses, meetings on local basis).
Assessment of the impact on the outcomes of the project
No impact on the project outcome. Many events were hosted online during the Covid pandemic. The last two years of the project on site events were organised again.

Measures taken / to be taken to overcome or alleviate the problems
Digitalization of communication activities. Many events were hosted online, both events organised by LIFE MICA and events organised by external parties. Meetings were transferred to virtual environments and even complex events like the first Advisory Board meeting and digital open days were successfully implemented. Valuable contacts and cooperation could be established. The last two years of the LIFE MICA project events on location were again organised and attended.

6.3.Evaluation of Project Implementation

A1 – Writing of the "Management of Invasive Coypus and Muskrats Plan"	
Objectives and Expected results	- Detailing of project areas and activities to be carried out. - Drafted project plan with clear phasing of actions.
Methodology applied to reach those objectives	- Overview maps compiled. - Project plan with phases.
Quantitative and qualitative indicators of achievement	Maps of the project areas and the project plan document are delivered. Objective has been met.
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

A2 – Coypu and Muskrat dashboards	
Objectives and Expected results	Dashboard ready for use with database and apps for feed-in, and distribution of the app with its guidelines to the other project partners.
Methodology applied to reach those objectives	• Decide on a strategy for collecting and storing the data • Build custom app for Germany using AppSheet • Exploring all the available data • Transforming the data • Publishing the data on GitHub • Building the dashboard
Quantitative and qualitative indicators of achievement	"we have distributed the app to some of our project partners and they really liked the simple features." – comment on the German app All data transformation scripts and the links to the datasets in GBIF can be found here: https://github.com/inbo/mica-occurrences The dashboard can be accessed here: https://mica.inbo.be/
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

A3 – Fine tuning of camera tracking and smart life traps	
Objectives and Expected results	Camera tracking • Database with images of detected animals • Script of image recognition • Smart camera tracking systems for use in the field Smart life traps Development of smart life traps that work with an image-recognition system in order to prevent unwanted bycatches of protected species as European beaver or otter and only catch target species like coypu and muskrat.
Methodology applied to reach those objectives	Camera tracking • To collect the necessary images for the database 43 cameras were deployed in 5 project areas and the sequences were stored and annotated using the Agouti platform. • The original algorithm of L. Hoebeke was updated and can now be used in recent versions of Python for research oriented applications and automation. • Our data was used to further train the new model developed by Agouti. • Field tests were carried out to determine the best camera model. 43 cameras of this type were purchased and distributed among partners during a demonstration event accompanied by a protocol on how to use and setup the cameras at waterways. Smart life traps • Robor developed 25 smart life traps, those were deployed in 5 project areas. Pictures taken by the smart life traps were collected to improve the recognition software • A total of 350.000 pictures were taken by the smart life traps. • The footage was collected four times during the project and delivered to ROBOR, so they could use the images to further develop and fine-tune the recognition software. Each time the updated software was immediately implemented. • Traps have also been placed at Dierenrijk Eindhoven, Gaia Zoo and Otter-Zentrum Hankensbüttel to collect pictures of otters, raccoons and beavers. • Trappers gave feedback, based on this feedback the software and hardware of the smart life traps was improved
Quantitative and qualitative indicators of achievement	Camera tracking • A database of over 150.000 annotated sequences, containing 9661 sequences of muskrat and 1522 sequences of coypu. The database of all images containing animals is accessible via GBIF: https://www.gbif.org/dataset/8a5cbaec-2839-4471-9e1d-98df301095dd. • The updated implementation of the old algorithm is available on the MICA Github repository and can be used and installed as a Python Package cameratrap.

	• The Agouti algorithm has been improved, the success rate of the validation data set went from 45% to 63% and the error rate dropped from 10% to 5%. Agouti is available for free at https://www.agouti.eu/ • 43 cameras have been deployed in 6 project areas. <u>Smart life traps</u> • 25 smart life traps have been developed, tested in 4 project areas and improved. • The AI recognition software has been developed and improved, the image database has been expanded • The smart life traps have taken 350.000 pictures, which was used to update the AI image recognition software • Hardware and software has been improved
Evaluation of the progress achieved	<u>Camera tracking</u> ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule). <u>Smart life traps</u> ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

A4 – Fine tuning of DNA approaches	
Objectives and Expected results	*Objectives:* Create DNA mapping protocol and optimized eDNA protocols. *Expected results:* DNA mapping protocol is suitable for transfer within the LIFE MICA project. eDNA protocol is suitable for transfer to water laboratories
Methodology applied to reach those objectives	DNA mapping protocol is handed over to the trappers (and DNA mapping protocol has been sent to Wallonia as well). eDNA protocols have been developed and shared with water laboratories.
Quantitative and qualitative indicators of achievement	Core protocols have been established. Objective has been met.

Evaluation of the progress achieved	DNA-mapping ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule). eDNA ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

C1 – Implementation of the field systems and operations developed in the pilot	
Objectives and Expected results	Smart camera tracking and smart life traps All partners gained experience with the innovative trapping methods and facilitating systems developed in LIFE MICA. The usability and impact of smart camera tracking and smart life traps on muskrat monitoring and management has been tested and evaluated. This will lead to a better understanding of these methods and will allow for every partner to evaluate which systems can be adopted in their management schemes. This will allow optimisation of the management schemes. The methods were improved using the lessons learned and feedback gained from the field application.
Methodology applied to reach those objectives	Smart camera tracking - Deployment of cameras in the project areas. - Collecting image material using the cameras and use it for the development of image recognition software (Agouti) - Database of animal observations, including overview of (target) species identified Smart life traps - Deployment of smart life traps in the project areas - Receiving feedback from trappers - Collecting image material using the smart life traps use it to train the AI image recognition software - Updating both the hardware and software based on received feedback

Quantitative and qualitative indicators of achievement	<u>Smart camera tracking:</u> - Field protocol smart camera tracking was written - 43 cameras deployed in the project areas - c1.1.1: database of images was delivered and used to train the image recognition software (Agouti). - Deliverable c1.1.2: database of animal observations (date+place+ time) from camera trapping is available. <u>Smart life traps</u> - 25 smart life traps deployed in the project areas - The AI recognition software has been developed and improved, the image database has been expanded - The smart life traps have taken 350.000 pictures, which was used to update the AI image recognition software - Hardware and software has been improved
Evaluation of the progress achieved	<u>Smart camera tracking</u> ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule). <u>Smart life traps</u> ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

C2 – Implementation of DNA approaches and linked catch activities	
Objectives and Expected results	*Objectives:* Create sampling strategy for DNA mapping and field strategy of eDNA. Testing of the field protocol and adapting for real life implementation. Water laboratories can routinely process eDNA samples for muskrat and coypu eDNA. *Expected results:* Sampling strategy for DNA mapping is suitable for involved trappers. eDNA protocol is suitable as a starting point for field implementation and scaling up. Field protocol(s) that can be used

	to reduce the time spend on detecting muskrat/coypu presence, and thus provide cost-effective early detection. At the end of the project all e-DNA processing analysis is transferred to the water laboratories.
Methodology applied to reach those objectives	<u>DNA mapping</u> DNA mapping protocol was used by the trappers. Samples of caught muskrats are collected, DNA was mapped and sequenced. Using the mapped DNA the populations and migration routes were determined. The found migration routes and advises for deployment were presented. <u>eDNA</u> Lab-protocols have been developed and delivered. Testing of the field protocol for real life implementation in project areas has started. Beta version of autosampler has been developed. Protocols have been shared with the water laboratories. Adjustments have been made to the protocols for implementation in analytic laboratories. Tests comparing qPCR between labs have been done.
Quantitative and qualitative indicators of achievement	<u>DNA mapping</u> Around 500 samples have been collected by trappers. 492 of the collected samples were usable. The set has been supplemented to 500 samples with 8 samples from the 2017 pilot for reference. On 27/1/2022 the results were presented to the local trapping organisation, which lead to additional catching efforts deployed <u>eDNA</u> Processing of sampling fully transferred to 3 water laboratories; objective met. Large scale sampling started in 2022. Results of sampling 2022 led to adjustment of field approach to Semi-randomised sampling. Semi-randomised sampling was tested in 2023 and was successful. A finalised field protocol was developed, objective met.
Evaluation of the progress achieved	<u>DNA mapping</u> ☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule). <u>eDNA</u> ☒ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations).

	☐ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

D1 – Assessment and improvement of the quality of the equipment and methodology and improvements	
Objectives and Expected results	Evaluation and improvement of the innovative LIFE MICA methods and equipment, leading to better monitoring and management of muskrats and coypu.
Methodology applied to reach those objectives	- Feedback was collected and surveys were held with trappers using the innovative methods and equipment - Continued improvement of the innovative life LIFE MICA methods and equipment based on field experiences.
Quantitative and qualitative indicators of achievement	- Trappers working with the methods were contacted regularly (weekly/ monthly). Two surveys were held. - All methods and equipment have been improved using the feedback collected. - A report was written on the effectivity of the methods
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

D2 – Evaluation of the environmental impact	
Objectives and Expected results	1. Evaluate the evolution of the numbers of muskrat and / or coypu in the project areas 2. Evaluate riparian vegetation change by decreasing numbers of muskrat and / or coypu 3. Evaluate the impact on protected species by monitoring numbers
Methodology applied to reach those objectives	- A list of relevant species was made per project area - Yearly field observations on protected species conducted - To monitor reed vegetation Sentinel-1 satellite-data has been collected in the Google Earth Engine platform for all the project areas - Yearly the data on muskrat and coypu trapped was collected - a model was developed - The UvA experts interpreted the data, made factsheets and wrote three reports

Quantitative and qualitative indicators of achievement	- A list of relevant species was made per project area - Yearly field observations on protected species conducted - To monitor reed vegetation Sentinel-1 satellite-data has been collected in the Google Earth Engine platform for all the project areas - Yearly the data on muskrat and coypu trapped was collected - a model was developed - The UvA experts interpreted the data, made factsheets and wrote three reports
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

D3 – Evaluation of the socio-economic aspect	
Objectives and Expected results	*Objectives:* Carry out baseline and final measurement on the socio-economic aspect. *Expected results*: Baseline measurement and final measurement on the socio-economic aspect are available.
Methodology applied to reach those objectives	Baseline and final measurement have been developed and delivered.
Quantitative and qualitative indicators of achievement	- Report on the economic impact has been delivered - Report on the social impact has been delivered - Table KPLI's, see Appendix IV 'Indicators for the social impact' and Appendix V 'Indicators for the economic impact'
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

E1 – Awareness raising and dissemination material	
Objectives and Expected results	The LIFE MICA project aims to raise awareness on invasive alien species, especially coypu and muskrat, their potential economic and ecologic damage and questions regarding the management of those species and the innovative methods developed.

Methodology applied to reach those objectives	Making websites, awareness videos, notice boards, using SharePoint etc.
Quantitative and qualitative indicators of achievement	• LIFE MICA website • Awareness and project videos • SharePoint • Notice boards • Templates for additional dissemination material
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

E2 – Communication and dissemination actions	
Objectives and Expected results	The LIFE MICA project aims to raise awareness on invasive alien species, especially coypu and muskrat, their potential economic and ecologic damage and questions regarding the management of those species and the innovative methods developed.
Methodology applied to reach those objectives	During the course of the project, a range of communication activities have taken place, targeting different stakeholders from hunters, policy makers, nature conservation organizations, researchers to general public.
Quantitative and qualitative indicators of achievement	A wide range of communication activities was performed by the LIFE MICA partners: ranging from numerous meetings with local authorities involved in management of coypu and muskrat, information of policy makers, interactive events such as the Advisory Board meeting, Open Days, publications in general press and lectures for scientific audience. The general feedback on the objectives and progress of the LIFE MICA project was positive and constructive.
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

E3 – Transfer and replicability	
Objectives and Expected results	Establish contacts and cooperation with institutions/stakeholders dealing with coypu/muskrat or other IAS for replication of

	developments and transfer of MICA methods and the outcomes to management of coypu/muskrat and other IAS.
Methodology applied to reach those objectives	Contacts and cooperation networks were established; visits of (other) projects; organisation of (digital) meetings; participation in advisory boards of similar projects
Quantitative and qualitative indicators of achievement	Techniques are already being implemented by stakeholders (e.g., eDNA) or are planned in future projects (LIFE and outside LIFE). Interest in MICA techniques has risen among many stakeholders in all beneficiary countries.
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

F1 – Overall project management	
Objectives and Expected results	Managing the project
Methodology applied to reach those objectives	Project plan & organization. Project boards meeting. Regular contact with project partners.
Quantitative and qualitative indicators of achievement	- the project plan document is delivered. - the partner agreement is signed by all partners. - project board meetings took place. - workshop for mid-term report has taken place. - monthly meetings with project leaders and coordinator have taken place - final report has been written
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

F2 – After-LIFE plan	
Objectives and Expected results	After life plan and exploitation plan
Methodology applied to reach those objectives	- Brainstorm session on after life and exploitation - Writing of the after life plan and exploitation plan

Quantitative and qualitative indicators of achievement	- Brainstorm session on after life and exploitation took place 30-6-2023 - After life plan and exploitation plan have been delivered
Evaluation of the progress achieved	☐ Excellent progress (the objectives are still highly relevant, and results have even exceeded expectations). ☒ Good progress (the objectives are still relevant and most of the technical goals/results for the period has been reached. ☐ Unsatisfactory progress (the objectives and results have failed to provide interesting scientific or biodiversity benefits /or are not at all on schedule).

6.4. Analysis of benefits

6.4.1. Environmental benefits

DNA mapping
For the region where DNA mapping has been applied (Wetterskip Fryslân), muskrat-travel routes (corridors) have been identified and already in 2023 extra effort towards catching in these corridors has led to lower population sizes in the receiving areas in Wetterskip Fryslân (approximately 260 individuals). Consequently, the damage to biodiversity by muskrats has been reduced as well. Using the relation between muskrat density and reed area (see report D2.2), it has approximately led to an increase of 0.4 km^2 reed land in 2023 alone.

For the future, the application of DNA mapping at a large scale seems not to be required. Only in cases where IAS-clean areas are invaded and the invasion pathways remain unidentified, the technique can be effective to help in narrowing down the control efforts.

eDNA method
eDNA positive signals can confirm that muskrats or coypu are present. This can make misinterpretation of ambiguous visuals signs less likely. eDNA can be used to successfully determine elimination of muskrats/coypu in an area, and serve as an early warning system for re-colonisation. Beavers can mask presence of coypu, eDNA can confirm coypu presence in these situations. eDNA detection can greatly contribute to driving back muskrat and coypu to the borders of the country, and thus contribute to preventing damage to ecosystems by these animals.

In the future, the eDNA method can (and will) be used to detect other species as well (both IAS as well as protected species), using a single field sample for environmental protection and management. The fact that only a single field visit would be required to collect samples for multiple purposes in environmental management makes the method attractive for scaling-up.

Smart life traps
The smart life traps will lead to no more unwanted bycatches of species like the European Beaver and the European otter in the Coypu traps, and therefore a more effective management in protected areas.

In the future we foresee that smart life traps will gradually replace conventional life traps, starting with nature reserves that harbour vulnerable species and subsequently in all remote areas. For this, continuing investment is required to improve the existing technology at the short term, but at the longer term also lower the costs.

Smart camera tracking
Smart camera tracking (using camera trapping) which was done during the project has provided direct evidence of the actual biodiversity in the project areas: in several cases the presence of some mammal and bird species that were of interest, while those were not considered in the actual management of that area. As a result of this, biodiversity management actions have been adjusted. As an early-warning system for the entry of muskrat or coypu in an area the systems have proven useful as a proof-of-concept only. The species have been detected on the wildlife camera's and this information was used by the control-organisations, but it was not feasible in this project to coordinate immediate follow-up actions to catch the detected animals in the field.

In the future, especially when camera traps are put online and species identification on the images will be automated further, we foresee that direct response by the control organization to detected muskrat or coypu will be feasible and also effective. It seems that this technology has already been developed but is still relatively expensive. To be adopted, it should be further applied in pilot projects in which the control organization can optimize the use of the information from the camera traps. At the same time, with online and automated camera traps, biodiversity monitoring of natural areas will become more systematic and less invasive. Finally, the information stream that results from camera trapping is well suited to inform and involve the general public about the biodiversity in natural areas. We expect that camera trapping will therefore be used more frequently for that purpose.

6.4.2. Economic benefits

There have been two measurement moments during the project to determine the economic benefits. At the beginning and end of the LIFE MICA project.

More details can be found in the report 'Evaluation of LIFE MICAs economic impact'. For the economic indicators used see Appendix V.

Here the expected economic revenue of the innovative LIFE MICA methods:

Expected revenue DNA Mapping	Migration routes can be better determined. Traps can therefore be placed more effectively. The DNA mapping report will be published on the project website.
Expected revenue eDNA	Conservative estimates show that recommended implementation can result in 50% cost reduction, see report C2.1.1 for details.
Expected revenue smart life traps	If all current cage transmitters are replaced by the smart life trap's, at least the weekend surcharge for the catchers will be abolished (saving € 12.000 per year). This will result in a direct saving in time and money. Because there are no more by-catches, trappers have to check the traps less often.
Expected revenue camera trapping	If camera traps work as described in the project, we expect to be able to reduce the number of prospections in low-density areas from 2 visit/year to 1 visit per year. Monthly visits to recover memory cards, administration and uploading and maintaining vegetation are to be considered in the business case. The revenue depends on how 'smart' we can make those camera traps and how economical we can place them.

6.4.3. Social benefits

There have been two measurement moments during the project to describe the social benefits. At the beginning and end of the LIFE MICA project.

More details can be found in the report 'Evaluation of LIFE MICAs social'. For the social indicators used see Appendix IV.

Replication & transfer	The concept of replication and transfer of LIFE MICA innovations shows broader application and scalability of opportunities and interests. The MICA project has established a wide range of contacts with other institutions working with coypu and muskrat in Europe. The partners of the MICA project regularly exchange knowledge and expertise with other institutions or research instituted that deal with management of coypus and muskrat in the MICA member states (the Netherlands, Germany, Belgium) and beyond (e.g. Denmark, Sweden). Furthermore, the results suggest that there is also interest in the developed methods of LIFE MICA for the management of other invasive species (e.g. raccoon, ruddy shelduck, Chinese mitten crab, crayfish) and provide interesting tools for innovative management.
Communication	Through the years, 2020 to 2023, an upward trend is seen in the number of times the LIFE MICA project was mentioned in communication platforms. Efforts were made by self-written articles, but the LIFE MICA results were also mentioned in articles written by others. Information and results of LIFE MICA were communicated in writing, but also through other communication platforms such as video, television or radio channels. This reflects a variety of communication efforts during the project time. By sharing the results and experiences of the LIFE MICA innovations, others sectors, entities, regions or countries can benefit from the knowledge and experience gained in the project LIFE MICA, and can use it to develop their own initiatives (transfer & replicability).
Awareness raising	The project's numerous communication events presenting LIFE MICA and the significant number of attendees indicate a notable level of stakeholder engagement, and the project success in raising awareness.
Behavioural change	The Netherlands anticipates no changes in the number of organizations managing muskrat and coypu throughout the project due to LIFE MICA, as it is already begin executed with 100% coverage. VMM (responsible for 3 provinces and part of 2 other provinces) from Flanders anticipates no changes in the number of organizations managing muskrat and coypu throughout the project due to LIFE MICA, as it is already begin executed with near 100% coverage of Flanders. In Germany, during the LIFE MICA project, communication events in hunters communities, with management authorities, nature conservation organizations and other stakeholder groups resulted in an increased awareness of the need for a joint management approach for coypus and muskrats.
Website	The analysis of the website's performance reveals promising results. Overall, the observed increase in website traffic, the growth in the number of news items, the rise in readership and the expansion of multilingual newsletters all point to a positive trajectory for the website. These results suggest that the website is successfully attracting a larger audience, engaging readers, and evolving into a more inclusive platform.

6.4.4. Replicability, transferability, cooperation

There is a high potential for transfer and replication of the innovative methods developed by the LIFE MICA project. In general, there is also a high potential for technical and commercial application of the developed techniques. Many stakeholders could benefit from MICA developments, which is reflected in the high interest in the LIFE MICA project experienced by the beneficiaries. In the face of biodiversity loss and the One Health approach (a concept postulating that the health of people, animals and ecosystems is interconnected), wildlife management currently gains importance. Therefore, the general potential for Replication and Transfer of the LIFE MICA management methods is high.
Potentially interested stakeholders in wildlife management tools are among others: wildlife management authorities, hunters associations, nature conservation organizations, research institutions and policy makers.

Dissemination aiming at Replication and Transfer
During the LIFE MICA project, the beneficiaries carried out numerous **communication activities** in order to disseminate information on the developed methods. In particular, the potential and challenges of replicating and implementing the methods for coypu and muskrat management in further regions or to transfer them for the management of other invasive alien or protected species were discussed with different stakeholder groups during diverse events.
Furthermore, **communication material** was produced to inform interested stakeholders about the LIFE MICA methods: a booklet and a short film. From 2022 to 2023, three workshops were organized to discuss Replication and Transfer options with different stakeholders. Those groups were also asked to evaluate the potential of the LIFE MICA methods for Replication and Transfer and to point out difficulties and challenges in a questionnaire.

Communication activities – aiming at Replication and Transfer
In Germany, ITAW and LWK participated in fairs on hunting and water management and informed interested visitors from the hunters´ community and water authorities about the developed management methods. During open days in the German project areas (online and in person), the methods were demonstrated in the field and future implementation of the tools in other regions was discussed with local stakeholders comprising employees of the regional nature conservation agencies, nature conservation organizations, hunters community and interested public. Furthermore, the methods were presented at numerous local meetings of hunting associations in Lower Saxony, where perspectives and future approaches in management of coypus were discussed. The LWK also engaged in several meetings and hearings with policy makers, among others: regional water authorities, environmental authorities, the Ministry of Environment (responsible for muskrat management) and the Ministry of Agriculture, the Lower Saxony State Agency for Water Management, Coastal Protection and Nature Conservation, the Hunting Association Germany, the Hunting Association Lower Saxony, the Hunting Association Bremen, the Water Authorities Lower Saxony, Saxon Anhalt and Bremen, the State Office for the Environment in Brandenburg.
There was a strong interest in replicating the LIFE MICA management methods locally for specific management purposes: in areas with occurrence of protected semi-aquatic species such as the Eurasian otter and the Eurasian beaver, smart life traps would offer a safe trapping

alternative to conventional life traps. Furthermore, eDNA analysis to detect the presence of coypu and muskrat was considered an interesting tool for specially protected areas like nature reserves where the management objective for coypu and muskrat is to keep the area free of the species. There was also an interest in prospectively transferring the LIFE MICA management methods to management of other invasive alien or protected species: e.g., smart life traps could be employed to catch raccoons or raccoon dogs and eDNA analysis could be used to monitor the occurrence of the Eurasian beaver.
In the Netherlands, WSRL, UvA and UvW organized several open days in the Dutch project areas and informed interested public and employees of trapping organizations about the eDNA analysis, DNA mapping and smart life traps. Further communication events targeted coypu and muskrat management organizations, which are part of the Dutch Water Authorities (Waterschappen): e.g. the yearly meeting of the water authority Borken or the event "Onze Digitale toekomst" organized by WSRL. Contacts were also established with the Dutch Mammal Society (Zoogdiervereniging), which is interested in the smart life traps hoping they might lead to less by-catch of Eurasian otters in the course of coypu and muskrat management.
In Flanders, an open day was organized in Hoogstraten, a LIFE MICA project area, to disseminate the LIFE MICA results to different stakeholders and interested public. The developed methods were presented to the muskrat trappers of VMM and the provincial governments in Flanders. VMM also participated in meetings of the regional committees on water management in Oost-Vlaanderen and West-Vlaanderen and held a technical IAS workshop with Flemish IAS managers. The LIFE MICA project was furthermore presented at the nature conservation NGO Natuurpunt in November 2020 to coordinating and technical staff. VMM also participated in the annual educational day for muskrat trappers (17.03.2023).

Communication material – aiming at Replication and Transfer
A booklet with detailed information on the management methods developed during the LIFE MICA project was published in 2023 in English, German and Dutch on the LIFE MICA website. It was additionally sent by email to numerous stakeholders, ranging from management authorities and hunters associations to nature conservation organizations in the beneficiary countries and beyond. Along with the booklet, a link to an informative film about the LIFE MICA project and a link to a short questionnaire on possible interest in Replication and Transfer of the developed management methods was included. The aim was to raise interest in the LIFE MICA methods and to gather feedback on whether stakeholders involved with management of IAS would consider replicating or transferring the management methods.

Workshops on Replication and Transfer
From 2022 to 2023, three workshops were organized in which numerous stakeholder groups participated: IAS management authorities, nature conservation agencies, nature conservation organizations, the hunters´ community, research institutions and interested public.

Figure 13: workshops

During the workshops, the LIFE MICA methods were presented in detail and the attendees were invited to ask questions and discuss the potential application and limitations of the developed management methods.

Table 7: LIFE MICA workshops

Date	Location	Title of the event	Topics
25.03.2022	online	Joint workshop LIFE RIPARIAS / LIFE MICA	IAS management: sharing good practices for IAS management and developing a data standard for reporting on IAS
13.07.2022	hybrid; Brussels / online	2nd Joint Workshop LIFE MICA / LIFE RIPARIAS	Innovative techniques and data exchange formats for managing IAS
06.06.2023	online	LIFE MICA workshop on Replication and Transfer	Innovative methods for monitoring and management of coypu and muskrat and other IAS

In the end of the 2nd Joint Workshop LIFE MICA/LIFE RIPARIAS, the attendees were encouraged to fill in a short survey created on "mentimeter" to capture their opinion on Replication/Transfer of the LIFE MICA management methods.

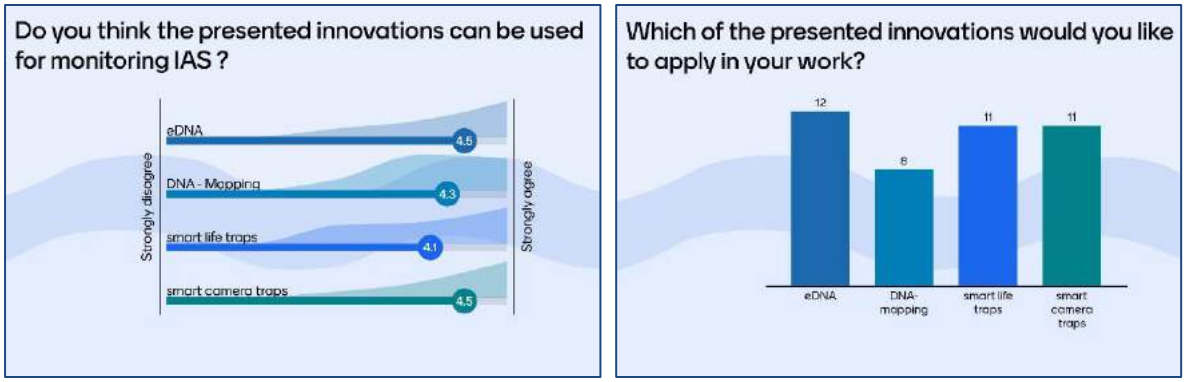

Figure 14: Results of the survey

Communication

The project's numerous communication events presenting LIFE MICA and the significant number of attendees indicate a notable level of stakeholder engagement and success in raising awareness. Also, the feedback on the communication and dissemination events was generally positive displaying a strong interest by Environmental and Water Authorities, hunters' associations and policy makers in the developed methods like eDNA and smart life traps. Partly, the general public and nature conservation organizations raised ethical questions regarding trapping of coypus and muskrats. However, the advantages of selective trapping and early detection of coypus and muskrats by eDNA screening were widely recognized.

Replication and Transfer: pilot projects and outlook

The following paragraphs summarize the potential of each management method for Replication and Transfer and describe some pilot projects and planned future activities.

DNA-mapping

In general, the method is replicable for muskrat management in other regions and could be transferred to the management of other invasive alien or even protected species.

eDNA

In the Netherlands, the eDNA analysis will be further implemented in muskrat management. The Dutch water authorities have set aside funds for 2024 and 2025. The method will be implemented in areas throughout the Netherlands. July 2023, the eDNA headquarters moved from UvA to the Wetterskip Fryslân. In the northeast of the Netherlands, another eDNA laboratory is being prepared. It has already been shown that, even with the most pessimistic estimates, the costs of eDNA are negated by the increased efficiency in localization of muskrats.

In Belgium, VMM has plans to purchase 10 autosamplers to continue the eDNA analysis. A part of VMMs budget for the management of muskrats will be used for this purpose. It is expected that costs will be recovered as eDNA makes the detection of muskrats and coypus more efficient. VMM is collaborating with the Research Institute for Nature and Forest (INBO) to establish laboratory facilities for eDNA analysis. Furthermore, VMM is in contact with the muskrat management institution of the Walloon region, which has shown an interest in innovative management methods for IAS.

In Germany, there is an interest in the use of eDNA in Germany especially in protected areas such as FFH or Natura 2000. eDNA analysis can be a valuable method for monitoring the effectiveness of local coypu and muskrat eradication.

Organizations in Sweden and Denmark have already shown an interest in the eDNA monitoring method: a pilot eDNA sampling was performed in Denmark in cooperation with the Environmental Ministery and UvA sent the qPCR protocols to the Department of Marine Sciences at the University of Gothenburg in Sweden. qPCRs for the detection of European beavers and invasive crayfish were developed by the university of Amsterdam and shared with the water laboratories.

In general, the eDNA analysis for muskrat detection can be easily replicated by other institutions. Trappers can be trained in the use of the autosampler in the course of one day. Protocols with instructions will be available on the LIFE MICA website. UvA, UvW and Wetterskip Fryslân can be contacted for more information.

Furthermore, the protocol for eDNA analysis can be transferred to the detection of other (semi)aquatic species than coypu and muskrat, as long as the laboratory has primers and probes for the specific species. Possible target species might be the American crayfish, the American bullfrog, invasive alien fish species or the protected Eurasian beaver. UvA, UvW and Wetterskip Fryslân can be contacted for more information.

Smart camera tracking

In the smart camera tracking method Agouti was further developed and it has proven to reduce the time needed to analyses image material taken by camera traps. As the Agouti platform is free of charge for non-profit organizations, this method can be used by interested stakeholders as long as they have camera traps and an Agouti account. The Agouti algorithm is regularly updated using further annotated images so that the classification of species on the images is constantly improving. In Germany, management authorities have already shown interest in smart camera tracking. A standard protocol on how to use camera traps in aquatic environments has been drawn up. It will be useful for anyone wishing to work with camera traps in an aquatic environment and can be downloaded from the LIFE MICA website.

Smart life traps

The smart life traps will be a useful tool to trap coypu and muskrat without bycatch. Trapping organizations in the Netherlands, Belgium, and Germany have shown interest in using the smart life traps once they have been further improved. Robor will continue with the improvements.

6.4.5. Best Practice lessons

eDNA
The main conclusion of eDNA sampling is that it is very useful to check if an area has muskrat or coypu presence. It can be used to detect the location of muskrats and coypu and to confirm if an area is empty. The method is most effective in areas with a low population of muskrats or coypu. The results of 2022 also show that full-coverage sampling is not a feasible approach, nor is it required. Therefore in 2023 a guideline for semi-randomized was developed and tested. The results confirms that semi-randomized sampling works equally well in determining the presence of muskrats in an area as full-coverage sampling. Using the eDNA method can reduce the costs of muskrat and coypu management significantly, by aiding in effectively detecting muskrat and coypus presence.

For eDNA it is important that the semi-randomised part of the approach is the standardised part of the method. This part should be implemented in the same way across all water authorities. The follow-up can be more variable and is more dependent on the specific field conditions. For this reason, good cooperation between the coordinators in the office and field experts (trappers) is crucial. The development of this method was successful due to a flexible attitude of the scientists and good feedback from the trappers.

DNA-mapping
DNA-mapping has proven to work, migration routes were detected. Trapping efforts were deployed at those routes and muskrats were caught. However DNA-mapping is very time consuming and costly. The people working on DNA-mapping were asked if they would like to continue the DNA-mapping. The responses varied. Some want to continue using DNA-mapping large scale, once every few years, because it gives insight into migration routes and can aid in preventing recolonization. Others did not think it should be continued because it is not very cost efficient, it takes a long time to get results and might not be useful for all areas. Furthermore, eDNA turned out to be far more efficient than DNA-mapping. It was decided not to continue DNA-mapping in the near future, but it might be repeated after several years. The genetic map will remain available and can be used for future research. The developed protocols can be used for others species.

Smart camera tracking
During the project, 43 cameras were deployed and image material was added to Agouti and the classification software was improved. Agouti reduces the time needed to analyse pictures. Smart camera tracking is most useful in a broader context, to monitor all types of species in nature reserves or for scientific research. Agouti is free to use and can easily be used by other organisations. To make smart camera tracking an excellent tool for muskrat and coypu management the camera should send the pictures real-time to Agouti and trappers should be notified immediately when a muskrat or coypu has been detected.

Smart life traps
Smart life traps were developed to prevent the bycatch of protected species and reduce the workload of trappers. The traps have proven to work, muskrat and coypu were caught and bycatch was avoided. However, further development is needed. The reliability of the system and the AI need to be improved. The smart life trap is not yet as effective as traditional life traps. Robor plans to continue developing the smart life traps.

6.4.6. Innovation and demonstration value

eDNA
The UvA developed a method to detect DNA traces of coypu and muskrat in water samples. DNA is constantly shed into the water by semiaquatic species through the loss of skin cells, urine or feces. Using qPCR, even these small amounts of eDNA can be detected in water samples. During this project eDNA has been used to detect muskrats and coypu and it has proven this method can be used for the monitoring and management of IAS.

During the project, the strategy for water sampling was continuously improved and adapted to field conditions. A practical eDNA autosampler was designed and several copies were built. Lab protocols and field guides have been written which can also be used by other laboratories and (trapper) organizations. The protocols for water sampling and sample analysis are easily adaptable to other environmental and working conditions and laboratories. Furthermore, during LIFE MICA it has also been proven that full-coverage sampling is not needed and a protocol semi-ramodmised sampling has been written and tested. All aspects of the innovative eDNA methods can easily be transferred and replicated to other organization.

DNA-Mapping
DNA-Mapping for the analysis of relationships between different muskrat populations and identification of migration routes was tested in the LIFE MICA project area Friesland in the Netherlands and has delivered conclusive results: in Friesland, muskrats originating from populations from neighboring regions could be identified and thus migration routes of the animals were detected. However, the DNA analysis has proven to be time-consuming. More than a year passed between sample collection and delivery of the results. In management of IAS, however, timely decisions are crucial and trappers need to react quickly in order to control populations of IAS. In general, the method is replicable for muskrat management in other regions and could be transferred to the management of other invasive alien or even protected species. The genetic map of the DNA of all collected muskrat samples can be used for future research on muskrats.

Smart camera tracking
The LIFE MICA project has developed an innovative method of camera trap monitoring that reduces the workload of image analysis with the help of artificial intelligence and thus enables a large-scale monitoring of the occurrence of coypus and muskrats on waterways. The camera trap data is uploaded on the platform Agouti (https://www.agouti.eu/) where the images are organized and screened for the occurrence of coypus and muskrats. The Agouti algorithm, trained to automatically identify coypus and muskrats as well as other species on the images, significantly reduces the workload of camera trap monitoring. A new data standard for camera trap observations (camtrap dp) has been developed using the LIFE MICA data as a test dataset. This data standard allows easy publication of Agouti data in GBIF, the Global Biodiversity Information Facility.

As the Agouti platform is free of charge for non-profit organizations, this method can be used by interested stakeholders as long as they have camera traps and an Agouti account. The Agouti algorithm is regularly updated using further annotated images so that the classification of species on the images is constantly improving.

A standard protocol on how to use camera traps in aquatic environments has been drawn up. It will be useful for anyone wishing to work with camera traps in an aquatic environment and can be downloaded from the LIFE MICA website.

The database of all images containing animals is accessible via GBIF: https://www.gbif.org/dataset/8a5cbaec-2839-4471-9e1d-98df301095dd.

The updated implementation of the old algorithm is available on the MICA Github repository and can be used and installed as a Python Package cameratrap.

Smart life traps

Trapping is an essential tool for population control of coypus and muskrats. However, both species share their habitat with protected mammals such as otters and beavers. In order to avoid unwanted bycatch of these protected species, the LIFE MICA project has developed smart life traps that work with an image recognition software and only close for the target species coypu and muskrat.

Life traps with emitters that give a signal when closed already existed. However a life trap with recognition software which only closes for target species muskrat and coypu was a new development. The smart life traps have proven to work, coypu and muskrat were caught and bycatch was avoided.

Working prototypes of the smart life traps has been developed, tested and improved. Using the images taken by the smart life traps the recognition software was updated several times. However it was concluded further improvements are needed. The reliability of the image recognition system and catch alert notifications need to be improved. In addition, the reaction time (time from detection of the target species to closing the trap) needs to be reduced. At present, the smart life traps are not as efficient as traditional life traps.

Several organizations will continue to cooperate to further improve the smart life traps: including ROBOR (the developer of the smart life traps), LIFE MICA partners, trapping organizations, government officials and companies specializing in smart systems and AI recognition software. The Dutch Water Authorities have reserved € 50.000 per year in 2024 and 2025 for the further development and testing of the smart life traps. Prospectively, the developed image recognition and closing mechanism will be adaptable for complying with different types of life traps. In future, the smart life traps might be also trained to recognize other target species, apart from coypu and muskrat, and could be used for trapping raccoons, raccoon dogs or American minks.

Dashboard

Management concepts for IAS should be based on available data from species monitoring and an evaluation of applied management actions. Since IAS usually occur transnationally, data on monitoring and management should ideally be exchanged between neighboring countries. The LIFE MICA project developed a dashboard that visualizes data from monitoring and trapping of coypus and muskrats in Flanders, the Netherlands and Germany. Data transfer scripts were written for the different datasets allowing the data to be published on GBIF, the global databank for biodiversity data. After the publication of the data on GBIF, the data is visualized on the dashboard of the LIFE MICA project (http://mica.inbo.be/). An exchange of data on management and monitoring of IAS between neighboring countries is essential for an efficient and coordinated transnational management. The dashboard developed by the LIFE MICA

project, therefore, aims to integrate data sets from other countries and serves as a model for data management on other IAS. The published data are open access and can be used by IAS management organizations, governments, nature organizations and educational institutions. In addition, the data on the dashboard could be useful for the European Alien Species Information Network (EASIN).

In Belgium and the Netherlands, registration of muskrat and coypu catches is mandatory. Muskrat trapping organizations, which are responsible for registration, will continue to add data to the LIFE MICA dashboard. In Germany, coypu trapping and shooting is performed by hunters on a voluntary basis. Therefore, data on coypu management will no longer be included in the dashboard after the end of the LIFE MICA project.

However, other organizations will continue to publish their management data on the dashboard: the LIFE RIPARIAS project, RATO vzw, which traps muskrats in the province of East Flanders, the remaining East Flanders municipalities and West Flanders. Once published, all data from these regions will be available on the dashboard. The dashboard is of interest to all Flemish managers.

The dashboard only needs a small budget to continue the website maintenance of € 3.400 per year. The dashboard developed shows the importance of collecting and sharing data. It is a very useful tool, depending that data is continually and timely added. It allows managers to not only know their own catches and observations but those of all actors around them, including observations made by citizen scientists.

6.4.7. Policy implications

Implementation
We do not foresee any obstacles to the implementation of our project due to regional, national or European legislation. On the contrary, with the help of the developed monitoring methods, management can be conducted more efficiently, which saves time and costs. In the future, the number of traps can be reduced, especially in areas with a low population of IAS, which reduces the risk of bycatch of protected species.

Wetterskip Fryslân (area 8) will continue with the eDNA method in its entire management area. Eight additional Regional Water Authorities have short term plans for implementation in sub-areas. Implementation of eDNA requires that policy makers take management of invasive species seriously, and management should be done by professionals. The effectiveness of management by professional trappers in Flanders and the Netherlands compared to ineffective management by amateur hunters in many areas in Germany is clear. For implementation of eDNA, a professional approach is even more important, as it requires good coordination between field workers, laboratories, and coordinators.

Meetings with policy makers
On May 11th (2022), the minister for Agriculture in Lower Saxony, Germany, Mrs. Barbara Otte-Kinast visited the Vechte in 48465 Quendorf on the border of the Emsland and Grafschaft Bentheim districts during an event with various stakeholders, including local hunters, water authorities and local authorities. During this meeting, the management of invasive species against the background of greening water bodies and their surroundings was discussed and two

trapping systems were presented: Trapper Neozoa and the smart life traps (new development as part of the LIFE MICA project). On May 31st (2023), a work meeting of Lower Saxony muskrat and coypu hunters was held in Hannover–Ahlem. At this meeting, information was provided about the situation of muskrat control and coypu hunting in Lower Saxony with several PPT presentations. A lecture also provided information about the results of the LIFE MICA project so far. Representatives from the specialist departments of the Ministry of Agriculture and the Ministry of the Environment were present. As a result, muskrat control and coypu hunting should be defined as a state task in Lower Saxony in the future.

Good examples
The different trapping organisations in the Netherlands, Belgium and Germany have learned from each other. Best practices and lessons learned can be used as examples for policy makers and trapping organisation throughout Europe. In Germany there is no professional trapping organisations, examples from the professional trapping organisations of the Netherlands and Belgium can be used to influence German policy makers and policy.

Cooperation and transnational management
Due to multiple originations working together in the LIFE MICA project there has been more cooperation. Several joint muskrat management actions have been conducted between the trapping organizations of the Netherlands, Belgium and Germany. For instance, Belgium and Dutch trappers have worked together in October 2022 and June 2023 at the border area Zeeland-Sint-Laureins to trap muskrats. Information on coypu and muskrat management in the Netherlands, Belgium and Germany is shown in the dashboard, which aids in transnational management.

7. Key Project-level Indicators

All filled in Key Project-level Indicators have been and checked updated November 2023 using the feedback received from the monitor.

Appendix

Appendix I: Key deliverables/actions and status

Action	Description of the action	Status
A.	Preparatory actions, elaboration of management plans and/or of action plans	
A.1	Writing of the "Management of Invasive Coypus and Muskrats Plan"	Delivered
A.2	Coypu and Muskrat dashboards	Delivered The dashboard can be accessed here: http://mica-uat.inbo.be/
A.3	Fine tuning of camera tracking and smart life traps	Delivered
A.4	Fine tuning of DNA approaches	Delivered
C.	Conservation actions	
C.1	Implementation of the field systems and operations developed in the pilot areas	Delivered
C.2	Implementation of DNA approaches and linked catch activities	Delivered
D.	Monitoring of the impact of the project actions (obligatory)	
D.1	Assessment and improvement of the quality of the equipment and methodology and improvements	Delivered
D.2	Evaluation of the environmental impact	Delivered
D.3	Evaluation of the socio-economic aspect	Delivered
E.	Public awareness and dissemination of results (obligatory)	
E.1	Awareness raising and dissemination material	Delivered Life Mica website https://lifemica.nl/, https://lifemica.eu/ and https://lifemica.de/
E.2	Communication and dissemination actions	Delivered
E.3	Transfer and replicability	Delivered
F.	Project management (obligatory)	
F.1	Overall project management	Delivered
F.2	After-LIFE plan	Delivered

Appendix II: List of LIFE MICA deliverables as shown in BUTLER

mid-term: these are deliverables which were due before mid-term and were delivered with the mid-term report
BUTLER: these are all deliverables after the mid-term report, the relevant documents of the deliverable have been uploaded in BUTLER

Name deliverable	**Action**	**Delivered**
A4.2.1 call for tenders done for DNA mapping	A4	mid-term
A2 Source code and database map	A2	mid-term
A1.1. Map of areas of intervention	A1	mid-term
A2.1 Guidelines for the data harmonisation	A2	mid-term
F1.1 Management toolbox	F1	mid-term
E1.1 Communication and dissemination plan	E1	mid-term
E1.2.1 Operating website in beneficiaries languages + English	E1	mid-term
A4.2.2 Protocol for DNA mapping done	A4	mid-term
A4.1.2 Established field strategies for eDNA sampling of water areas	A4	mid-term
A3.1.1 Database with images of detected animals	A3	mid-term
A4.1.1 Optimized eDNA laboratory protocols	A4	mid-term
C1.1.1: Database of images	C1	mid-term
A1.2. MICA management plan	A1	mid-term
A3.2 50 smart life traps ready for use	A3	mid-term
A3.1.2 Script of image recognition	A3	mid-term
A3.1.3 50 smart camera tracking systems ready for use	A3	mid-term
F1.2.1 First progress report	F1	mid-term
D3.2 Report on the economic impacts of coypu/muskrats	D3	mid-term
D3.1 Report on the social impact of coypu/muskrats	D3	mid-term
C1.1.2 Database of animal observations (species, time, location) from camera trapping sessions	C1	mid-term
F1.2.2: Second progress report	F1	mid-term
C2.2.1 Recommendations for spatial distribution of active trapping efforts within the Province of Friesland	C2	mid-term
F1.2.3: Mid-term report	F1	mid-term
C2.1.2. 3 water laboratories that are able to routinely process high volumes of eDNA samples	C2	BUTLER
C2.1.1 Standardized eDNA-based monitoring protocols for early prevention of re-population	C2	BUTLER
F2.1: After LIFE plan	F2	BUTLER
F2.2: Exploitation plan	F2	BUTLER
D1 Report on the quality and usability of the deployed equipment	D1	BUTLER
Report on transferability activities	E3	BUTLER
Report on replicability activities	E3	BUTLER

E2.1 Report on communication and dissemination activities	E2	BUTLER
E2.2 Report on networking activities	E2	BUTLER
D2.2 Report on vegetation change by decreasing numbers of muskrat and / or Coypu	D2	BUTLER
D2.1 Report on the evolution of the numbers of muskrat and / or coypu in the project areas	D2	BUTLER
D3.1 Report on the social impact of coypu/muskrats	D3	BUTLER
D3.2 Report on the economic impacts of coypu/muskrats	D3	BUTLER
D2.3 Report on the impact of coypu/muskrat decrease on protected species	D2	BUTLER
Final report (CINEA)	F	BUTLER

Appendix III: Action D2. Evaluation of the environmental impact

List of target species for field observation, including both riparian vegetation and protected species.

Category	Scientific name
Vegetation	*Phragmites australis* *Typha latifolia* *Typha angustifolia* *Phalaris arundinacea* *Glyceria maxima* *Sparganium erectum* *Calla palustris* *Carex elongata* *Nymphoides peltata* *Carex acuta* *Carex riparia* *Bolboschoenus maritimus*
Birds	*Botaurus stellaris* *Chlidionias niger* *Acrocephalus arundinaceus* *Aythya farina* *Aythya fuligula* *Ixobrychus minutus* *Remiz pendulinus* *Tachybaptus ruficollis* *Mareca penelope* *Spatula clypeataI*
Insects (dragonflies and damselflies)	*Platycnemis pennipes* *Ischnura elegans* *Coenagrion hastulatum* *Coenagrion lunulatum* *Coenagrion puella* *Coenagrion pulchellum* *Coenagrion armatum* *Eryhtromma najas* *Erythromma viridulum* *Enallagma cyathigerum*

The status of field observations, measuring vegetation and protected species at 6 project areas for 2020-2021

Country	Area	Site Name	Survey Type	Status (August 2021)	Survey Dates
Germany	1	Lake Dümmer	Birds	Complete	May- end of June 2021
			Insects	Complete	June-July, 2021
			Vegetation	Complete/ Planned	1st surveys performed August 27- September 23, 2020, 2nd surveys planned for September 2021
	2	Aschau Teiche	Birds	Complete	May- end of June 2021
			Insects	Complete	June-July, 2021
			Vegetation	Complete/ Planned	1st surveys performed August 27- September 23, 2020, 2nd surveys planned for September 2021
	3	Vechtegebiet	Birds	Complete	May- end of June 2021
			Insects	Complete	June-July, 2021
			Vegetation	Complete/ Planned	1st surveys performed August 27- September 23, 2020, 2nd surveys planned for September 2021
Belgium	4	Sint-Laureins	Birds	Complete	May 5-17, 2021
			Insects	Complete	June- July 2021
			Vegetation	Planned	August- September 2021
	5	Sint-Maartensheide/ De Luysen	Birds	Complete	April 26- May 6, 2021
			Insects	Complete	June- July 2021
			Vegetation	Planned	August- September 2021
Netherlands	10	Gelderse Poort/ Kreis Kleve	Birds	Complete	5 surveys completed May 26, 2021
			Insects	Complete	June 4- July 2021
			Vegetation	Complete	1st surveys performed July-August 2020 2nd surveys performed July 22-23, 2021

Appendix IV: Indicators for the social impact

Action D3.1 Evaluation of LIFE MICA'S social impact

The **Replication and Transfer KPI** is estimated as the number of new areas where LIFE MICA innovations will be either replicated or transferred. Both implementations during and after the end of the project will be taken into account. For each new area, its participation to the replication and transfer KPI will be pondered by the number of different ideas from LIFE MICA it will have taken over and by the surface on which it will be enforced. This type of information is easily obtained by simple contact with the leading authorities.

KPLI	Description	Parameters
Replication and transfer	The number of new areas where LIFE MICA innovations are either replicated or transferred	# areas DNA Mapping
		# km^2 or hectares controlled by eDNA
		# smart life traps to control influx
		# smart camera traps to control influx

The **Communication KPI** will be estimated as the impact of all the dissemination effort done during and after the project to present LIFE MICA's results.

KPLI	Description	Parameters
Communication	The impact of all the dissemination effort done during and after the project to present LIFE MICA's results.	# own written articles about LIFE MICA innovations (please also mention type of article: scientific, popular, news).
		# times LIFE MICA projects are mentioned in articles (written by others)
		# notice boards placed in project areas
		# all received questions and requests due to MICA

The **Awareness raising KPI** will be the number of invited people and institutions to the workshops, conferences and other communication meetings that will be held to inform about the LIFE MICA project.

KPLI	Description	Parameter
Awareness raising	The number of invited people and institutions to the workshops, conferences and other communication meetings that will be held to inform about the LIFE MICA project.	# of communication events presenting LIFE MICA with # attendees
		# contact moments from external companies with project staff
	Measure of public awareness	# notifications of presence of muskrat or coypu in project areas by the public

The **Behavioral change KPI** will be a count of the institutions that will take action against muskrat and coypus, whether with LIFE MICA improvements or not.

KPLI	Description	Parameter
Behavioral change	Count of the institutions that will take action against muskrat and coypus, whether with LIFE MICA improvements or not.	# institutions (outside LIFE MICA partners) that will take action or ask to take action against muskrat and/or coypu

The **Website KPI** will be fulfilled as the creation of a website dedicated to inform about the LIFE MICA project and is one of the consortium's commitments.

KPLI	Description	Parameter
Website/Online	Will be fulfilled without fault as the creation of a website dedicated to LIFE MICA actions.	# visitors website
		# news items
		# times news items read
		# times mentioned in social media
		# posts published on social media with a # reach
		# newsletters made
		# newsletter recipients

Appendix V: Indicators for the economic impact

Action D3.2 Evaluation of LIFE MICA's economic impact

The **Employment KPI** is simply calculated as the number of new jobs provided by the different beneficiaries whose recruitment necessity is directly connected to the implementation of LIFE MICA. These new jobs can range from trappers and hunters to lab members.

KPI	Description	Parameter
Employment	Number of new jobs provided by the different beneficiaries whose recruitment necessity is directly connected to the implementation of LIFE MICA.	Number of new jobs in FTE's connected to LIFE MICA (in FTE).

The **Expected revenue KPI** will be calculated as the avoided damage costs minus the implementation costs. The damage costs mainly consist of flood damage and crops deterioration. Using the above-mentioned baselines, it is possible to reckon what the reparation and loss costs should be over a certain period of time. The difference with the actual reparation and loss costs make for the avoided damage costs. Since the water authorities are the ones to take care of said reparations, and the one the farmers turn to in order to complain about the damage caused by the IAS, the financial data is easily available.

KPI	Description	Parameter
Expected revenue	Calculation of the avoided damage costs minus the implementation costs. The damage costs mainly consist of flood damage and crops deterioration. Using the above-mentioned baselines, it is possible to reckon what the reparation and loss costs should be over a certain period of time. The difference with the actual reparation and loss costs make for the avoided damage costs. Since the water authorities are the ones to take care of said reparations, and the one the farmers turn to complain about the damage caused by the IAS, the financial data is easily available. Only LIFE MICA areas.	Number of kms dikes and dams
		% of dikes and dams in working condition
		Number of floodings
		Number of trapped muskrats and coypus
		Repair costs for dikes and dams as a result of digging by muskrats and coypus
		Crop damage in € from feeding by muskrats and coypus

The **Expected Revenue/Payback time**, if alone, can be deceiving because the return on investment will not be immediate. Indeed, implementation represents a big yet one-time investment, while the avoided damage costs keep progressively increasing with time. Even if some maintenance costs may arise because of LIFE MICA, they are expected to be much smaller than the benefits per year. Over time, LIFE MICA will eventually become moneymaking. This duration will be evaluated by the Payback time KPI, which will be easily inferred from the Expected revenue KPI (the time when it becomes positive).

KPI	Description	Parameter
Payback time	The Expected revenue KPI, if alone, can be deceiving because the return on investment will not be immediate. Indeed, implementation represents a big yet one-time investment, while the avoided damage costs keep progressively increasing with time. Even if some maintenance costs may arise because of LIFE MICA, they are expected to be much smaller than the benefits per year. Over time, LIFE MICA will eventually become moneymaking . This duration will be evaluated by the Payback time KPI, which will be easily inferred from the Expected revenue KPI (the time when it becomes positive).	Expected revenue DNA Mapping
		Expected revenue eDNA
		Expected revenue smart life traps
		Expected revenue smart camera trapping

The **Reduction of cost** per process is measured as the variation of IAS catching cost-effectiveness between LIFE MICA's and the current ones. It is defined as the average price to pay to catch a targeted animal. All costs must be included: from the research of the burrows' location to the cost of the trap and the human resources. The cost effectiveness has to be empirically evaluated on a global scale. Indeed, not only can the pure efficiency of the traps be calculated over large time periods and spatial distribution, but also the costs are of many kinds, some having meaning only when considering the bigger picture.

KPI	Description	Parameter
Reduction of cost per process	The reduction of cost per process is measured as the variation of IAS catching cost-effectiveness between LIFE MICA's and the current ones. It is defined as the average price to pay to catch a targeted animal. All costs must be included: from the research of the burrows' location to the cost of the trap and the human resources. The cost effectiveness has to be empirically evaluated on a global scale. Indeed, not only can the pure efficiency of the traps be calculated over large time periods and spatial distribution, but also the costs are of many kinds, some having meaning only when considering the bigger picture.	Reduction of cost due to DNA Mapping
		Reduction of cost due to eDNA
		Reduction of cost due to smart life traps
		Reduction of cost due to smart camera trapping from 2021 and onwards

Appendix VI: List of communication and dissemination activities

Action E2 – Communication and dissemination actions

E2.1 Communication and dissemination campaigns

E2.1: Communication and Dissemination	Location	Beneficiaries
presentation of project LIFE MICA and/or attendance		
Hunting Association Region of Hannover - Meeting and lecture	Hannover	LWK
Hunting Association county of Aurich - Meeting and lecture	Aurich	LWK
Hunting Association town of Oldenburg - Meeting and lecture	Oldenburg	LWK
Meeting with LIFE project ALIENAR and ELO (European Landowners Organization)		WSRL
Meeting with the Water Authorities and hunters county of Ammerland	Ammerland	LWK
Fair Pferd und Jagd, with project desk	Hannover	ITAW
Presentation at Rapid LIFE event	Bruxelles	INBO, ITAW, WSRL
Presentation of video to Dutch waterauthorities		WSRL
5 Meetings with regional committee Oost-Vlaanderen		VMM
5 Meetings with regional committee West-Vlaanderen		VMM
Presentation eDNA and DNA mapping for trappers	Baarlo NL	UvW
Lower Saxony Hunting Association, Seminar Springe 1 - Presentation	Springe	ITAW
Lower Saxony Hunting Association, Seminar Springe 2 - Presentation	Springe	ITAW
Lower Saxony Hunting Association, Seminar Springe 3 - Presentation	Springe	ITAW
Lower Saxony Hunting Association, Seminar Goslar - Presentation	Goslar	ITAW
Hunting Association county of Vechta - Meeting and lecture	Vechta	LWK
Lower Saxony Hunting Association , Seminar Thüle - Presentation	Thüle	ITAW
Meeting with the muskrat catchers and the Water Authorities “Mittlere Hase”		LWK
Lower Saxony Hunting Association, Seminar Verden - Presentation	Verden	ITAW
Fair Jagd und Hund, with project desk	Dortmund	ITAW
Presentation in ITAW/postdocs TiHo (Labmeeting)	online	ITAW
Presentation Wasserverband Bremen	Bremen	ITAW, LWK
Video Workshop “Invasive Species” TiHo Hannover	online	ITAW, LWK
Meeting environment committee (political) county of Oldenburg	Oldenburg	LWK
Meeting with the Water Authorities and the hunting association Federal State of Bremen	Bremen	LWK
Meeting and lecture with the hunting and environment authorities and hunting association county of Grafschaft Bentheim	Bentheim	LWK
Presentation at Future discourse Neozoa	Hannover	ITAW, LWK
Meeting and lecture with the environmental authorities and professional Muskrat- and Coypu hunters Federal State of Brandenburg		LWK
Education of the agricultural trainees at the chamber of agriculture Lower Saxony on IAS	Oldenburg	LWK
Lecture at the Videoconference working team environment at LWK	online	LWK
Presentation on eDNA method LIFE Watch ERIC NIS Workshop	online	UvA
Lecture at the Videoconference D/NL Boarderwater commission	online	LWK
Open Day Aschauteiche	online	ITAW
Videoconference with the environment Administration Hamburg “Coypu in Lower Saxony”	online	LWK
Meeting and excursion with the “Landesrechnungshof”		LWK
Fair for water maintenance, with project desk		LWK
Open Day Lake Dümmer	online	ITAW

Open Day Vechte region	online	ITAW, LWK
Presentation IAS Expert Meeting, Alfred Toepfer Akademie/NLWKN	online	ITAW
Presentation intermediate results DNA mapping	online	UvW
Open day of Invasive Alien Species Threats in Terrestrial Areas and Inland Waters in Turkey Project	online	ITAW, WSRL, UvW
Presentation for Svenska Jegereforbundet		UvA
Presentation ICAIS Conference		UvA, INBO
Meeting with hunting organisation and Dyke Association Bremen		LWK
Presentation Annual meeting of the Water Management Associations of Borken county	Borken	WSRL
Meeting with the minister of Agriculture in Lingen at the Vechte	Lingen	LWK
Presentation of eDNA method to water laboratories		UvA
Presentation VWJD Conference	Nationalpark Hainich	ITAW
Presentation at IUCN Workshop on humane management of vertebrate IAS	Bruxelles	INBO, ITAW, VMM, LWK
Open day of Friesoyther Wasseracht, with information desk	Netherlands	LWK
Open day Gelderse Poort	Gendt	WSRL, UvA
Open day of the Huntloserr Wasseracht, with information desk	Netherlands	LWK
Presentation and demonstration at CaLutra day	Netherlands	WSRL
Waterauthority Rivierenland "Onze Digitale toekomst"	Tiel	WSRL
Presentation Expert Meeting, BfN	Bonn	ITAW
Open day Hoogstraten	Wortel	INBO, VMM
Open day Wetterskip Frylsân	Lemmer	WSRL, UvW
Projectboardmeeting - external muskrat organisations joined	Vechte region	ITAW
Presentation at 1st European Raccoon Meeting	online	ITAW
Presentation at Nordic reference group on the management of invasive alien predators	Tønder, Denmark	UvW
Presentation at Life INVASAQUA Conference	Malaga	ITAW
Meeting with ministries, government officials, Water Authorities, hunting association about semiaquatic burrowing animals		LWK
Field-days of CALS , with project desk	Poppenburg	LWK
Arte feature about Coypu in the Netherlands and Germany		LWK
Presentation eDNA method Trapping organization NON	Borger	UvA
Presentation eDNA method, results Life-MICA MRB midden Nederland	Schermerhorn	UvA
Meeting with Life Oxyura		INBO
presentation preliminary final result DNA mapping	Online	UvW

Appendix VII: List of networking activities

Action E2 – Communication and dissemination actions
E2.2: Networking with other projects

E2.2: Networking activities	Location	Beneficiaries
Meeting with Hunting Association Region of Hannover	Hannover	LWK
Meeting with Hunting Association county of Aurich	Aurich	LWK
Meeting with Hunting Association town of Oldenburg	Oldenburg	LWK
Meeting with LIFE project ALIENAR and ELO (European Landowners Organization)		WSRL
Meeting with the water authorities and hunters county of Ammerland	Ammerland	LWK
Networking at Rapid LIFE event	Bruxelles	INBO, ITAW, WSRL
5 Meetings with regional committee Oost-Vlaanderen		VMM
5 Meetings with regional committee West-Vlaanderen		VMM
3 Seminars at Lower Saxony Hunting Association Springe	Springe	ITAW
Seminar with Lower Saxony Hunting Association Goslar	Goslar	ITAW
Meeting with Hunting Association county of Vechta	Vechta	LWK
Seminar at Lower Saxony Hunting Association Thüle	Thüle	ITAW
Meeting with the muskrat catchers and the water authorities “Mittlere Hase”		LWK
Seminar at Lower Saxony Hunting Association Verden	Verden	ITAW
Meeting Wasserverband Bremen	Bremen	ITAW, LWK
Meeting environment committee (political) county of Oldenburg	Oldenburg	LWK
Meeting with the water authorities and the hunting association Federal State of Bremen	Bremen	LWK
Meeting with the hunting and environment authorities and hunting association county of Grafschaft Bentheim	Bentheim	LWK
Networking at Future discourse Neozoa	Hannover	ITAW, LWK
Meeting with the environmental authorities and professional Muskrat- and Coypu hunters Federal State of Brandenburg		LWK
Networking on eDNA method LIFEWatch ERIC NIS Workshop	online	UvA
Meeting with the environment Administration Hamburg “Coypu in Lower Saxony”	online	LWK
Meeting with the “Landesrechnungshof”		LWK
Networking at IAS Expert Meeting, Alfred Toepfer Akademie/NLWKN	online	ITAW
Networking at Open day of Invasive Alien Species Threats in Terrestrial Areas and Inland Waters in Turkey Project	online	ITAW, WSRL, UvW
Networking with Svenska Jegereforbundet		UvA
Networking at ICAIS Conference		UvA, INBO
Meeting with hunting organisation and Dyke Association Bremen		LWK
Annual meeting of the Water Management Associations of Borken county	Borken	WSRL
Meeting with the minister of Agriculture at Vechte	Bremen	LWK
Networking at VWJD Conference	Nationalpark Hainich	ITAW
Networking at IUCN Workshop on humane management of vertebrate IAS	Bruxelles	INBO, ITAW, VMM, LWK
Networking at CaLutra day		WSRL
Networking at Expert Meeting, BfN	Bonn	ITAW
Networking at 1st European Raccoon Meeting	online	ITAW
Networking at Nordic reference group on the management of invasive alien predators	Tønder	UvW
Networking at LIFE INVASAQUA Conference	Malaga	ITAW

Meeting with ministries, government officials, Water authorities, hunting association about semiaquatic burrowing animals		LWK
Networking on eDNA method with Trapping organization NON	Borger	UvA
Networking on eDNA method, results LIFE MICA MRB midden Nederland	Shermerhorn	UvA
Meeting with Life Oxyura		INBO