D2.4 User and System Requirements

Deliverable for the Horizon Europe Project BirdWatch

V2.0

Legal Disclaimer

This document reflects only the views of the author(s). Neither the European Global Navigation Satellite Systems Agency (EUSPA) nor the European Commission is in any way responsible for any use that may be made of the information it contains. The information in this document is provided "as is", and no guarantee or warranty is given that the information is fit for any particular purpose. The below referenced consortium members shall have no liability for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law.
This document and the information contained within may not be copied, used, or disclosed, entirely or partially, outside of the BirdWatch consortium without prior permission of the project partners in written form.
© 2023 by BirdWatch Consortium.

Funded by
the European Union

Document Information

GA Number	101082634	**Type of Action**	Horizon-IA
Full Title	BirdWatch - a Copernicus-based service for the improvement of habitat suitability of farmland birds via satellite-enabled monitoring, evaluation and optimisation of CAP greening measures		
Project Acronym	BirdWatch		
Start Date	February 1st, 2023	**Duration**	36 Months
Project URL	https://birdwatch-europe.org/		
Deliverable	D2.4: User and System Requirements		
Work Package	WP2		
Project Month of Delivery	**Contractual** M8 (M6)	**Actual**	M9
Nature	Data	**Dissemination Level**	
Lead Beneficiary	LUP		
Responsible Author	Stefan Braumann, LUP		
Contributions from	Pierre Babeck - LUP Nastasja Scholz - LUP Martynas Rimgaila - NPA Janosch Fiedler - Bioland		

Funded by
the European Union

History of Changes

Version	Issue Date	Stage	Description	Comments	Contributor
1.0	30.09.2023	Draft	First draft of D2.4	Please note: this is also an interim version, as there are currently issues with the access to the internal cloud system where the main draft has been created.	Stefan Braumann - LUP Pierre Babeck - LUP Nastasja Scholz - LUP
2.0	20.10.2023	Draft	Second draft of D2.4		Stefan Braumann - LUP Pierre Babeck - LUP Nastasja Scholz - LUP

Funded by
the European Union

Table of Contents

Funded by
the European Union

Introduction

BirdWatch's aim is to provide an EU-wide service supporting the monitoring and improvement of farmland habitat suitability for bird species which breed or forage on agricultural land.
The BirdWatch service will consist of an Earth Observation (EO) data-based monitoring service which evaluates the habitat suitability of farmland parcels for specific bird species as well as of an optimisation workflow, serving as a decision-support for the identification of appropriate eco-schemes. Several different types of stakeholders have been identified in the previous months, adding both to the complexity of the service to be developed and increasing the potential of a wide uptake.

Therefore, BirdWatch is foreseen to consist of a robust, cost-efficient web-based platform, which needs to cater to the different potential user types.

This requires well defined user and system specifications which are presented in this deliverable. The purpose of this document is to first, elaborate on the ways different stakeholders should be able to interact with BirdWatch and second, to specify the system requirements that will guide the development and implementation of the first iteration of the BirdWatch platform, detailing the different components, their functions and their relationships and dependencies.
The development of the platform will be an iterative process, with the aim of this document to set up an initial platform version which will subsequently be tested in our demonstration regions, starting with Flanders and followed by Lithuania, Germany and South Tyrol.
The demonstration activities will be planned in such a way as to allow for the collection of user feedback. The user feedback will then be reviewed by the technical team and value-adding changes will then be added to the new version of the platform. The BirdWatch platform will thus be developed in an interactive process.

This deliverable builds on the collected stakeholder requirements, as presented in Table 8 of *D2.3 - Stakeholder Requirements - Flanders*, while taking into account the constraints inherent in the methodology to derive habitat suitability. Probably the most critical methodological constraint is the amount and quality of bird observations we can use to build our habitat models.

Funded by
the European Union

Goals of the User and System Requirements Definition

The goal of determining user and system requirements in this deliverable is to define the components and information flow of the initial version of the BirdWatch platform with relevance to BirdWatch's different potential users.

The requirements definition for the *initial* platform is guided by the following criteria:

- establishment of an end-to-end composition of the service
- achievement of a proof-of-concept version which can be used in the first demonstration case in Flanders

Based on the initial user and system requirements, the first iteration of the BirdWatch software architecture will be established, starting with the Geospatial Database (i.e., *D6.1 - BirdWatch Backend Database*)

The establishment of the *final* version will be guided by the following criteria:

- validated end-to-end composition of the service, including the coverage of all user requirements
- validated quality of the service output
- validated aspects regarding service reliability, security and stability
- ease of use, especially for farmers
- achievement of a platform ready to be launched to the public

Funded by
the European Union

Service and Value Propositions

Below is a list of service and value propositions foreseen for BirdWatch's stakeholder groups. They are based on the questionnaires and discussions with representatives of stakeholder groups described in D2.3.

The envisioned services and value propositions are an important input for the definition of the system requirements and capabilities.

Stakeholder type	BirdWatch services and value propositions
Individual Farmer	Farmers in the EU are highly dependent on financial support (including via direct payments, rural development support) as this represents a large percentage of their income (REF). At the same time, society relies on their services for the provisioning of basic resources. The effective implementation of EcoSchemes can save farmers money and time. ***BirdWatch's services for individual farmers are to enable to:*** a) remotely check the state of habitat suitability for each parcel. b) remotely check the evolution of the state of habitat suitability for each parcel. c) compare habitat suitability of one's parcels against regional values. d) remotely check parameters that correlate with habitat suitability, like textural richness or the absence or presence of landscape elements. e) identify possible pathways to improve farmland bird habitat suitability on specific parcels, specified by a choice of possible eco schemes, applicable in the specific region, considering his / her financial and operational constraints. ***BirdWatch's value propositions to individual farmers are:*** i) support for compliance with CAP regulations ii) reduction in the need for on-site checks iii) support in the choice of and education on the available agri-environmental measures iv) reduction in the need for visual interpretation.
Farmers Organisation	Farmers organisations consult their members in agriculture and environmental issues and provide monitoring and implementation of protocols concerning good agricultural practices. BirdWatch is especially of interest to experts in CAP measures dedicated to environmental and climate resilient strategies, who visit members farms, evaluate their compliance with agri-environmental interventions and who provide information and advisory services on how to sustainably manage a farm. ***BirdWatch's services for farmers organisations are to enable to:*** a) advise their members to identify possible pathways to improve farmland bird habitat suitability on specific parcels, specified by a choice of possible eco schemes,

Funded by the European Union

	applicable in the specific region, considering members' financial and operational constraints. ***BirdWatch's value propositions to farmers organisations are:*** i) support advice on the compliance with CAP regulations ii) reduction in the need for on-site visits iii) support advice on the choice of and education on the available agri-environmental measures iv) reduction in the need for visual interpretation.
Supervisory Institution	Among the tasks of supervisory institutions (including paying agencies, environmental agencies) is the monitoring to ensure that certain standards and requirements are met. In case of paying agencies, this concerns the direct payment support schemes together with some of rural development measures. As this often involves field visits and on-the-spot visual checks, a key value proposition is to simplify and lower the monitoring and administrative costs and perform more accurate, frequent and wider-sample compliance checks. ***BirdWatch's services for supervisory institutions are to enable to:*** a) remotely check claims regarding the application of specific eco schemes on a claimant's parcels. b) remotely check the temporal evolution of farmland bird habitat suitability on a claimant's parcels to see if it corresponds with the expected habitat suitability based on the claimed eco schemes. c) assess the potential impact of CAP guidelines or their changes on habitat suitability. ***BirdWatch's value propositions to supervisory institutions are:*** i) reduction of the need for onsite checks. ii) higher spatial coverage (and therefore larger subset of controlled farms) per year due to reduction in number of onsite checks. iii) new information layers to combine with other compliance-relevant data for a more holistic view. iv) reduction in the need for visual interpretation. v) data-backed knowledge on the potential impact or effectivity of CAP ecoschemes on farmland habitats
Policymaker	Policymakers need information to evaluate and maximise the effectiveness of current and future policies. Currently, the new CAP framework (2023-2027) is under review and there is a very strong need for policy evaluation tools. ***BirdWatch's services for policymakers are to enable to:*** a) remotely check which eco schemes are applied in his / her region of interest together with the farmland bird habitat suitability in the region. b) remotely check the temporal evolution of farmland bird habitat suitability in his / her region of interest

Funded by the European Union

	c) associate changes in habitat suitability with applied eco schemes in the region to evaluate the impact of eco schemes d) evaluate the potential impact of the new or changes policy guidelines on habitat suitability to pick the most appropriate measures ***BirdWatch's value propositions to policymakers are:*** i) provision of data on habitat suitability and habitat suitability-influencing factors on farmland that will assist policymakers in evaluating the effectiveness of current CAP regulations. ii) provision of scenarios on habitat suitability and habitat suitability-influencing factors on farmland that will assist policymakers in shaping future CAP regulations. iii) data-backed knowledge on the potential impact or effectivity of CAP ecoschemes on farmland habitats.
Nature Conservation Organisation	Professionals as well as volunteers working in nature conservation are active on different levels, including in the evaluation and monitoring of ecosystem health and impact of policies. The outcome of their work often supports policy-making. ***BirdWatch's services for nature conservation organisations are to enable to:*** a) remotely check farmland bird habitat suitability in the region of interest. b) remotely check which eco schemes are applied in his / her region of interest c) remotely check the temporal evolution of farmland bird habitat suitability in his / her region of interest d) associate changes in habitat suitability with applied eco schemes in the region to evaluate the impact of eco schemes ***BirdWatch's value propositions to nature conservation organisations are:*** i) assistance in the evaluation of agri-environmental measures. ii) remote detection of areas of low habitat quality. iii) provision of scenarios on habitat suitability and habitat suitability-influencing factors on farmland that will assist policymakers in shaping future CAP regulations. iv) data-backed knowledge on the potential impact or effectivity of CAP ecoschemes on farmland habitats. v) reduction in the need for visual interpretation.
Research & Academia	Scientists and researchers focusing on ecology, ornithology or the environment often study the negative and positive influencing factors on environmental or species health. This is done within purely academic but also in policy-supporting research. ***BirdWatch's services for research and academia are to enable to:*** a) obtain data on farmland bird habitat suitability, enabling them to research new patterns of the relation between biodiversity and farmland management. b) remotely check which eco schemes are applied in his / her region of interest together with the farmland bird habitat suitability in the region. c) remotely check the temporal evolution of farmland bird habitat suitability in his / her region of interest it

Funded by
the European Union

	d) associate applied eco schemes in the region with habitat suitability to study impact factors ***BirdWatch's value propositions to research and academia are:*** i) assistance in the evaluation of agri-environmental measures. ii) remote detection of areas of low habitat quality. iii) development of management scenarios…

Table 1: BirdWatch's services and value propositions to its stakeholders

The service and value propositions along with the technical service requirements will be tested with stakeholders during the demonstration phases and might be updated depending on the feedback of test users.

Funded by
the European Union

The elements of the BirdWatch service

The BirdWatch service will offer different stakeholders (individual farmers, farming organisations, supervisory institutions, policymakers, nature conservation organisations, individuals or working groups in research and academia) access to spatial and temporal information on the farmland bird habitat suitability of agricultural areas.

Within the lifetime of the project, this information will become available in the four test regions of the project, with the aim to eventually extend the service to further Member States of the European Union in the future. Region transferability of the habitat models will be tested in WP4000.

The BirdWatch service will be accessible via a registration / login process, in order to assign functionalities to individual users based on their stakeholder type. Stakeholder-dependent functionalities will be further described in the next section.

As the overarching goal is to support the restoration and conservation of farmland habitats, which usually function on a landscape or even regional scale, BirdWatch focuses its main support to decision makers on a regional, national and international scale, while giving landowners, especially farmers, who cultivate the land, the opportunity to explore their options in favour of farmland biodiversity, in line with the regional habitat requirements (at landscape level). The focus on habitat requirements on a landscape level thus avoids suggestions of agri-environmental measures which have conflicting implications for the farmland bird habitats.

The following image contains a high-level overview of the components of the BirdWatch service, also differentiating between the components inherent in the BirdWatch plattform and the additional components (i.e., the optimisation via *MooV*) which makeup the BirdWatch service.

Funded by
the European Union

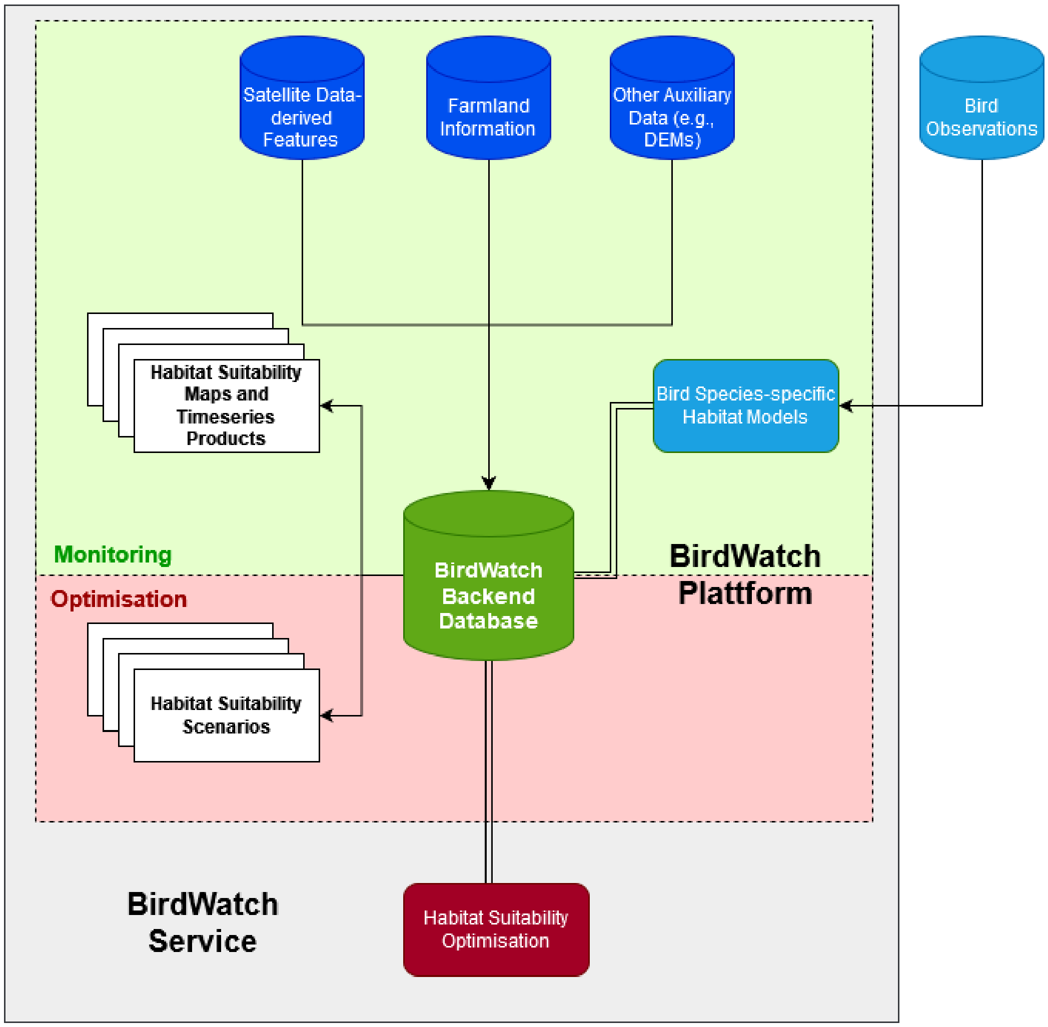

Fig. 1: Schematic overview of BirdWatch's components

Some notes on the figure above:

- As bird observation data will be used only once to set up the habitat models, it is pictured outside of the BirdWatch service.
- The Habitat Suitability Optimisation is part of the service but not part of the platform, as it will be carried out by consortium partner VITO. The link between VITO's optimisation service and the BirdWatch platform will be the BirdWatch Backend Database

The individual components of the figure above are described in a bit more detail the following.

Funded by
the European Union

Habitat suitability monitoring

All users will have access to habitat suitability monitoring capabilities. This means that they will have the option to display current and past habitat suitability values (either as species-aggregated or species-specific) for their region of interest. The extent to which we will be able to derive habitat suitability for multiple years is still to be explored test region by test region and strongly depends on the availability of high quality bird observation data. Going forward, we aim to provide a new habitat suitability assessment at least once a year.
The habitat suitability will be calculated taking into account only the species which occur in the region. For example, the black-tailed godwit (*Limosa limosa*) does not occur in South Tyrol or in large parts of Germany. The BirdWatch platform also aims to inform its users which bird species were taken into account, both to provide service transparency and educational content.
The latter is important to us, as one of our assumptions is (which is also mirrored in the farmers' questionnaire responses described in *D2.3 - Stakeholder Requirements - Flanders*) that clearly explaining why certain agri-environmental measures are necessary and how they could play a role in habitat improvement could increase the openness towards practising sustainable farming.
How educational content will be integrated into the platform will be explored in a later iteration of the platform. In the initial development phase, priority lies on the basic functionalities, necessary to carry out habitat suitability monitoring in the test regions.

Fig. 2 below shows the habitat suitability monitoring component from a technical point of view.

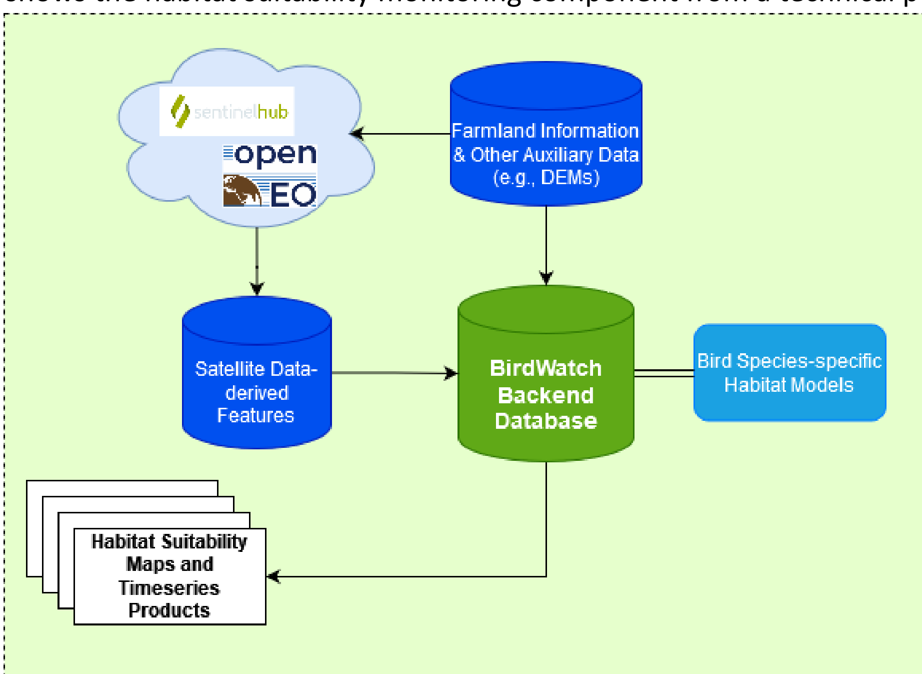

Fig. 2: Schematic overview of the habitat suitability monitoring component

Funded by
the European Union

The following aspects regarding Fig. 2 are important:

- The BirdWatch Backend Database is the heart of the BirdWatch Platform. This database is currently foreseen to be updated at least once a year, to allow for the annual update of the habitat suitability maps. Currently, it consists of a relational database with vector based datasets like parcel information, hedgerows, trees and crops. Along with this satellite data from optical and SAR sensors and various derived features will be processed and stored in cloud platforms like openEO[1] and Sentinel-Hub[2]. This relational database will be replaced by the BirdWatch Backend Database, to be developed as part of D6.1.
- For all test regions, the farmland (e.g., Land Parcel Identification System (LPIS) data) and any other auxiliary data (e.g., Digital Elevation Models, stakeholder specific information), are collected and fed into the BirdWatch Backend Database. During the project phase, the collection of this data is performed in a non-automated way.
- Raw satellite data is not stored in the BirdWatch Backend Database but only used for the *mic tools to integrate harmonised Sentinel-1 timeseries in the modelling workflow*.
- Data access and processing for the provision of the habitat features will be API-based (i.e., via the Bring Your Own Data (BYOD) functionality of Sentinel Hub, Sentinel Hub's Batch and Process APIs as well as the openEO API, as elaborated in the deliverables D3.1-D3.3).
- Initially, the year for which the auxiliary data and habitat features are collected, depends on the year for which sufficient bird observation data is available. For subsequent years of the project, the BirdWatch platform will be able to rely on the habitat models which are to be developed within the upcoming year.
- The bird species-specific habitat models will be stored in the BirdWatch Backend derivation of the habitat features via Sentinel Hub and openEO , as described in *D3.1 - Database of geospatial data*, *D3.2 - Dynamic tools to integrate harmonised Sentinel-2 and Landsat timeseries in the modelling workflow* and *D3.3 - Dyna*Database as model-based weights for each relevant parameter. These weights can be used to update the habitat suitability once new data on each parameter becomes available.
- Both Sentinel-hub and openEO will have reading and writing permissions to the BirdWatch Backend Database in order to read in any new boundary and temporal information for which the habitat features have to be derived and to write the respective results back into the database.
- Output to the user will then be the habitat suitability maps for specific years for which satellite data are available (i.e., starting 2017 and later).

[1] openEO

[2] Sentinel Hub (sentinel-hub.com)

Habitat suitability optimisation

Using VITO's *MooV*[3], optimised scenarios for an improved habitat suitability will be derived for each year for which habitat suitability has been calculated. This can be updated once a year as well, reflecting any changes in local parameters (including habitat parameters, changes in farmland management, etc.). The optimisation process uses the constraints inherent in the bird species-specific requirements (e.g., see *D2.2 - Bird Species Requirements List*) but also the operational and budgetary constraints which limit the execution of agri-environmental measures.

This way, users can get access to a list of options on how to improve the habitat quality in a region. Depending on stakeholder-type, BirdWatch will also allow to explore the impact of different scenarios (e.g., different configurations of landscape elements) on the habitat suitability.

The details of this process will be part of *D5.1 - Description of a Land Use Allocation Algorithm*.

In the BirdWatch platform, the habitat suitability optimisation is represented as in Fig. 3.

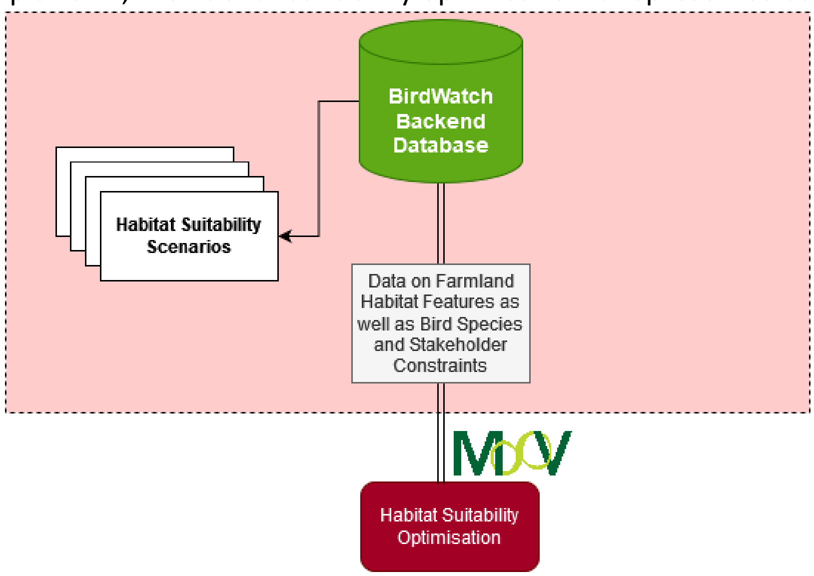

Fig. 3: Schematic overview of the habitat optimisation monitoring component

The following aspects regarding Fig. 3 are important:

- The optimisation workflow itself is not part of the BirdWatch platform but occurs on VITO's side
- The connection between VITO's MooV service and the BirdWatch platform is the BirdWatch Backend Database to which VITO has reading and writing permissions.

[3] [Home | MooV (vito.be)]

Funded by
the European Union

- BirdWatch Backend Database will store the data on farmland habitat features, parameter weights (i.e., parameter importance) but also stakeholder-relevant constraints (e.g., cost of performing a certain agri-environmental measure, available farmland for a certain agri-environmental measure, etc.).
- As it is currently foreseen, VITO will read the data from the BirdWatch Backend Database into their MooV service and calculate the scenarios of optimised habitat suitability per farmland (e.g., attributable by parcel or holding ID in the BirdWatch Backend Database).
- Output to the user are thus pre-selected scenarios for habitat suitability improvement under the current conditions of the farmland (as derived from the habitat suitability monitoring component). The user can then see what feasible options there are for a specific farmland location. The optimised habitat suitability values (i.e., the potential) will also be available to the user as maps.

Funded by
the European Union

BirdWatch User Interface

The user will be able to interact with both the habitat suitability monitoring and habitat suitability optimisation components via a web-based interface.

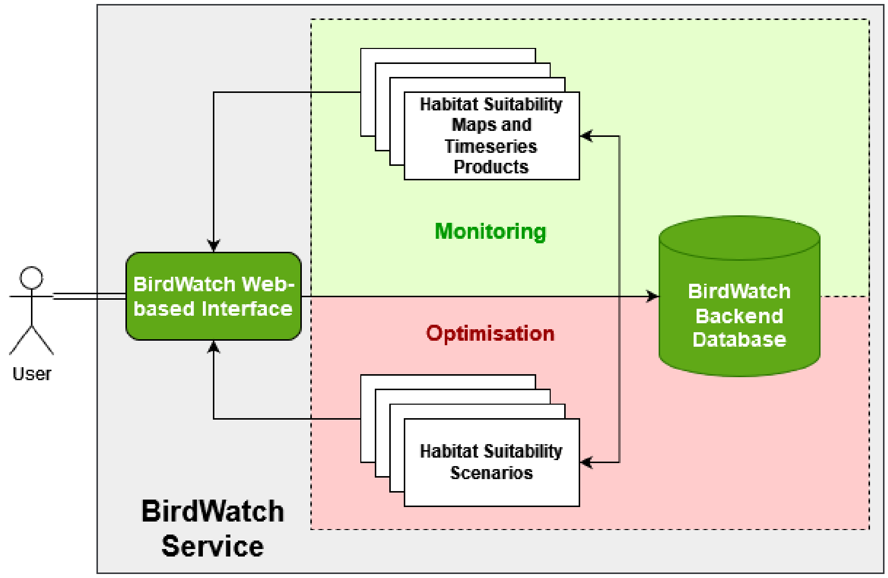

Fig. 4: Schematic overview of the user- facing component of BirdWatch

The following aspects regarding Fig. 4 are important:

- Access management will occur via the web-based interface. LUP's system administrators / technical staff will be in charge of overseeing the access management and maintaining an internal access database with entries for each user. The internal database will also include the user permissions per user (i.e., as determined by user type).
- Account management will occur through technical staff with the aim to gradually increase automatisation, but starting account management with an individualised approach (i.e.., direct contact, e.g., via email, between user and technical staff).
- The services are described in more detail in the next section. In summary, they allow the
    - retrieval of habitat suitability information for a region of interest, including via uploading one's own boundary-describing files of a region of interest and overlaying it with the respective habitat suitability maps.
    - retrieval of information on pathways to improve habitat suitability based on pre-calculated optimised parameters (e.g., suggestions on planting further hedgerows or avoiding certain types of crops / vegetation for the benefit of regionally occurring bird species).
    - download of maps (vector- and raster-based) and PDF-based summaries of the derived current and optimised habitat suitability for further use.

Funded by
the European Union

Users’ proposed interaction with BirdWatch

The BirdWatch platform will have user type-specific and user type-independent functionalities. Especially aspects regarding platform accessibility, service reliability, as well as data security should remain the same for all users. These aspects will be described in more detail in *D6.2. - First implementation of the web-based platform*.

In the following, we first describe the general functionalities shared with all users, followed by stakeholder type-specific considerations.

General

There will be several functionalities which will be shared among all users (see also Fig. 5). These will include:

- Registration via the web-based interface with BirdWatch
- Login and logout functionalities, together with password recovery
- A menu page which gives access to account details, user type-specific functionalities, account history, etc.
- Possibility to contact technical staff
- Access to a FAQ / Help page
- Access to an About page
- Access to data functionalities (including map views, time series views, data up- and download)
- Access to data filtering functionalities (search by ID, place name, etc. or by year)

Funded by
the European Union

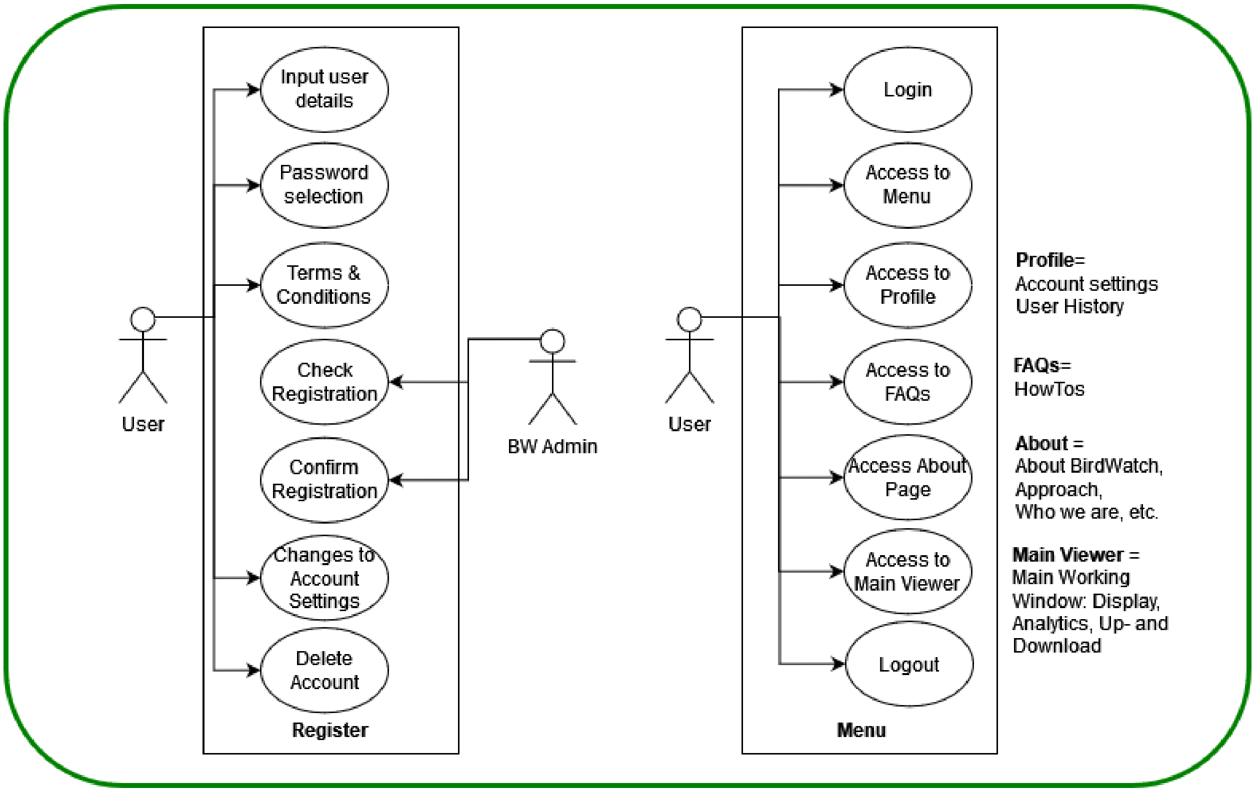

Fig. 5: General functionalities for all stakeholder types

Apart from the general requirements and functionalities we need to consider user type-specific aspects which will be described in the followed by examples how different stakeholders could interact with BirdWatch.

Please note that the following images appear fairly similar. As they individually play an important role for the design of the system architecture, we decided to show them individually despite the high overlap of the currently envisioned services between different stakeholders.

Funded by the European Union

Individual farmers (IF)

With regard to individual farmers, important considerations are:

- the service needs to speak to both technologically savvy as well as non-savvy farmers and therefore should be as intuitive as possible. There should be no functional or visual overload.
- the service needs to speak to farmers who practise both sustainable and conventional farming. This includes service transparency and background information on the necessity for agri-environmental measures.
- to facilitate uptake and increase usefulness, farmers should be able to also look at BirdWatch-results in the software they use to manage their parcels, such as their parcel-management apps.
- keyword-based search functionalities should focus on parcel identification
- the list of potential agri-environmental measures accessible to farmers should only include those which increase overall (i.e., on a landscape scale) habitat suitability

Fig. 6 gives an overview of the foreseen services individual farmers will have access to and which serves as an input for the development of the BirdWatch system architecture.

Funded by
the European Union

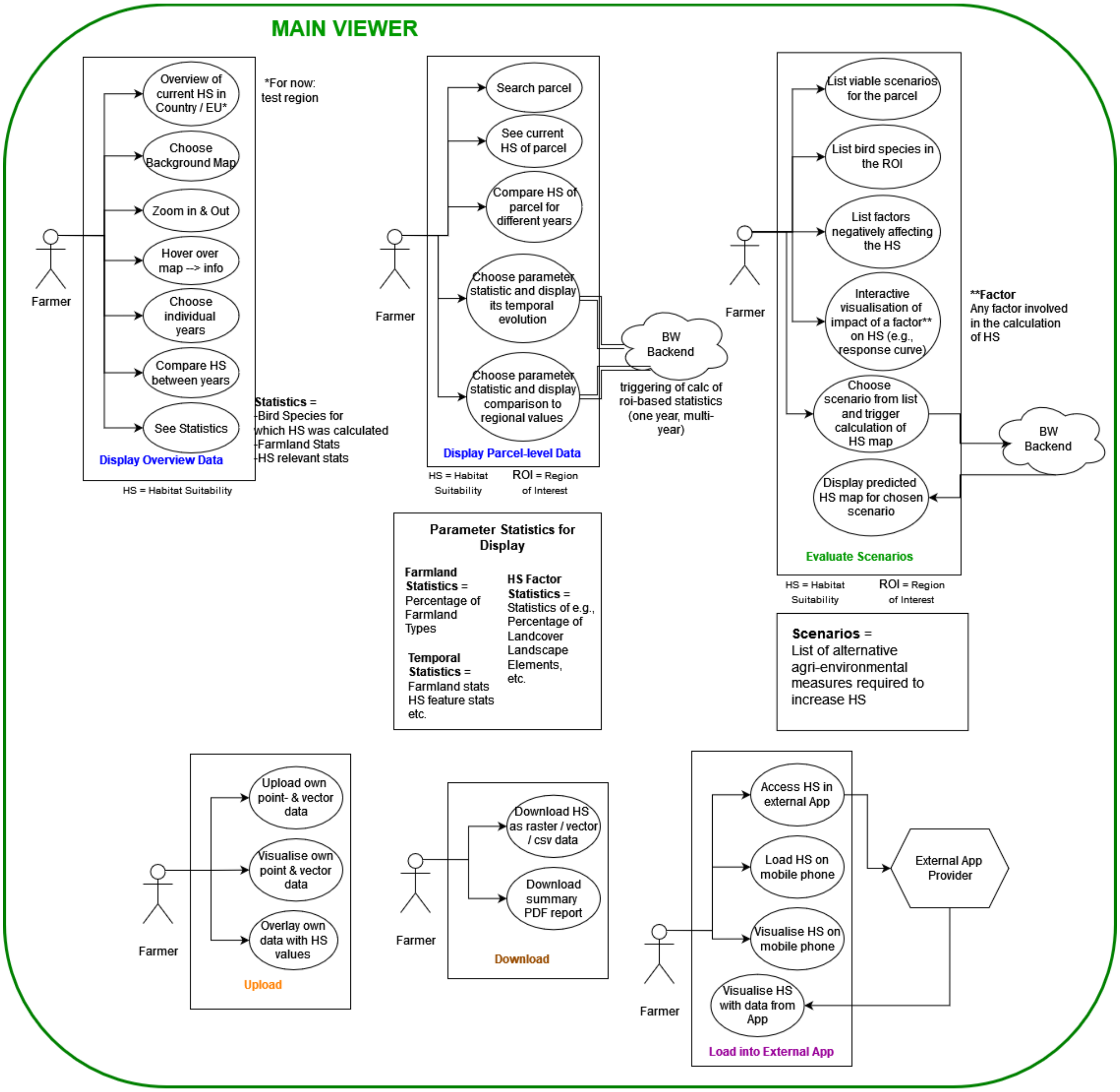

Fig. 6: Farmer's version of BirdWatch

Funded by
the European Union

Farmers Organisations (FO)

With regard to farmers organisations, the considerations are similar to individual farmers:

- the service needs to speak to both technologically savvy as well as non-savvy individuals and therefore should be as intuitive as possible. There should be no functional or visual overload.
- the service needs to speak to individuals who consult both farmers who practise sustainable farming and those who don't. This includes service transparency and background information on the necessity for agri-environmental measures.
- unlike farmers, the spatial scope of their region of interest will usually be larger and comparison functionalities between farms / regions might be of higher interest
- keyword-based search functionalities should focus on holding ID or farmer's name

Fig. 7 gives an overview of the foreseen services farmers organisations will have access to and which serves as an input for the development of the BirdWatch system architecture.

Funded by
the European Union

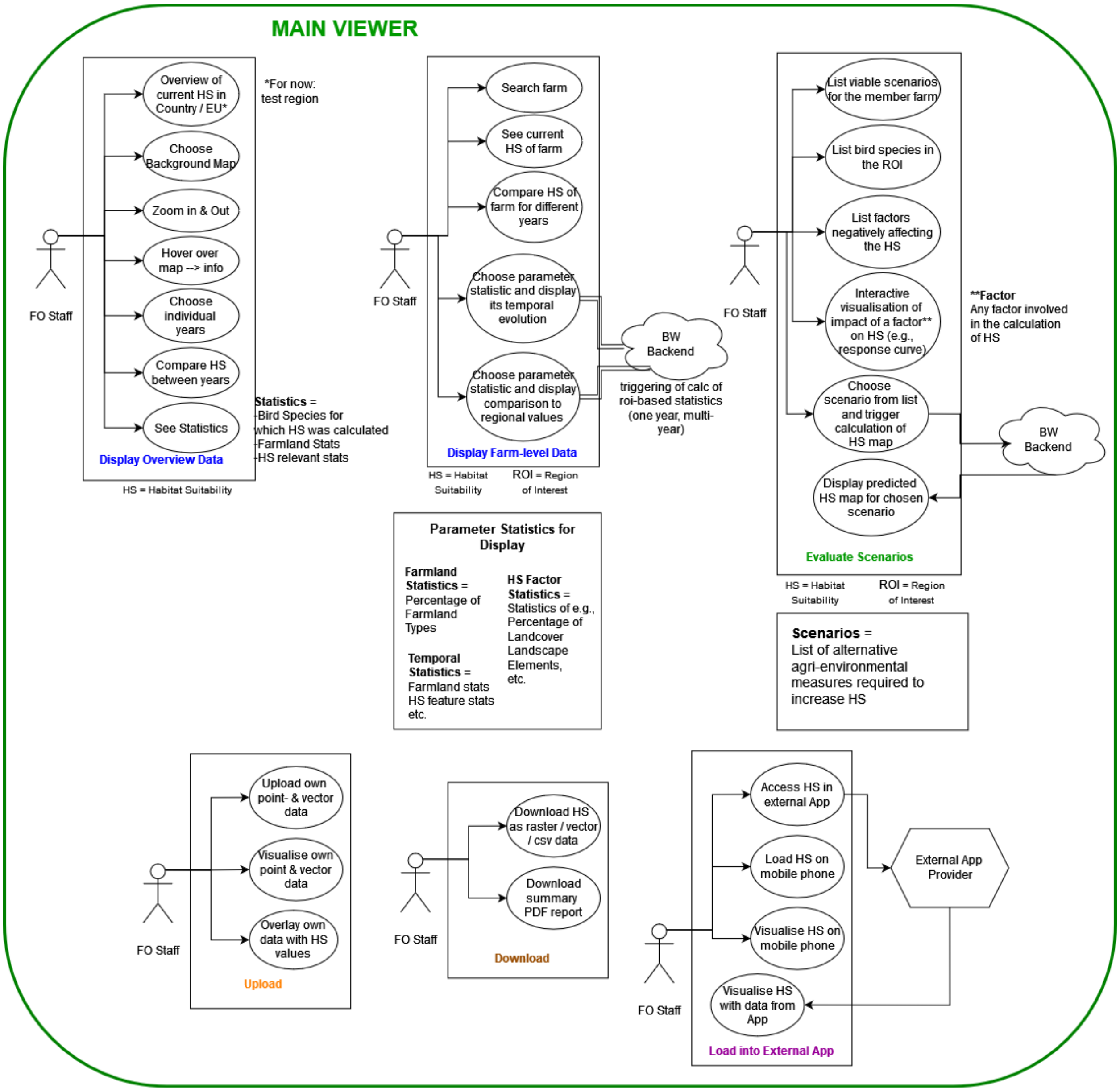

Fig. 7: Farmer organisations' version of BirdWatch

Funded by
the European Union

Supervisory Institutions (SI)

With regard to supervisory institutions, the considerations are:

- keyword-based search functionalities should focus on holding ID or farmer's name
- supervisory institutions should have a broader access to impact information with respect to agri-environmental schemes (e.g., in the form of response curves for individual species) compared to farmers or farmers organisations

Fig. 8 gives an overview of the foreseen services supervisory institutions will have access to and which serves as an input for the development of the BirdWatch system architecture.

Funded by the European Union

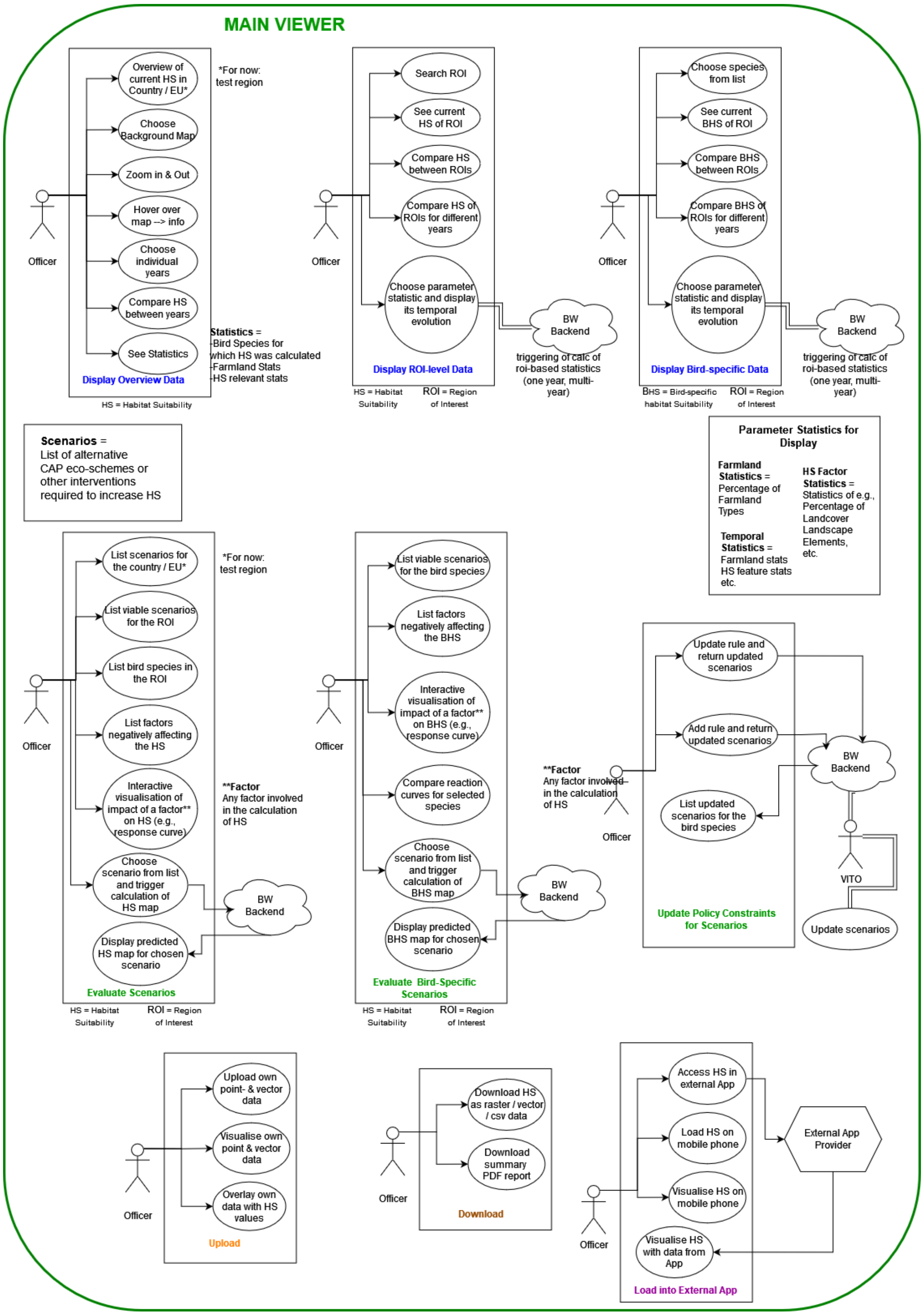

Fig. 8: Supervisory institutions' version of BirdWatch

Policymakers (PM)

With regard to policymakers, the special considerations are:

- keyword-based search functionalities should focus on local, regional and national scope.
- policymakers should have a broad access to impact information of agri-environmental schemes (e.g., in the form of response curves for individual species).
- there should be the possibility for policymakers to task an optimisation workflow based on planned policy guidelines for a region, i.e., to task VITO with the optimisation of the proposed new / adapted policy.

Fig. 9 gives an overview of the foreseen services policymakers will have access to and which serves as an input for the development of the BirdWatch system architecture.

Fig. 10 zooms on the habitat suitability optimisation, which here includes the option to trigger the optimisation via VITO's MooV service.

Funded by
the European Union

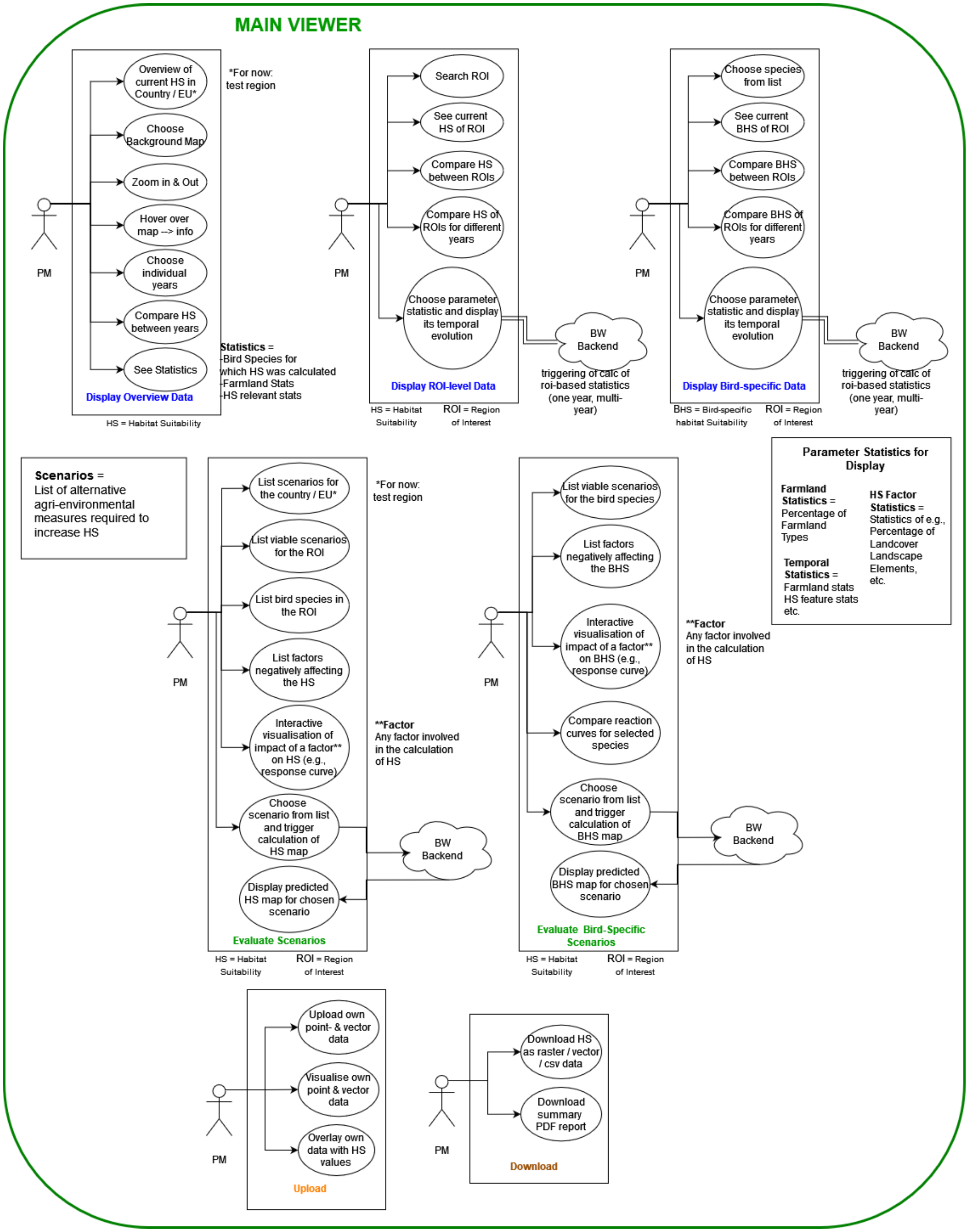

Fig. 9: Policymakers' version of BirdWatch

Funded by the European Union

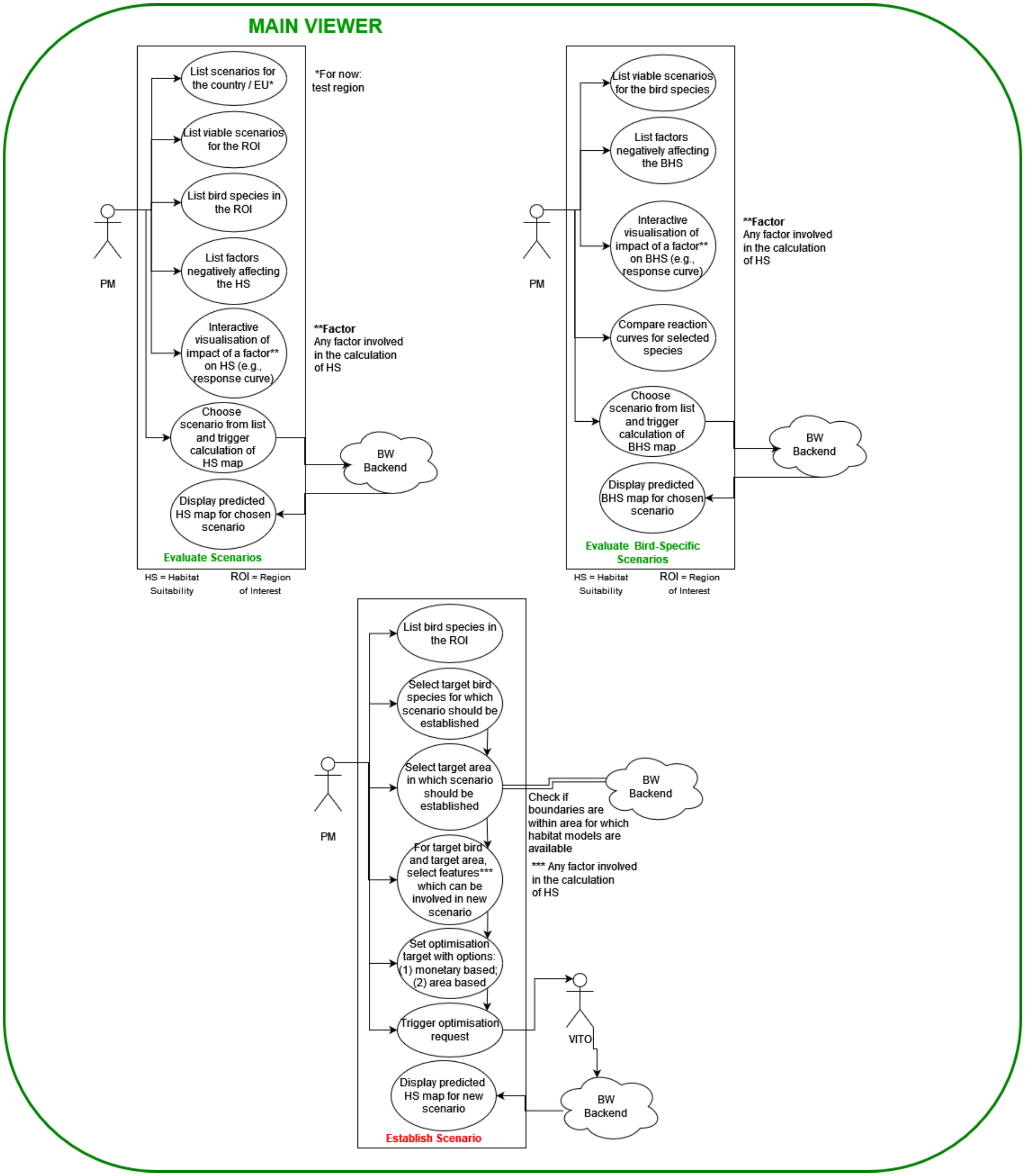

Fig. 10: Policymakers' version of BirdWatch, including the potential to test newly developed or adapted policies

Funded by the European Union

Nature Conservation Organisations (NCO)

With regard to nature conservation organisations, the special considerations are:

- keyword-based search functionalities should focus on local, regional and national scope.
- individuals and organisations should have broad access to impact information of agri-environmental schemes (e.g., in the form of response curves for individual species).
- clicks on the region's name and habitat suitability map is visualised automatically.

Fig. 11 gives an overview of the foreseen services nature conservation organisations will have access to and which serves as an input for the development of the BirdWatch system architecture.

Funded by
the European Union

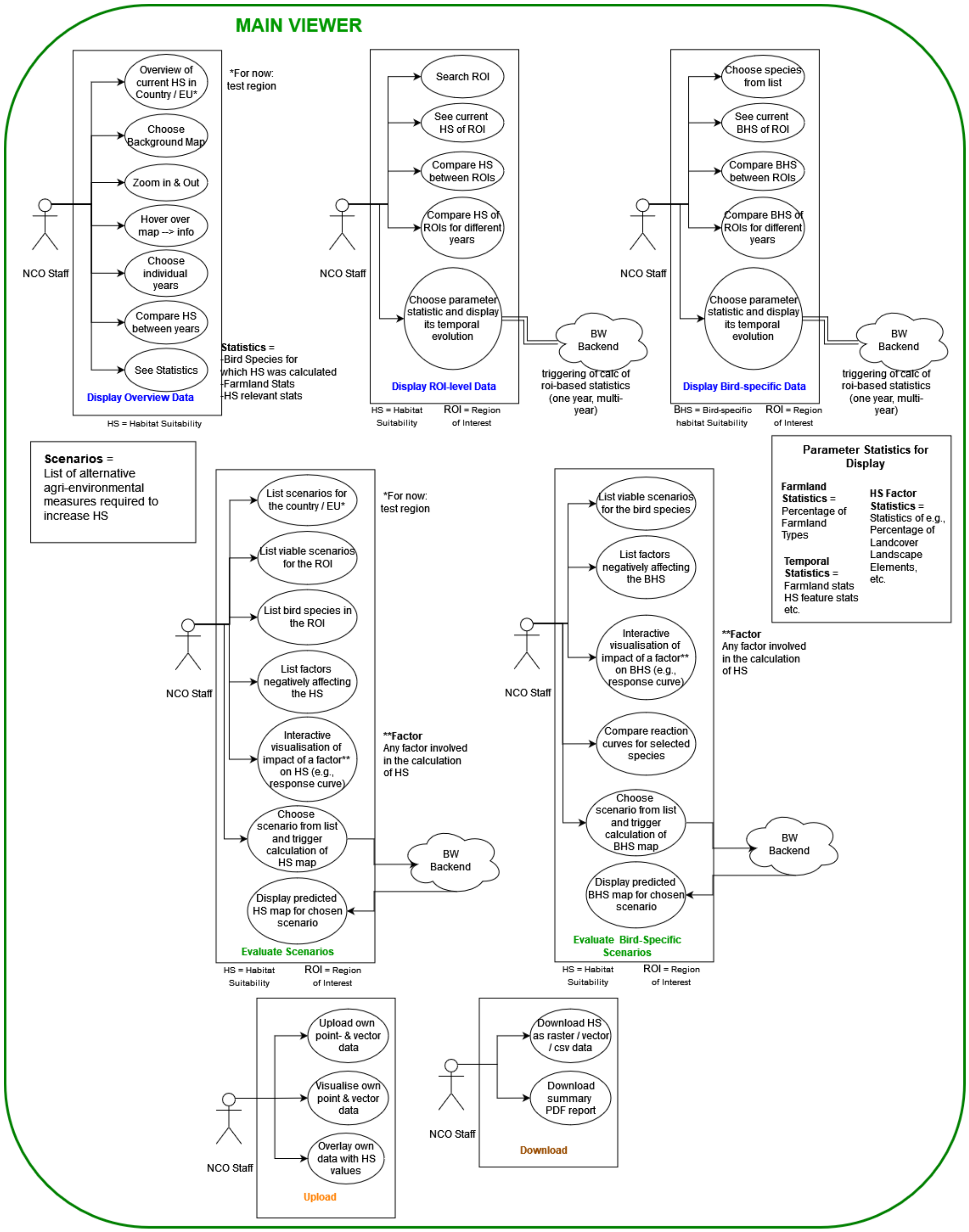

Fig. 11: Nature conservation organisations' version of BirdWatch

Funded by
the European Union

Research & Academia (RA)

With regard to research and academia, the special considerations are:

- keyword-based search functionalities should focus on local, regional and national scope.
- individuals and institutions should have broad access to impact information of agri-environmental schemes (e.g., in the form of response curves for individual species).

Fig. 12 gives an overview of the foreseen services research and academia will have access to and which serves as an input for the development of the BirdWatch system architecture.

Funded by
the European Union

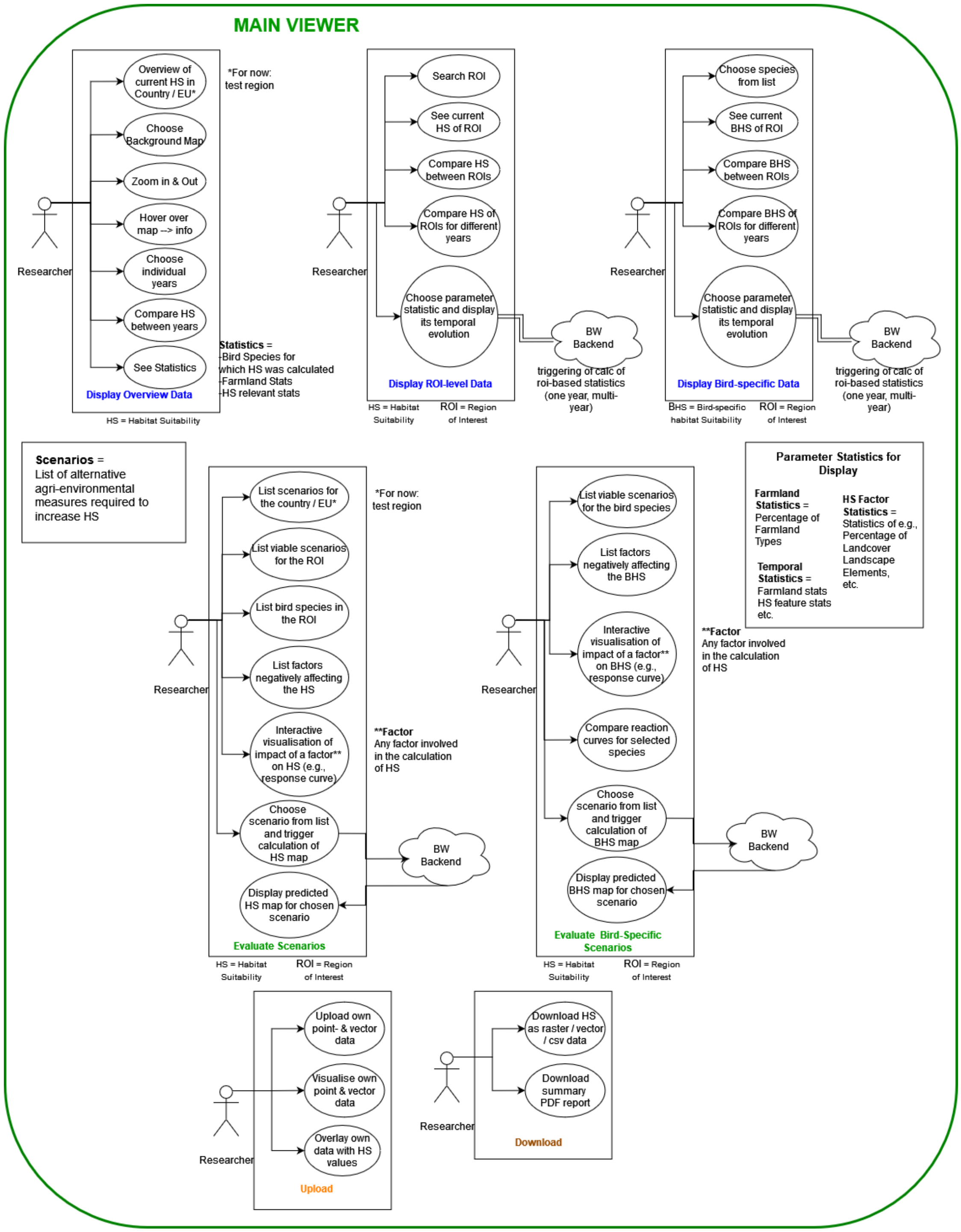

Fig. 12: Research and academia's version of BirdWatch

Funded by
the European Union

Example use

To underline the similarities and differences of the use of BirdWatch per stakeholder type, the following lists a number of example uses. These example uses were partly established together with the NPA and Bioland, in part they are based on the answers to the questionnaires discussed in D2.3. These examples will also guide the design of the software architecture (D6.2).

a) A **farmer** from Germany wants to plant a hedgerow on her fields. In order to do so, she wants to have an overview of her parcels, including the degree (and reason) of importance of different parcels for farmland birds.
Therefore, she logs on to the BirdWatch platform on her computer and selects the map viewer, showing the current habitat suitability in Germany. From a dropdown-list, she can access the IDs of her parcels and click on each individually, to look at the current habitat suitability of the respective parcel. BirdWatch automatically zooms close to the parcel such that its boundaries approximately fill the screen.
On a tab in the viewer, she can access the list of bird species relevant in her region, together with links to more information on these birds, including the measures needed to improve their habitats. From there, she can see which birds would benefit from landscape elements, such as hedgerows, on how they could benefit.
Going back to her parcels view, she can display the habitat elements associated with the current habitat suitability (e.g, percentage cover of shrubberies, crop type, structural complexity). This is displayed as a bar plot, with the habitat element on the x-axis and on the y-axis a percentage value of the relative importance (with respect to habitat suitability) of the respective habitat element.
She can download an overview of the habitat elements and the associated habitat suitability per parcel as a PDF file for record keeping.
She then can access the display of the optimised habitat suitability by clicking on another tab in the viewer which displays her parcels but with a potential habitat suitability value. This is the maximum habitat suitability improvement she can achieve when focusing on her parcels, inherently reflecting the regional context (neighbouring farms, climatic factors, geographic context such as close distance to a city, etc.).
From a dropdown-list, she can access the different actions she can take to reach an improvement in the habitat suitability per parcel and see in which parcel a hedgerow would provide the most value for habitat suitability.
She also prints these options as a PDF file, together with an overview of the bird species relevant for her region and their respective benefits from agri-environmental measures applicable for the farmer's region.

Funded by
the European Union

b) A **farmer** wants to carry out ecologically & economically optimised cultivation planning. Therefore, he logs on to his parcel-management software and accesses a particular field for which he wants to plan the cultivation.
He then imports the current and potential habitat suitability map from the BirdWatch platform and looks at the map within his parcel-management software.
Both habitat suitability maps are overlaid with the parcel-information of his parcel-management software. This way, he can match the location of, e.g., his yield information with information on the habitat suitability of the respective parcel.
This way he can see where he has the highest potential to increase habitat suitability but also how his most valuable crops are located with respect to where he can contribute the most to habitat improvement.
He then can upload his parcel-information (e.g., polygon-data of crop yields) into BirdWatch and access a list of ecologically viable crop types for each of his parcels, which would increase the ecological value of his parcel, together with an approximation of the costs for each viable crop per hectare.
He can also upload soil quality information and overlay it with the habitat suitability to check for spatial coincidence of low habitat values and low soil quality to estimate how soil quality could affect the cultivation of the ecologically viable crop type.

c) An employee of a **farmers organisation** wants to consult a farmer on his compliance with agri-environmental policies.
Therefore, she logs on to the BirdWatch platform to access the ID of her clients farm parcels and click on each individually, to look at the current habitat suitability of the parcels.
She then accesses the display of the optimised habitat suitability, i.e., the maximum achievable habitat suitability improvement within the regional context.
From a dropdown-list, she gets the different actions she can take to reach an improvement in the habitat suitability for each of her client's parcels and their expected operational and financial costs. She sees that there are parts of his parcels which have a geometrical complexity which makes them harder to cultivate and therefore good candidates to be turned into fallow land. She can digitise the boundaries of the parts of the field with the highest potential as fallow land, to calculate the area of the potential fallow area and export it as vector data.
She prints this also as a PDF file, to consult her client on this option to both comply with agri-environmental policies and apply ecologically sound measures with the least necessary effort.

d) An officer of a **supervisory institution** wants to upload declared parcels under CAP eco-schemes or other interventions and to overlay the parcels with information on

Funded by
the European Union

habitat suitability to compare and monitor how new elements and the activities performed by farmers affect the habitat suitability by comparing different years and scenarios.

Therefore, he logs on to the BirdWatch platform and uses the ID of the specific farm holdings to look at the current habitat suitability of holding's parcels. He then uploads information about the declared parcels of the farm holding he is looking back by uploading the data from his local desktop or the institution's own data storage location. In a sidebar, he can check the information on the parcels coming from his own data to see what activities were declared.

From a dropdown list with available years (i.e., the years for which habitat suitability maps have been generated) he then selects the years of interest to him. He also selects a timeline map view which displays the habitat suitability for each selected layer side by side. Hovering over the parcels with his cursor, he can also see the habitat suitability value of the parcel in question and quickly see if the value has increased or not.

For each year, he also displays the habitat elements associated with the habitat suitability of each selected year as a bar plot, to see which elements have contributed to the changes of habitat suitability between the selected years.

He then prints a PDF with a summary of the habitat suitability per parcel of the farm holding with a statistical overview of the inferred changes between the years (e.g., increase in percentage of shrub cover, crop type) that are associated with the habitat suitability distributions in the years of interest.

e) An officer of a **supervisory institution** wants to evaluate a new project for investment support. The officer needs to check if the selected area and the suggested new elements in the project are in line with habitat requirements in the region and how they will impact the species.

She logs into BirdWatch and searches for the region (via name of region) in which the new investment project is planned. She sees the current habitat suitability of the region.

On a tab in the viewer, she can access the list of bird species relevant in the region to know which species could potentially be affected. For each bird species, the habitat requirements and the potentially harmful farm management practices are available.

For each bird species, the bird species-specific habitat suitability can be displayed, together with the response curves for individual habitat elements. To check how an increase in the coverage and diversity of landscape elements could affect habitat suitability, she toggles the respective parameter values to retrieve the expected impact on the habitat suitability value. She chooses the parameter values which indicate a positive net effect on habitat suitability and downloads a PDF with a summary of the target values regarding landscape elements together with a map of the potential habitat suitability.

Funded by
the European Union

f) An officer of a **supervisory institution** wants to check habitat suitability within his mobile app which he usually uses for his tasks. He wants to use the habitat layer to inform other users of this app.
He logs on to his mobile app and imports the current habitat suitability map from the BirdWatch platform.
The habitat suitability map is overlaid with the information of the client's claim to compare the expected vs. the observed status of habitat suitability. The officer uses the resulting comparison together with a PDF-based summary of the results to communicate his decisions on the eligibility of the client's parcels.

g) A **policymaker** wants to evaluate farmland bird habitat suitability in her region of interest to see if there is any indication that agri-environmental measures have led to a significant ecological improvement of the farmland.
Logging on to BirdWatch, she selects the region in the map viewer and sees the current distribution of habitat suitability values. Some areas show low suitability, some indicate good habitat quality.
She compares two selected areas regarding their habitat suitability and extracts an overview of the habitat elements contributing to the respective suitability result. She does this for every year she is interested in.
It becomes apparent that the low habitat suitability values are associated with farmland where a lot of trees have been planted which is financially supported in the region.
She then checks the bird species relevant in the regions and sees that this is a region where bird species are dominant which avoid vertical structures. The farmland with few to no vertical structures are in turn associated with better habitat suitability values.
She downloads the two different areas with respective information on the habitat suitability and associated habitat features to take this information to her discussions on future policy strategies for the region in question.

h) A **policymaker** wants to select the agri-environmental measures which should be supported in the upcoming CAP for his region of interest.
On a tab in the viewer, he accesses the list of bird species relevant in the region to know which species should be taken into consideration. He sees that the Black-tailed Godwit (*Limosa limosa*) occurs within the region of interest. On the BirdWatch plattform, he can access information on the habitat preferences of this bird species and what aspects to consider with regard to farm management. From there, he already concludes that the support of landscape elements would not be beneficial for his target region.
He tests this hypothesis using the response curves of the Black-tailed Godwit to see how the percentage coverage of landscape elements could affect the habitat suitability. Then,

Funded by
the European Union

she examines the impact of increasing distance to landscape elements and concludes that farmland with a distance of 200m to the next vertical structure should not introduce landscape elements in this region. Instead, these farmers should be financially supported for providing spacious fallow land for the Black-tailed Godwit or for the postponement of mowing activities until the Black-tailed Godwit has finished breeding.

i) A member of a **nature conservation organisation** studies the impact of farm management on farmland birds in Flanders. He wants to know what suggestions he should provide to decision makers regarding the improvement of farmland eco systems in Flanders.
He uses BirdWatch to access a map of the habitat suitability for the whole region. He checks which farmland areas are suitable for which farmland bird species that generally occur in Flanders.
He sees that the habitat suitability for the Turtle Dove (*Streptopelia turtur*) is consistently low in the region.
He checks for the habitat elements contributing to the low habitat suitability. From a bar plot, he reads that in all cases, the structural and vegetation diversity is very low. As a nature conservationist, he knows that the Turtle Dove prefers mosaic-like structures.
He also checks if other occurring bird species, which prefer landscape mosaics, have low habitat suitability and explores the habitat suitability maps for the Red-backed Shrike (*Lanius collurio*). The farmland with low habitat suitability for the Turtle Dove is equally unsuitable for the Red-backed Shrike.
He exports the habitat suitability maps for both bird species as vector files to explore this data further using GIS software with which he usually explores spatial contexts for his conservation work.
He concludes that, in order to increase habitat suitability for farmland bird species which need structural diversity, farmers should introduce more landscape elements, apply differential mowing and leave more marginal structures intact.

j) A **scientist** studies the decline in the number of birds in a specific region. In her study region there occur bird species which either rely on the presence of humid soils or require close distances to water bodies.
Her focus species is the Eurasian Tree Sparrow (*Passer montanus*) which likes dry ground but prefers to nest in the vicinity of wetland. The presence of this bird is expected in the region of interest but the observations have been low.
Logging on to BirdWatch, the scientist views the habitat suitability of the Eurasian Tree Sparrow on farmland within her study region. She is interested to see if farm management factors impact the occurrence of the bird. The habitat suitability values of the farmland is shown to be low.

Funded by
the European Union

Looking at the factors contributing to the low values of habitat suitability, the distance of the farmland to wetlands appears to be high. The farmland itself appears to be high in structural diversity, contains many landscape elements, and the crops grown in the region are generally beneficial for the Eurasian Tree Sparrow.

The likeliest candidate for the decline in the numbers of this bird are the drying up / disappearance of wetlands.

The scientist exports the habitat suitability layer for the Eurasian Tree Sparrow for several years to continue working with this information as she has complementary data on soil moisture with which she wants to correlate the habitat suitability.

Funded by
the European Union

List of User and System Requirements

Our foreseen interaction with the BirdWatch platform and the inherent constraints of our approach (i.e., habitat parameter derivation via remote sensing data, habitat suitability calculation via species distribution modelling, optimisation of habitat suitability) resulted in a list of user and system requirements, distinguished between system, user and data requirements.

Table 2 includes all identified user and system as well as data requirements which are foreseeable at the point of writing.

Each requirement has an unique identifier, in order to keep track of it and its development and to be able to assign and associate specific tasks to it. The logic behind the choice of identifiers also helps to assign requirements to functional ("F") and non-functional ("NF") requirements.

On top of the attribution of each requirement to a requirement type, they were also classified in terms of:

- Priority (reflecting its relevance to fulfil the project goals)
- Complexity (reflecting the necessary technical aspects of implementation)
- Risk (reflecting its relevance to fulfil the project goals as well as to fulfil the stakeholder requirements)

Please note that in some cases the priority value is conditioned on another requirement to be fulfilled. Their respective priorities might, thus, at first look seem illogical. For example, (*NF_07* is only required if either *F_27* or *F_28* are fulfilled), as a data security disclaimer for uploaded data is only "High" priority, if the user can actually upload his / her own data. The possibility to upload own data, however, is of "Medium" priority for the purposes of the project.

Finally, the table includes a column (i.e, "V1") which indicates if a requirement must be implemented in the first version of the platform necessary for the conduction of the first tests. Requirements which have a "High" priority value but don't necessarily have to be in place for the first test phase (i.e., V1 = N) are requirements which MUST be in place latest at the end of the project.

ID	Requirement	Priority	Complexity	Risk	V1
System Requirements					
F_01	The system should provide a web-based platform that allows users to access the BirdWatch service.	High	High	High	Y

Funded by
the European Union

F_02	The system should generate maps of farmland bird habitat suitability based on satellite data and species distribution models and visualise it as raster- and vector data.	High	High	High	Y
F_03	The system should generate maps of optimised habitat suitability for farmland birds and return region-specific eco-schemes and agri-environmental interventions to the user.	High	High	High	Y
F_04	From the optimised habitat suitability, users should be able to see the approximate amount of subsidies they would obtain for a specific measure.	High	High	High	Y
NF_01	The resulting options to improve habitat suitability should be logically consistent and not at odds with any locally viable agri-environmental policy.	High	High	High	Y
NF_02	The quality of the optimisation output should allow the users to make their choice of an agri-environmental decision more easily than without the output.	High	High	High	Y
F_05	The system should conduct AI-based feature aggregation on satellite and auxiliary data to provide input for the habitat suitability models.	High	Medium	High	Y
F_06	The system should be able to feed satellite and auxiliary data-based features into habitat models and store the resulting habitat suitability data.	High	Low	High	Y
F_07	The system should be able to read optimised habitat suitability maps for farmland birds and return region-specific eco-schemes and agri-environmental interventions from the backend database.	High	Low	High	Y

Funded by
the European Union

F_08	The system should provide reading and writing access to the backend database for Sinergise' Sentinel Hub.	High	Medium	High	Y
F_09	The system should provide reading and writing access to the backend database for openEO.	High	Medium	High	Y
F_10	The system should provide reading and writing access to the backend database for VITO's MooV service.	High	Medium	High	Y
F_11	The system should have a map viewer with zoom and search functionalities as well as map navigation (moving towards the map's North, South, West, East).	High	Medium	High	Y
F_12	The map viewer should allow search by input polygon and bounding box.	Medium	Medium	Medium	N
NF_03	The map viewer should have background map services as default view (OpenStreetMap, Google Earth Images).	High	Low	Medium	Y
F_13	The system should allow the visualisation of aggregated habitat suitability.	High	Low	High	Y
F_14	The system should allow the visualisation of species-specific habitat suitability.	High	Low	High	Y
F_15	The system should have a timeseries viewer with zoom functionalities.	High	Low	Medium	N
F_16	The system should allow the visualisation of pixel-based habitat suitability timeseries data in cases where habitat suitability was calculated for more than one year.	High	Low	Medium	N
NF_04	The system should exist beyond the project's lifetime to allow for the detection of trends and changes in habitat suitability.	High	Medium	High	N
F_17	The system should allow the visualisation of statistical summaries of the habitat suitability	High	Low	Medium	Y

Funded by
the European Union

	as well as of the underlying habitat descriptors.				
F_18	The system should be accessible via API, including from mobile devices.	Medium	High	Medium	N
F_19	The system should be able to provide regular updates and improvements based on user feedback and technological advancements.	Medium	High	Medium	N
F_20	The system should be able to handle different types and sources of data, such as optical, radar and thermal satellite imagery, bird observation data and stakeholder data, including formats such as raster, vector and tabular data as well as geospatial databases.	Medium	Medium	Medium	Y
NF_05	The system should follow the FAIR principles and the GEO and INSPIRE directives for data management and sharing.	Medium	Low	Low	N
NF_06	The system should follow the EU Data Protection Law and other security policies for data protection and recovery.	High	Low	High	Y
F_21	The system should be able to adapt to different regions and scales in Europe by changing configuration parameters.	Medium	Medium	Medium	N
F_22	The system should provide an interface which allows the registration / login of users, including an input mask that allows the input of the stakeholder type of the user who wants to register.	High	Low	High	Y
F_23	The system should provide an administration interface for system administrators.	High	Low	High	Y
F_24	The system should automatically evaluate the permissions for a new registration.	High	Medium	High	N
F_25	The system should provide a randomised password for the first-time login.	High	Low	High	N

Funded by
the European Union

F_26	The system should provide an automatic confirmation of registration via email.	High	Low	High	N
NF_06	The stakeholder type is linked to specific account settings and permissions.	High	Low	High	N
F_27	The system should provide an interface which allows users to upload their own geospatial data via a pop-up interface.	Low	Medium	Medium	N
F_28	The system should provide an interface which allows users to upload their own geospatial data via a drag & drop.	Low	Medium	Medium	N
NF_07	The system should show a disclaimer on data protection when the user is uploading / selecting own data.	High	Low	High	N
F_29	The system should allow the user to select subsets of his / her data to be uploaded (i.e., a subset of attributes in vector data, a subset of columns in tabulated data)	Low	Medium	Low	N
F_30	The system should show a progression bar for uploading data	Low	Low	Low	N
F_31	The system should automatically zoom on the map view of the uploaded data	Medium	Low	Low	N
F_32	The system should be able to handle the upload of zipped folders and automatically unzip them.	Low	Low	Low	N
F_33	The system should automatically detect the coordinate system of user's geospatial data and adapt it to the system's preferred coordinate system	Low	Low	Low	N
F_34	The system should allow to be integrated into other software, services or platforms.	Medium	Medium	Medium	N
F_35	The system should have the relevant interfaces to be used with QGIS, R and Python	Medium	Medium	Medium	N

Funded by
the European Union

User Requirements					
F_36	The users should be able to customise their account settings according to their preferences.	Medium	Low	Low	N
F_37	Every registered user has his / her personal working space with reading and writing permissions.	High	Low	High	N
F_38	The users should be able to access the web-based platform with an internet connection and a web browser.	High	Low	High	Y
F_39	The users should be able to select their region of interest, either by using a zoom or a search functionality, querying specific parcels, holdings or locations.	High	Low	High	Y
F_40	The users should be able to select parcel-based habitat suitability values by clicking on the parcel to retrieve parcel-based information.	Medium	Low	High	Y
F_41	The users should be able to select between different years for which habitat suitability is available.	High	Low	Medium	N
F_42	The users should be able to compare the maps over different time periods and observe the changes in habitat suitability.	High	Low	Medium	N
F_43	The users should be able to view the optimised solution as a map overlay or a table with detailed information about the suggested greening measures for each parcel or location.	High	Low	High	Y
F_44	The users should be able to completely delete the geospatial information they uploaded themselves from storage.	Medium	Low	High	N
F_45	The users should be able to input their own constraints and regionally viable greening	High	Low	Medium	N

Funded by
the European Union

	measures.				
NF_08	BirdWatch's service should remain stable and reliable for the users 99% of the time.	High	High	High	N
NF_09	The user should understand on what data and methodological basis the habitat suitability and the optimised habitat suitability were derived.	High	Medium	High	Y
F_46	The users should be able to provide feedback on the system's performance and usability through a survey or a contact form.	Medium	Low	Low	N
NF_10	The users should be able to access the service in their national language.	Medium	Medium	Medium	N
NF_11	The users should have access to a manual on how the system can be operated.	Medium	Low	Medium	N
NF_12	The interface of the platform should be designed in a user-friendly way (e.g., not cluttered, no functional overload, pleasant colouring, intuitive display of functionalities)	Medium	Low	High	Y
Backend Data Requirements					
F_47	The backend database should be able to store raster-based optical, radar and thermal satellite imagery from sources such as Copernicus Sentinel-1/2/3 missions or the Landsat 8/9 mission as well as the habitat suitability raster data derived by the platform.	High	Low	High	Y
F_48	The backend database should be able to store a background grid database which serves as the reference grid for the parameter derivation and habitat suitability calculation.	High	Low	High	Y
F_49	The backend database should be able to store information on land use types, crop types, soil types, administrative boundaries, protected areas, etc.	High	Low	High	Y

Funded by
the European Union

F_50	The backend database should be able to store the calculated habitat suitability in vector-, raster- and tabulated format, as derived by the platform.	High	Low	High	Y
F_51	The backend database should be able to store the bird observation data with information on species, location, date, number of individuals, etc.	High	Low	High	Y
F_52	The backend database should be able to store tabular data with bird-specific and stakeholder-specific constraints.	High	Low	High	Y
F_53	The backend database should be able to store stakeholder data with information on their role, location, preferences, feedback, etc. from sources such as questionnaires, workshops and interviews.	Medium	Medium	Medium	Y
F_54	The backend database should be able to store weather data such as temperature, precipitation, wind speed, etc. from sources such as meteorological stations or weather APIs.	Low	Low	Low	N

Table 2: User, system and data requirements of the BirdWatch platform

Funded by
the European Union

Conclusions

Figures 5 to 11 summarise the currently foreseen interaction of different users with the BirdWatch platform. The possibilities of interaction are mainly constrained by bird data availability for habitat model generation as well as by the methodologies to infer habitat suitability and its optimisation. These limitations have been and continue to be explained as part of our stakeholder requirement analysis.
We expect to be able to update BirdWatch's products once a year, in line with the temporal resolution of the habitat models. This will facilitate the automatisation of the derivation of the habitat features and the data flow within the BirdWatch service compared to other satellite data-backed services which require high-temporal recurrence rates for result delivery.

Details of the dataflow, the implemented functions (both functional and non-functional), data security aspects, service reliability and maintenance will be elaborated in more detail in D6.2, the first implementation of the platform. This initial platform version will subsequently be tested and evaluated in our first test region, in Flanders.

Table 2 presents the list of all functional and non-functional requirements which should be fulfilled by the BirdWatch platform, latest by the end of the project's lifetime. Some of them might be adapted and some requirements might be added as a result of testing the platform internally and with users. The last column of Table 2 shows which of the requirements will need to be in place for the first tests with users to take place. These will be the requirements which will be implemented first.

Funded by
the European Union