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MS29 Initial design of the Single Access Point

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Summary

This milestone (MS29) documents the initial design and prototyping phase of the **Single Access Point (SAP)**, the central digital platform of the **Biodiversity Meets Data (BMD)** project. The SAP is envisioned as a unified, modular, and interactive web-based environment that brings together key functionalities across the biodiversity data lifecycle: from in-situ monitoring tools to data publication, search and retrieval, analysis through virtual research environments (VREs) or Biodiversity Explorer, and geospatial visualisation.

The core goal of this phase has been to validate the **functional logic, layout strategies, and user navigation models** that will underpin the SAP's future development. To this end, three distinct interactive mockups have been deployed online at https://bmd.lifewatch.eu. Each represents an alternative interface for the same content architecture—offering different visual metaphors and interaction cues (horizontal layout, circular design, dashboard layout). These prototypes serve as a testbed for gathering structured feedback from stakeholders.

The SAP is a continuation and will be an integral part of the Biodiversity Knowledge Hub (BKH), developed by the BiCIKL project[1].

The SAP is organised into **five interlinked modules** that reflect key stages in biodiversity data workflows:

- **M1: Biodiversity Monitoring Tools** – camera traps, acoustic devices, eDNA sampling, etc.
- **M2: FAIR Data Publication** – preparation and publication of datasets in line with international standards.
- **M3: Data Catalogue** – search and access to biodiversity, climate, and environmental data.
- **M4: VREs & Data Analysis** – access to domain-specific analytical environments (marine, terrestrial, freshwater).
- **M5: Web-GIS Data Viewer** – interactive geospatial visualisation tools.

There is also an alternative entry by using the three realms, i.e. terrestrial, freshwater, and marine. Each of the three mockups integrates these components differently, enabling users to evaluate how layout and navigation impact usability, engagement, and accessibility. The implementation was carried out using **WordPress** and the **Divi** page builder, enabling a low-code, flexible approach that supports modular content management and stakeholder-led iteration.

As an innovation layer, an **AI-powered chatbot**—developed with OpenAI's API—was embedded across all layouts. This assistant is capable of answering user queries in natural language based on project documentation and contextual prompts, offering real-time, accessible support and helping lower entry barriers for users unfamiliar with complex research infrastructure platforms.

In terms of methodology, the development of the SAP followed principles of:

- **Co-design and participatory development** to actively involve stakeholders;
- **Evidence-based prototyping** through real-world interaction with live mockups;
- **Technological feasibility testing** using scalable and maintainable platforms.

[1] *https://biodiversityknowledgehub.eu/*

The feedback collected from user testing will guide the selection of a preferred layout, the improvement of information architecture, and the visual refinement of the SAP for future milestones—particularly **Deliverable D6.2**, which will report on the next iteration of the platform. This milestone also serves as a reference for future integration of data services and policy-facing tools in support of the EU Biodiversity Strategy and the Nature Restoration Law.

In conclusion, MS29 marks a pivotal first step in building a community-codesigned, FAIR-aligned, and functionally robust digital hub that will support biodiversity monitoring, restoration, and knowledge-sharing across Europe and beyond.

List of abbreviations

AI Artificial Intelligence

API Application Programming Interface

BMD Biodiversity Meets Data (https://bmd-project.eu/)
BKH Biodiversity Knowledge Hub (https:// biodiversityknowledgehub.eu/)

CMS Content Management System

DIVI Divi Theme and Visual Builder. Wordpress theme used to develop the mockup.

DOI Digital Object Identifier

eDNA Environmental DNA

EU European Union (https://european-union.europa.eu/index_es)

FAIR FAIR principles: Findable, Accessible, Interoperable, Reusable

GBIF Global Biodiversity Information Facility (https://www.gbif.org)

GIS Geographic Information System

MS29 Milestone 29

OBIS Ocean Biodiversity Information System

SAP Single Access Point

VRE Virtual Research Environment

WP Work Package

WP6 Work Package 6 – Stakeholder Engagement and SAP Development

WCAG Web Content Accessibility Guidelines

1. Introduction

The **Single Access Point (SAP)** is envisioned as the flagship digital entry point of the **Biodiversity Meets Data (BMD)** project. It is conceived as a unified, modular, and interactive platform that provides access to the project's core digital components: biodiversity monitoring tools, FAIR data publication workflows, curated datasets, advanced analytical tools, and interactive geospatial visualisations.

The SAP is a continuation and will finally be an integral part of the Biodiversity Knowledge Hub (BKH) (https://biodiversityknowledgehub.eu/), developed by the BiCIKL project.

In a fragmented landscape of biodiversity data and tools, the SAP plays a key integrative role: it brings together multiple functionalities under a single, coherent interface, enabling different types of users to access and interact with relevant resources in a streamlined manner. These users include field researchers, data managers, site managers, restoration practitioners, and policymakers. As such, the SAP is both a **technical integration layer** and a **user-centric engagement environment**.

This milestone (MS29) documents the initial functional design of the SAP. Rather than focusing on aesthetics or branding, this phase is aimed at identifying the most intuitive and effective structural arrangement of content and navigation logic. To this end, three mockup versions of the SAP interface have been developed and published online. These prototypes are designed to capture real user preferences and behavioural patterns during interaction.

The rationale behind offering three layout options is to apply a **co-design and evidence-based development approach**. By engaging stakeholders at this early stage, the project team aims to understand:

- How users interpret the modular logic of the SAP
- Which content groupings and positions feel more intuitive
- What level of visual hierarchy aids usability
- Where additional explanation or interactivity may be needed

This process allows for iterative improvement grounded in real user input, ensuring that the final interface is not only functionally robust but also **aligned with user expectations and needs**.

Importantly, all three mockups share the same core content and backend logic, meaning that the user interface layer can evolve independently of the functional and semantic layers of the SAP architecture. This modularity also facilitates later scaling, integration of new tools, or adaptation to different thematic entry points.

In conclusion, the work reported in MS29 represents a **critical first step** toward a platform that will not only serve as a technical enabler for the BMD project but also as a public-facing digital hub for the broader community of biodiversity stakeholders.

2. Objectives of the Initial SAP Design

The initial design of the BMD Single Access Point (SAP) is driven by a clear set of strategic and technical objectives. These align with best practices in participatory design (Sanders & Stappers, 2008), user experience design (Norman, 2013), and agile development methodologies in research infrastructures (Wilkinson et al., 2016; EOSC Executive Board, 2020). The goal is to create a platform that is **useful, usable, and used** by its intended communities.

At this stage, the primary focus of this first stage of the process is not on final aesthetics or branding, but rather on verifying the **functional structure**, **user interaction model**, and **technical feasibility** of the SAP concept. To achieve this, the following core objectives have guided the development of the initial version:

1. Deliver a functional prototype for stakeholder validation:
The SAP mockups serve as testable artefacts that stakeholders can interact with directly. By offering a hands-on experience, users are empowered to explore the modules, identify gaps or pain points, and express their preferences in real terms.

2. Explore alternative content architectures:
Three distinct layout proposals (mockups A, B, and C) have been developed to test different ways of presenting the same modular structure. Each one implements a unique information hierarchy, visual grouping, and navigational logic. This approach helps uncover which design logic best supports intuitive discovery, accessibility, and engagement.

3. Deploy a live, web-based platform:
Rather than relying on wireframes or mockups in static formats, the SAP prototypes are implemented on an active website (https://bmd.lifewatch.eu) to simulate real use conditions. This allows for early detection of usability or integration issues and enables iterative refinement.

4. Engage stakeholders through structured feedback:
The initial design aims to support co-creation and participatory evaluation by involving key stakeholder groups in the evaluation process. Feedback mechanisms are embedded within the platform to collect both quantitative and qualitative input.

5. Demonstrate technical feasibility through real tools:
The SAP was implemented using **WordPress** as the CMS, **Divi** as the visual builder, and integrated an **AI-based chatbot powered by OpenAI** which will “translate” human-generated questions into API calls and data delivery. This toolchain demonstrates that a low-code, modular architecture can support the diversity of services and interfaces required by a modern biodiversity data portal.

These objectives collectively support a robust, inclusive, and scalable design approach, ensuring that the SAP evolves not only as a software product but as a **shared knowledge infrastructure** (Edwards et al., 2010) capable of supporting Europe’s biodiversity goals.

3. Overview of the SAP Functional Architecture

The functional architecture of the BMD SAP is built upon five key, interlinked modules, each of which represents a distinct stage in the biodiversity data value chain. These modules have been defined based on a combination of technical priorities, stakeholder needs, and alignment with European and global standards for environmental data infrastructures. The goal is to support seamless integration, accessibility, and interpretability of biodiversity information, regardless of domain or data origin.

Each module is described below in terms of its core function, associated components, and expected interactions with other modules:

3.1. M1 High-throughput Biodiversity Monitoring Tools

This module is the starting point of the SAP and focuses on how biodiversity data is collected in the field. It brings together different types of equipment and digital tools used to monitor ecosystems, such as camera traps, sound recorders, and eDNA sampling kits that are combined with AI species identification.

The goal is to enable fast, standardised, and reliable data collection, ensuring that observations from nature can be easily processed and shared. M1 serves as a connection between fieldwork and digital platforms, making sure that the collected data can later be published, analysed, and reused.

A key strength of this module is its flexibility: it is designed to incorporate new technologies and methods that may be introduced by BMD partners or recommended by European standards for biodiversity monitoring.

3.2. M2 FAIR Data Publication

The second module focuses on the curation and publication of collected data in accordance with FAIR (Findable, Accessible, Interoperable, Reusable) principles. M2 leverages existing infrastructures (e.g., GBIF, OBIS, ENA, DiSSCo) to enable dataset deposition, DOI assignment, metadata enrichment, and licensing compliance. It also includes tools for legacy data mobilisation and transformation, allowing historical baseline and unpublished data to be integrated into GBIF/OBIS. M2 ensures that data from M1 are not only archived but actively usable in broader scientific and policy contexts. An important goal of M2 is to assist data suppliers in preparing their data to an AI-readiness level, that is the data should not only be FAIR-ised but also be cleaned up and semantically structured to be re-used by domain-specific AI tools on purpose.

3.3. M3 Data Catalogue

M3 serves as the central access point for searching, filtering, and downloading datasets from multiple domains. It provides access to biodiversity, environmental, and climate-related data, harmonised across sources and aligned with community standards such as Darwin Core and OGC-compliant formats. The catalogue offers advanced filtering by taxonomy, geography, time period, data type, and source. In future iterations, this module will be enriched with semantic search and AI-assisted discovery features. M3 acts as a pivot module, feeding data into both visualization (M5) and analysis (M4).

3.4. M4 VREs & Data Analysis

This module connects users to a number of Virtual Research Environments (VREs) tailored to different ecological domains: marine, terrestrial, and freshwater, addressing several international (EU) policies and regulations. Each VRE provides access to curated tools, workflows, and computational resources that support modelling, data analysis, and scenario exploration. Tools include species distribution models, trend analysis, and restoration impact assessment utilities, based on past and current data and projections of scenario assumptions into the future. The modular design allows future extension to include other ecosystems or analysis types (e.g., socio-ecological models). M4 leverages ShinnyApp-based platforms and is interoperable with data cubed in WP3 and provided by WP4.

3.5. M5 Web-GIS Data Viewer

The final module is a dynamic, map-based interface for visualising data outputs from M1–M4. It enables spatial analysis, layer overlays, and geospatial storytelling. M5 is critical for end-users such as site managers and decision-makers who rely on intuitive, location-based insights to inform planning and action. It supports the integration of vector and raster data, time series animations, and direct linking to datasets and VRE outputs. This module is designed to be embeddable, responsive, and accessible, providing the visual front-end of the SAP.

Together, these modules embody a service-oriented architecture where each component is loosely coupled but semantically interoperable. They form the functional backbone of the BMD SAP and are designed to evolve based on user feedback, technological advances, and policy developments related to biodiversity monitoring and restoration in Europe.Milestone 29 (MS29) – Initial Design of the Single Access Point (SAP)

4. Mockups and Web Deployment

As part of the co-design and validation strategy of the BMD SAP, three distinct mockup versions have been developed and deployed online at https://bmd.lifewatch.eu. These mockups serve as interactive prototypes, allowing stakeholders to explore different information architectures and interface styles, and to provide valuable feedback that will guide the next design iteration.

Each mockup is built upon the same underlying modular logic and content structure, reflecting the five core functional modules (M1–M5) and the three ecosystem-specific Virtual Research Environments (Marine, Terrestrial, Fresh Water). However, they differ in how the user navigates and perceives these elements, prioritizing different visual metaphors, layout patterns, and interaction cues.

4.1. Option A: Horizontal Layout (Tile-Based Interface)

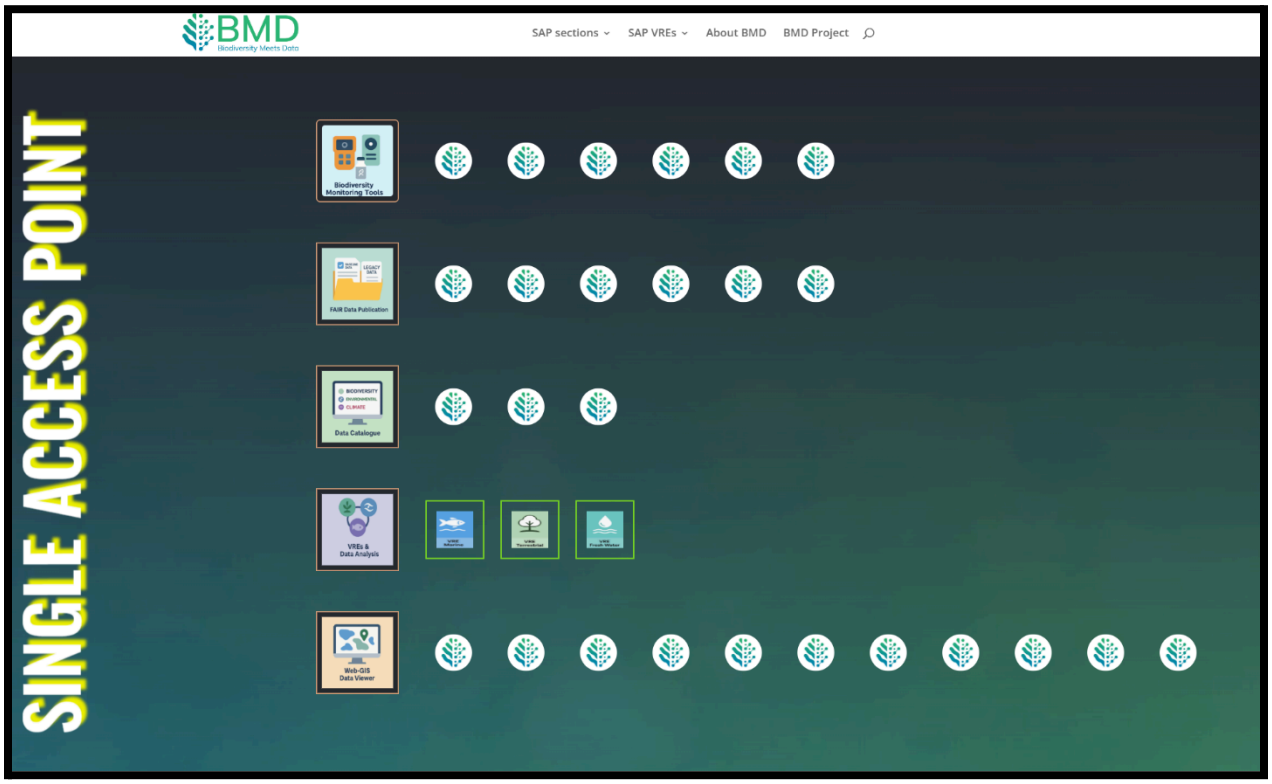
This version presents the five SAP modules in a row across the top of the page, with the three VREs positioned below in a second horizontal line. Each module and VRE is represented by a color-coded tile with iconography and short text labels. The simplicity of this layout supports quick orientation and direct access. It favors clarity and symmetry, particularly for users who appreciate a grid-based, low-friction entry point. The tile-based approach is mobile-friendly and highly modular.

4.2. Option B: Circular Layout (Gamified Radial Interface)

Inspired by game board logic and circular visual storytelling, this version presents the eight components in a radial arrangement, where the modules and VREs are positioned around a central point. Hover effects and subtle animations draw attention to each element, inviting users to explore interactively. This design aims to appeal to users who prefer a more playful, exploratory experience. It is particularly suitable for educational or outreach contexts, where visual engagement is key.

4.3. Option C: Classic Dashboard Layout (Block-Based Interface)

This version divides the interface into two main content blocks. The top section displays the five SAP modules in a linear or grid layout, while the lower section presents the three VREs along with brief descriptive texts. The layout mimics a traditional control panel or web portal, with space for future widgets, updates, or usage statistics. It provides a balanced mix of structure and contextual information, ideal for professional users who require both clarity and context.



4.4. Summary

All three versions have been implemented using the Divi theme builder within WordPress, allowing for flexibility in layout design without requiring advanced coding. Each version includes placeholder visual elements that will later be enhanced with high-fidelity graphics, accessibility features, and responsive behaviours.

Importantly, these mockups are not final designs. They are presented as **functional wireframes**, designed to validate the conceptual structure of the SAP and to generate informed discussion among stakeholders. The emphasis at this stage is on user flow, interaction logic, and modular coherence, rather than graphical fidelity or branding.

Each version is linked from a shared landing page that introduces the exercise and invites users to:

- Test each interface in context
- Indicate their preferred version through a survey form

- Leave additional comments or suggestions

This multivariant mockup approach is part of the BMD commitment to **evidence-based design**, user-centered innovation, and transparency in the development of research infrastructures.

5. Technical Implementation

The technical development of the SAP mockups was grounded in a pragmatic and scalable strategy focused on low-code, modular technologies. The decision to use **WordPress** as the Content Management System (CMS) in combination with the **Divi theme and visual page builder** was intentional, enabling rapid prototyping without requiring full-stack development expertise.

Divi is a popular WordPress theme and visual page builder developed by Elegant Themes. It allows users to design websites using a drag-and-drop interface without coding. With its real-time visual editor, you can customize layouts, fonts, colors, and content easily. Divi includes hundreds of pre-made templates and responsive design options. It's widely used by beginners and professionals for building modern, flexible, and visually appealing websites.

This choice aligns with the project's goal of fostering a platform that can be maintained and extended by multidisciplinary teams, including those with limited web development backgrounds.

Key technical characteristics of the implementation include:

- **Divi's Advanced Visual Builder:** Each of the three mockups was constructed using Divi's front-end visual editor, allowing the design team to experiment with different layout logics (tile-based, circular, dashboard-style) in an intuitive drag-and-drop environment. Divi's built-in responsiveness ensured compatibility with mobile and tablet devices, a requirement for stakeholder accessibility.
- **Modular Architecture Using WordPress Blocks and Shortcodes:** All modules (M1–M5) and VREs were implemented as modular content blocks using Divi sections, WordPress widgets, and custom shortcodes. This approach ensured high flexibility for layout restructuring and future integration of live services.
- **Custom Iconography and Thematic Colour Coding:** A custom visual identity was applied to differentiate between the modules and VREs. Marine environments use a deep blue (#003366), Fresh Water uses light blue (#00B3E6), and Terrestrial environments are represented by green tones (#339966). This visual differentiation aids usability and thematic clarity.
- **Embedded Animations and Hover Interactions:** Basic animations and hover-triggered effects were added to improve user experience, particularly in the radial and tile-based mockups. These micro-interactions help guide user attention and reinforce the modular structure.
- **Support for Multilingual Expansion and Accessibility:** The WordPress framework used is compatible with multilingual plugins (e.g., WPML or Polylang), which will allow future internationalisation of the platform. Accessibility settings are being planned according to WCAG 2.1 guidelines.
- **Low-Code Maintenance Model:** All content and layout components are editable without programming. This ensures that content managers, communication officers, or project

coordinators can independently update the SAP as it evolves, without the need for developer intervention.

This technical stack was selected not only for ease of use, but also for its compatibility with external tools, data sources, and APIs. It lays the foundation for future integration of dynamic content such as data visualisations, live dashboards, or AI-powered search. The current implementation already includes an embedded AI chatbot, whose setup is detailed in the next section.

In summary, the technical implementation of the initial SAP mockups demonstrates that a low-code and modular web architecture can effectively support the project's vision: to create an accessible, user-driven, and functionally rich digital environment for biodiversity monitoring and decision support.

6. AI Integration for Project Support

One of the distinguishing features of the initial SAP deployment is the integration of an **AI-powered conversational assistant**, designed to enhance user orientation and provide seamless support across the final mockup version. This virtual assistant represents a forward-looking step in digital infrastructure development, aiming to make the platform more accessible, responsive, and self-explanatory to users with diverse backgrounds.

The chatbot has been implemented using the **OpenAI API**, enabling the use of state-of-the-art natural language processing models. A customised prompt was developed to align its behaviour and tone with the goals of the BMD project. The assistant is accessible from every mockup version, offering real-time support regardless of the layout selected.

Key functionalities and characteristics include:

- **Contextual Awareness:** The bot can respond to questions related to each of the five modules (M1–M5), the three VREs, the structure of the platform, and the general objectives of the BMD project.
- **Document-Based Retrieval:** The bot has been trained with project documentation, including deliverables, milestones, FAQs, and key concepts, enabling it to provide precise and reliable responses based on authoritative sources.
- **Natural Language Dialogue:** Users can engage with the bot using any language, removing the barrier of technical jargon. The assistant is capable of clarifying terms, suggesting navigation pathways, and summarising key functionalities of the SAP.
- **User-Centric Design:** The chatbot interface is minimalist and intuitive, designed to fit within the visual ecosystem of each mockup without distracting from the main content.

From a development standpoint, the AI integration was achieved with minimal code via plugin-based embedding of the OpenAI API key and custom prompt settings. This allows for future scalability, such as multilingual support (European official languages), dialogue logging for improvement, and integration with other project websites or services.

Including this AI assistant reflects the BMD project's commitment to intelligent, FAIR-aligned, and user-oriented infrastructures. By reducing entry barriers and providing on-demand support, the chatbot contributes to a more inclusive and empowering digital experience for all stakeholder categories.
The integration also serves as a testbed for future use of AI in environmental research infrastructures, particularly in domains such as metadata generation, automated tagging, and adaptive content delivery.

7. Stakeholder Testing and Feedback Collection

Visitors to the SAP mockup landing page are invited to **explore each layout and rate them** based on usability and clarity of structure through a general form available in the landing page. This built-in feedback form collects:

- Preference ranking (1 worst–5 best) for each version.
- Stakeholder profile (e.g., site manager, researcher, policy-maker).
- Open comments and suggestions.

This process will inform the iterative refinement of the SAP in future milestones **(D6.2 and beyond).**

8. Next Steps

- Analyse feedback from the stakeholder consultation process.
- Consolidate preferences to define the final layout strategy.
- Develop high-fidelity design and front-end visual consistency.
- Continue testing the AI chatbot and integrate feedback into its training prompt.
- Align with other WPs to integrate VRE functionalities and data services.

9. Summary

Milestone 29 marks the first public deployment of the BMD Single Access Point, with three layout mockups presented to gather user feedback. The focus of this milestone is on **functional navigation and modular representation**, rather than visual branding.
Through an agile, low-code development framework and a strong emphasis on stakeholder co-design, the BMD SAP is positioned to evolve into a highly usable, FAIR-compliant, and community-driven biodiversity data platform.
The results of this milestone will directly feed into Deliverable D6.2 and future iterations of the SAP design and implementation.