14. (D) Annual Report V02

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Short description: This document presents the draft version of the Annual Report 2023 of LW ERIC and supports the discussion item: "14. (D) Annual Report".	
Question(s) to the General Assembly (GA): The Executive Board invites the General Assembly to endorse the above LifeWatch ERIC Annual Report 2023.	

LifeWatch ERIC Draft Annual Activity Report
Period of operation: 2023

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Foreword by Vice Chairperson of General Assembly

I was given the privilege to be elected as the Vice Chairperson of the LifeWatch ERIC General Assembly in 2023. It is with this authority I have the honour to address the Annual Report of this year. The activities carried out by LifeWatch ERIC, its highlights and milestones achieved, are presented in the following pages.

The year 2023 was a challenging one for LifeWatch ERIC because it went through a serious crisis, which had a severe impact on its smoothfunctioning. Although this situation was caused by unforeseen circumstances, LifeWatch ERIC demonstrated both its resistance and the flexibility needed in order to take brave decisions and implement measures to overcome it. The massive support it received from the partnering countries through their delegations in the General Assembly, as well as from its personnel, was the decisive factor to face this challenge and finally be able to stabilise its long-term sustainability.

In 2023, LifeWatch ERIC multiplied its hitherto Infrastructure both in terms of hardware (e.g. HPC power) and software (e.g. web services and workflows), and continued their consolidation, thus providing the Infrastructure with the attributes of an operational Landmark ERIC. This progress has been reflected also at the level of organisation and of the community. For another year, LifeWatch ERIC continued on its path to develop collaborations with organisations at global, European and national levels, and solidified its positioning in the European Research Area, as well as in the international landscape, as a mature Research Infrastructure on Biodiversity and Ecosystems. Its efforts, in collaboration with other ERICs and Research Infrastructures of the Science Clusters, as well as with the e-Infrastrucutres, demonstrated the potential the European Open Science Cloud can provide to current and future generations of scientists in doing multidisciplinary and cross-domain research.

As a distributed infrastructure, LifeWatch ERIC continues on its vision and mission thanks to the strong commitment of its members, which have been making significant investments at national level. Investments have also been made at the regional level by using the European cohesion funds, thus demonstrating their importance in the sustainability of the ERICs and also in serving societal demands at regional scale. This paradigm was highlighted as exemplary in a report of the ERIC Forum.

In LifeWatch ERIC, we're all much indebted to the commitment of the member countries and the endless efforts of all the people working both in its Common Facilities and the Distributed Centresto make the vision of LifeWatch ERIC to become a reality.

Professor Vladislav Popov,

Vice Chairperson of the LifeWatch ERIC General Assembly

Agricultural University of Plovdiv, Plovdiv, Bulgaria.

Foreword by Chief Executive Officer

During 2023, LifeWatch ERIC was able to complete the consolidation of a large number of its research resources and products. However, 2023 was marked by a deep crisis during which LifeWatch ERIC experienced significant budget deviations, caused by unforeseen circumstances. LifeWatch ERIC was able to overcome this crisis and to secure its long-term financial sustainability thanks to the support of the members of its General Assembly, the adaptive resilience of its personnel to the reforms made, the availability of its reserves and the continuous strengthening of its accounting and financial management framework.

At the Organisation level, progress has been made on the implementation of the Actionable Roadmap, an online monitoring tool for the performance of its Strategic Working Plan. The consolidation of the organisation has been achieved by the Policies, Strategies and Guideline documents produced and operated by an active Quality Management team. LifeWatch ERIC was also strengthened by the hiring of its People and Culture manager, who played an instrumental role in the development of measures to establish a healthy working environment and the personnel reforms to address the impact of the crisis. At the end of the year, LifeWatch ERIC had 46 employees in a perfect gender balance. Finally, the Risk Management Strategy was established and implemented.

The Infrastructure of LifeWatch ERIC has been tremendously increased primarily because ofthe ERDF resources made available by the Junta of Andalusia and the Spanish Government. At the end of the year, LifeWatch ERIC demonstrated a consolidated technical Infrastructure with a large computing capacity, resources and products for the discovery and exploration of FAIR data and information, an ecosystem of reproducible analytical web services, and mylifewatch.eu, a portal for individual researchers and their networks to collaborate and conduct their research. The technologies deployed can flexibly switch between systems using a federating system architecture of high-performance computing (HPC), which also includes GPUs, AI capabilities, as well as resources for short- and long-term data storage.

The number of publications in 2023 almost doubled that of 2022, with half of them occurring in the first quartile of the most impactful journals on the fields of biodiversity and ecology. In addition, LifeWatch ERIC has worked systematically to solidify its presence in the EU and international landscape. In parallel, LifeWatch ERIC completed its task to coordinate the collaboration between all the Science Clusters and their ERICs, the other

Research Infrastructures, as well as the e-Infrastructures in order to explore and prove the potential the European Open Science Cloud has for the development of multidisciplinary and cross-domain research. During 2023 several formal agreements with relevant legal entities at global and regional levels have been signed.

The number of partners with which LifeWatch ERIC had collaborated so far exceeded 250 from 46 countries worldwide. In addition, more than 700 persons were engaged either in LifeWatch ERIC own events or in events organised by others and to which the Consortium significantly contributed. The organisation of the first LifeWatch ERIC Biodiversity and Ecosystem eScience Conference, held in Seville from 22 to 24 May, was a milestone. The conference opening marked the International Day for Biological Diversity, with a dedicated Round Table. Many other events were organised by LifeWatch ERIC in 2023, among which the Semantic Academy intensive school to be the one which consolidated LifeWatch ERIC's position in the fields of data FAIRness and semantic research. The overall performance in communications followed the increasing trends observed in the previous years, while the new Community Platform along with the LifeWatching Science Channel were launched over the year. At the same time, LifeWatch ERIC initiated its Training Strategy.

Finally, seven new projects were awarded to LifeWatch ERIC and kicked-off in 2023. Over the last five years, the EU projects have corresponded to an extra annual budget of 2M€, on average, on the top of the grants from national sources (e.g. ERDF, Spain).

In closing this section, I would like to thank our member countries for their commitment, the members of the General Assembly and those of the Advisory Boards for their support and, finally, our colleagues working both in our Common Facilities and the Distributed Centres for their efforts. We all remain humble servants of the big community of researchers and scientists working on Biodiversity and Ecosystems.

Christos Arvanitidis, CEO,

LifeWatch ERIC,

Seville, Spain.

About LifeWatch ERIC

Vision

The vision behind LifeWatch ERIC is to become the Research Infrastructure providing access to the world's biodiversity content, services and communities in one click.

Mission

LifeWatch ERIC aims to accelerate the research efforts of the scientific community by delivering a European state-of-the-art e-Science Research Infrastructure on biodiversity and ecosystem research: a Digital Twin which

- provides access to, and support for, key scientific services by applying cutting-edge ICT technology,
- enables reproducible analytics,
- is co-designed and co-created with the user communities and
- is tuned with the needs for research that provides key insights for society, in particular science-based policy.

History

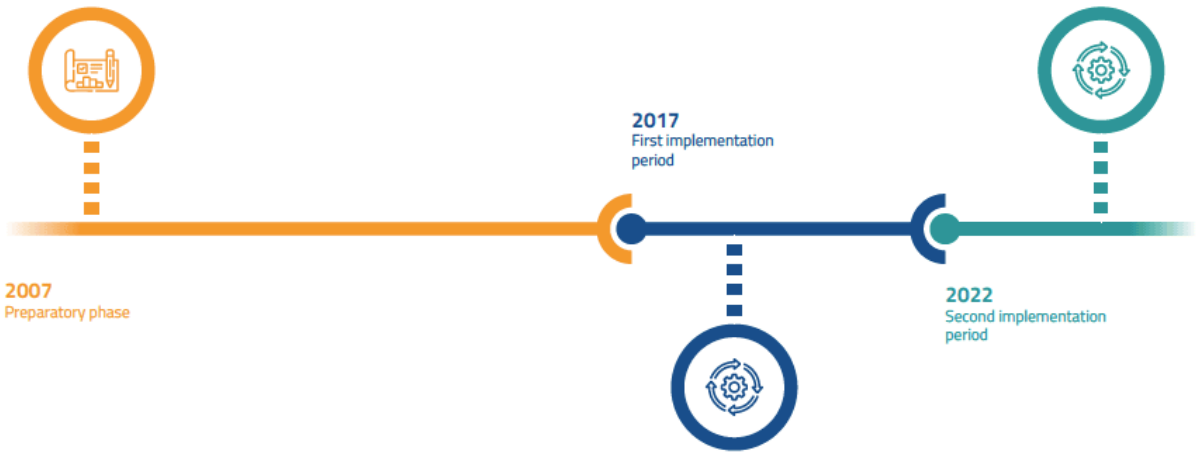

Figure 1. LifeWatch ERIC's timeline

What We Do

LifeWatch ERIC provides integrated solutions to current constraints and impediments affecting biodiversity and ecosystem research, such as the pressing need for increasingly diverse, open and FAIR compliant data, advanced models, analytical services and other research products. It also makes available a collaborative and democratic research space in the form of Virtual Research Environments (VREs). The above elements are the essential ingredients for the exploration of new frontiers in biodiversity and ecological science, and they support society in addressing planetary challenges, such as the impacts of climate change, with evidence-based scientific knowledge and advice.

Specialised Knowledge

A wide variety of expertise is available within LifeWatch ERIC from biological, environmental, earth, agricultural and biotechnologies to data science, information and communication technologies and computer engineering.

Open data and FAIR principles

LifeWatch ERIC fosters the improvement of data, analytical services and other research products in compliance with FAIR data principles to ensure comparable end-to-end scientific approaches, including hypothesis testing.

Semantic Resources and Tools

LifeWatch ERIC has produced its own comprehensive semantic resources and other research products repositories, EcoPortal, and MetaData Catalogue.

Big Data

Simultaneous access to multiple resources (**7**) including global aggregators, with 1,512 datasets is also provided, along with various options for their discovery and exploration through cutting-edge technologies (LifeBlock).

Web Services

Reproducible analytical services (**191**), including models, are available through LifeWatch ERIC Thematic Services access point.

Computational Power

Cloud and computational power, and storage capacity are available to support both individual and collaborative research.

Workflows and VREs (vLabs)

The analytical services are often orchestrated in workflows (currently **7**) and Virtual Research Environments (currently **29**) in order to support an end-to-end scientific approach, including hypothesis testing. They are accessible through our Catalogue of Virtual Labs and My LifeWatch.

Training Centre

Currently, **25** webinars and workshops, **12** tutorials, **9** schools and courses have been organised to train users how to make better use of the infrastructure resources, tools and services, focusing on both practice and policy aspects. Related training resources are

available on the LifeWatch ERIC training platform and contribute to the ENVRI Community training offer.

Stakeholder Connection

LifeWatch ERIC serves and interacts with a wide community of stakeholders at all levels, spanning from scientists, researchers and students to environmental managers, policymakers, civil society and the wider public, in order to provide evidence-based knowledge and advise on biodiversity and ecosystems issues.

Biodiversity Management Support

LifeWatch ERIC, through its strong presence within the European Research Area and in European Consortia and Fora, contributes to biodiversity and ecosystem management, monitoring and conservation at local, regional, national and European levels.

Gender, equality and inclusiveness

LifeWatch ERIC has developed and currently implementing a detailed gender, equality and inclusiveness plan, based on the UN principle that nobody should be left behind in humanity's efforts for sustainable ecosystems. The outline of this plan has been adopted by many other ERICs in the framework of the ERIC Forum project. Additional services, serious games and learning platforms supporting citizen science and education, make part of this plan.

Networking

LifeWatch ERIC is actively involved in a dense grid of networking activities, through which it builds its trading zones with the relevant Research Infrastructures, Global aggregators and research networks. This approach leads to production of new knowledge and innovation and ensures access of communities to multi-disciplinary and cross-domain research resources and products.

1. LifeWatch ERIC as an Organisation

A strong organisational structure is the prerequisite for achieving LifeWatch ERIC strategic objectives; this includes all phases from planning and coordination to management and monitoring of all relevant activities.

1.1 Coordination and Planning

The LifeWatch ERIC Strategic Working Plan (SWP) sets the framework of activities to be carried out by the infrastructure until 2026 in order to achieve its strategic objectives. The SWP has been complemented by an Actionable Roadmap (ARM), a tool created to articulate specific elements of the SWP with critical connections between the strategic and specific objectives, priorities, tasks and related activities, monitor progress on deliverables and relevant Key Performance Indicators (KPIs), and prevent risks or mitigate their impact where applicable. This ARM has become a primary implementation and monitoring system, offering a real-time view of all ongoing and future activities.

In 2023, LifeWatch ERIC released one Policy and two Procedures: the **Policy for Intellectual Property Rights (IPR)**, the **Procedures for Internal Audit** and **for Onboarding New Employees**. The IPR outlines definitions, principles, responsibilities of data owners and data providers; the Procedure for Internal Audit defines how LifeWatch ERIC conducts first party audits to assist the monitoring, analysis and improvement of management systems and organisational activities; the Procedure for Onboarding New Employees ensures consistent, harmonised onboarding process, enabling new employees to work in compliance with LifeWatch ERIC's best practices, policies, and principles. In addition, LifeWatch ERIC focused on strengthening the existing policies approved during the previous year. These policies are now part of the day-to-day running of the organisation thanks to the implementation of related procedures and guidelines, such as: Procedures for Recruitment, Prevention of harassment at work and action in case of occurrence, Guidelines for Work Life Balance (for each Common Facility) and Occupational Health & Safety Manual (for each Common Facility).

At the end of 2023, LifeWatch ERIC Management System has established **35** Policies, Strategies and other quality documents, as well as another **16** Guideline documents, and is being actively operated by a Quality Management team.

1.2 Governance

LifeWatch ERIC is a distributed research infrastructure consortium composed of eight European Union Member States (Belgium, Bulgaria, Greece, Italy, Netherlands, Portugal, Slovenia and Spain). LifeWatch ERIC's members operate from national entities, known as Distributed Centres, while its Common Facilities are located in three Member States: Spain (Statutory Seat & ICT-Core), Italy (Service Centre) and the Netherlands (Virtual Laboratories and Innovations Centre).

Statutory bodies

The **General Assembly** is the highest governing body in charge of the overall direction and supervision of infrastructure activities and is composed by representatives of all the member

states of the consortium. It recommends the polices and internal rules necessary to ensure the smooth functioning of LifeWatch ERIC.

The **Executive Board** is responsible for day-to-day management, ensuring the consistency, coherence and stability of the infrastructure services and coordination between the Common Facilities and Distributed Centres.

Subsidiary bodies

The **Scientific and Technical Advisory Board (STAB)** provides recommendations on the scientific, technical and ethical quality of the LifeWatch ERIC activities.

The **In-Kind Contribution Committee (IKCC)** addresses matters related to in-kind contributions and carries out the valuation of in-kind contributions.

The **Financial Committee (FINCOM)** provides recommendations to the General Assembly in relation to LifeWatch ERIC financial management and adherence to the Financial Rules.

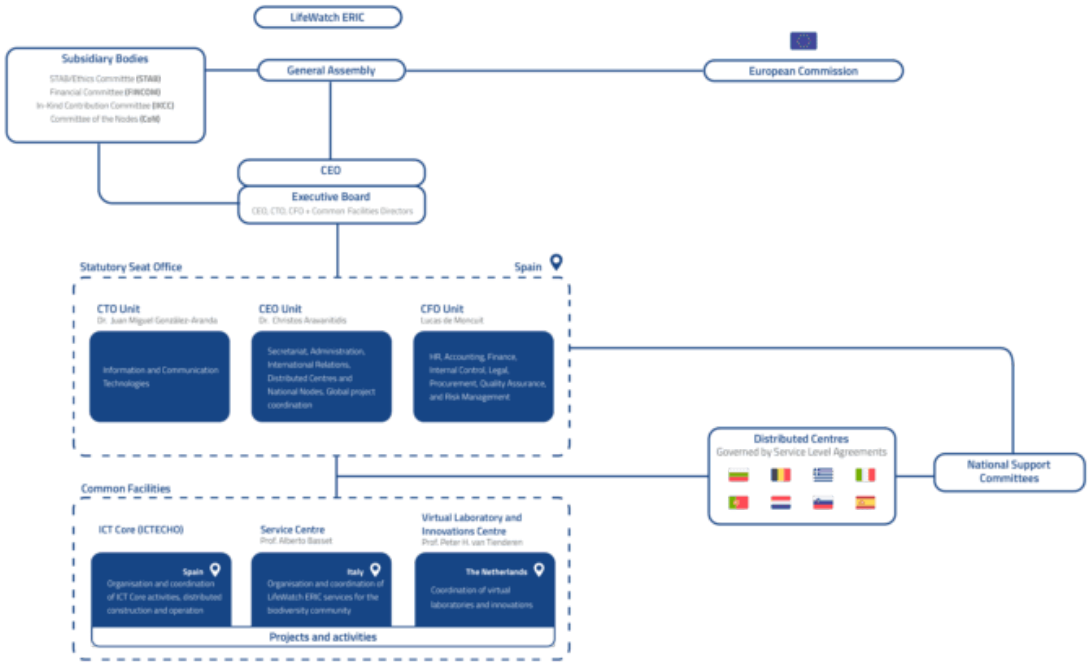

Figure 2. Governance scheme

1.3 Employment Structure

LifeWatch ERIC's personnel is distributed among its three Common Facilities and consists of directors, officers and employees with international, long-standing experience and expertise, as well as multidisciplinary skills. These skills span from IT, scientific and technical profiles, to

EU project management, administration and finances, communication and training.

The number of employees reached **46** by the end of 2023. The gender balance among employees is 50/50, that is **23** males and **23** females. Their distribution within the Common Facilities is: SSO: **10**; ICT Core: **14**; Service Centre: **17**; Virtual Laboratories and Innovation Centre: **5**.

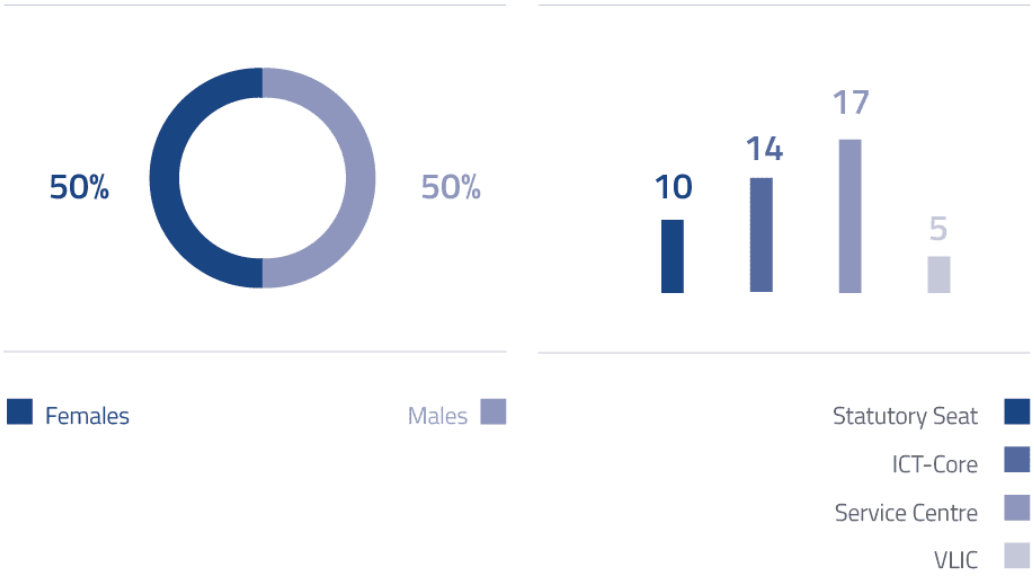

Figure 3. Staff breakdown by gender and Common Facility

The People & Culture area (also known as HR) has worked on the consolidation of a high-performance work team to ensure the sustainability of the organisation through different actions:

- Recruitment of a full-time People & Culture Manager.
- Identification of misconducts, development and implementation of mitigation measures, to establish a healthy working environment.
- Investment in human capital and capacity building plans, to bring out the maximum potential of the employees.

The training of internal staff has been deemed as critical for the professional growth and the strengthening of staff capacities and skills. Through the collaboration between HR and the Training Team, this view has reflected in the concept and planning of the LifeWatch ERIC Training Strategy. An initial programme dedicated to the infrastructure personnel was developed and implemented in the field of Gender Equality and Gender Analysis into

Research.

1.4 Environmental and Energy policy

LifeWatch ERIC is deeply committed to sustainability and environmental responsibility, to reducing the carbon footprint and energy consumption. Key initiatives and practices implemented include:

1) Blockchain Technology: It is based on the Besu standard, which utilises a Proof of Stake (PoS) mechanism, which is energy-efficient and does not require extensive computational work.

2) Remote Working and Reduced Travel: LifeWatch ERIC has embraced remote working policies and practices, significantly reducing the need for physical office space and the associated energy consumption. By leveraging digital communication and collaboration tools, LifeWatch ERIC maintains high productivity and engagement levels of its personnel.

3) Energy Consumption in Common Facilities: While direct control over the energy consumption of the buildings occupied may be limited, LifeWatch ERIC is committed to advocating for and supporting energy-efficient practices within these facilities. It explores possibilities for reducing energy use and implementing sustainable practices wherever possible, and continuously seeks opportunities to relocate activities to more energy-efficient environments.

4) Collaboration with Environmentally Conscious Partners: LifeWatch ERIC actively seeks partnerships with organisations that prioritise environmental sustainability. A sound example is its collaboration with the University of Amsterdam (UVA), known for its commitment to becoming climate neutral.

1.5 Finances

The long-term financial plan of the infrastructure is part of the five-year Strategic Working Plan adopted in 2022. Despite having experienced significant budget deviations from 2021 to 2023, caused by unforeseen circumstances, the long-term financial sustainability of the organisation is secured thanks to the availability of reserves. In addition to a strict budget discipline, the continuous strengthening of the accounting and financial management framework allows the organisation to closely monitor its financial

capacity and plan for the short- and long-term achievement of its objectives.

LifeWatch ERIC's consolidated Financial Statements are audited, each year, by an external auditor and then submitted for approval to the General Assembly, while project budget may be subjected to independent auditing according to project's requirements. The Finanacial Statements of 2023 are provided at the end of the Annual Report.

In order to respond to the increase of its costs, primarily caused by the higher rates of inflation, and to strengthen the presence of LifeWatch ERIC in its relevant scientific fields, the Executive Board has been actively promoting the participation of the infrastructure in EU funded projects, based on well-defined criteria. LifeWatch ERIC has also actively pursued and benefitted from grants from national sources (e.g. ERDF, Spain), which over the period of 2021-2023 allowed LifeWatch ERIC to receive an additional **17M€** budget in projects. Moreover, the EU projects correspond to an extra annual budget of **2M€**, on average, over the last five years.

1.6 Risks and Quality Management

To ensure effective and consistent management of risk management activities within LifeWatch ERIC, a Strategy for Risk Management was established. This new strategy document adheres to the ISO 31000 Risk Management Guideline along to other best practices. Its aim is to proactively manage risks as part of the SWP, and to do it is supported by a risk register.

The risk register is revised bi-monthly to ensure the effective deployment of all necessary activities. Furthermore, any lessons learned, including mechanisms, strategies, approaches, and techniques observed during the evolution of a risk event, is systematically analysed, thus increasing the organisation capacity to anticipate potentially critical situations and creating a mechanism for continuous improvement of its management system and processes.

1.7 Deliverables

Priority	Task	Deliverable	Type*	Date
LifeWatch ERIC as an Organisation	Task 1.1. Upgrade of the Management System	D 1.6: Revised and structured regulatory and	R	M18

		quality documentation of LifeWatch ERIC following Quality Management System rules		
	Task 1.3. Distributed Centres (DCs)	D1.7: Governance schemes of both CFs and DCs published on the website	R	M24
	Task 1.4. Development of organic links and dependencies between CFs and DCs	D1.8: Updated mechanisms for coordination of the activities between CFs and DCs, including RIC, published on the website	R	M24

*R: Document, report (excluding the periodic and final reports), DEM: Demonstrator, pilot, prototype, plan designs, DEC: Websites, patents filing, press & media actions, videos, etc., OTHER: Software, technical.

2. LifeWatch ERIC as an Infrastructure

LifeWatch ERIC is at work to bring its infrastructure to the next level, implementing the transformation from its prototype to the next-generation Infrastructure on biodiversity and ecosystem research that achieves a maximum production, meets the quality standards, and adresses requests for the needs of projects, communities or individual scientists or developers.

2.1 Scientific Excellence

LifeWatch ERIC has a clear identity and a unique niche within the ESFRI landscape of Environmental Research Infrastructures. It is the only e-Science Infrastructure dedicated to supporting biodiversity and ecosystem research at national, European and global levels. These concepts are multidimensional: biodiversity is studied across the many levels of the biological organisation (from genes to ecosystems), as well as across scales of observation (geographic, temporal and functional), and ecosystems include a multitude

of abiotic, biotic and socio-economic variables, which interact between and among them.

To allow the investigation of this complexity, LifeWatch ERIC deploys cutting-edge e-infrastructure technology which federates FAIR compliant data, reproducible analytical services and mobilised research communities, and which generates new knowledge and innovation. Virtual Research Environments (VREs) provide the required resources (*technological push*) to researchers to test their hypotheses and ultimately derive evidence-based knowledge (*scientific pull*). As the VREs include resources from multiple disciplines or even domains, enable the testing of the same hypothesis with multiple data sources and analytical services and the production of knowledge that comes from evidence produced by those disciplines or domains, which is called *synthetic knowledge.*

The results of this process have contributed to the advancement of various fields in biodiversity and ecosystem research at national, European and even global levels, such as the macroecology, agroecology, aquatic ecology, invasive taxa and marine ecology. Equally, this process has contributed to the advancement of engineering topics such as semantics, blockchain and text mining, with the corresponding services developed by LifeWatch ERIC to be operational.

The number of peer-reviewed articles referring to LifeWatch ERIC has almost doubled in the first two years of the second implementation cycle (2022-2026) with respect to the entire previous one (2017-2021). The number of publications had almost been doubling in 2023, as compared to that of 2022, with half of those from 2023 occurring in the first quartile of the most impactful journals on the fields of biodiversity and ecology.

2.2 E-NEEDS

The core ingredients of LifeWatch ERIC e-infrastructure are: open FAIR data, reproducible analytics and mobilised communities. Its development has been guided by a *holistic approach* that employs agile and cross-cutting solutions and addresses the researchers' needs *from measurement to manuscript*, as opposed to *piecemeal development* and addressing issues one at a time. LifeWatch ERIC actively consolidates national repositories along with European and global aggregators (e.g., GBIF, eLTER, DiSSCo, Zenodo, Rediam), which adhere to current data standards, are uploaded onto searchable platforms (federated, semantic, and AI-based), and comply with the FAIR principles (BlockChain-based Science Knowledge Graph (SKG)). There is an ongoing evaluation of the degree of maturation of new repositories, towards the seamless integration and utilisation of data within the LifeWatch ERIC ecosystem. Technologies deployed can

flexibly switch between systems using a federating system architecture of high-performance computing (HPC), which includes GPUs, AI capabilities, as well as resources for short- and long-term data storage. These systems are interconnected. A continuous monitoring of potential future needs is in place. The following overview shows the e-Infrastructure components at the end of 2023.

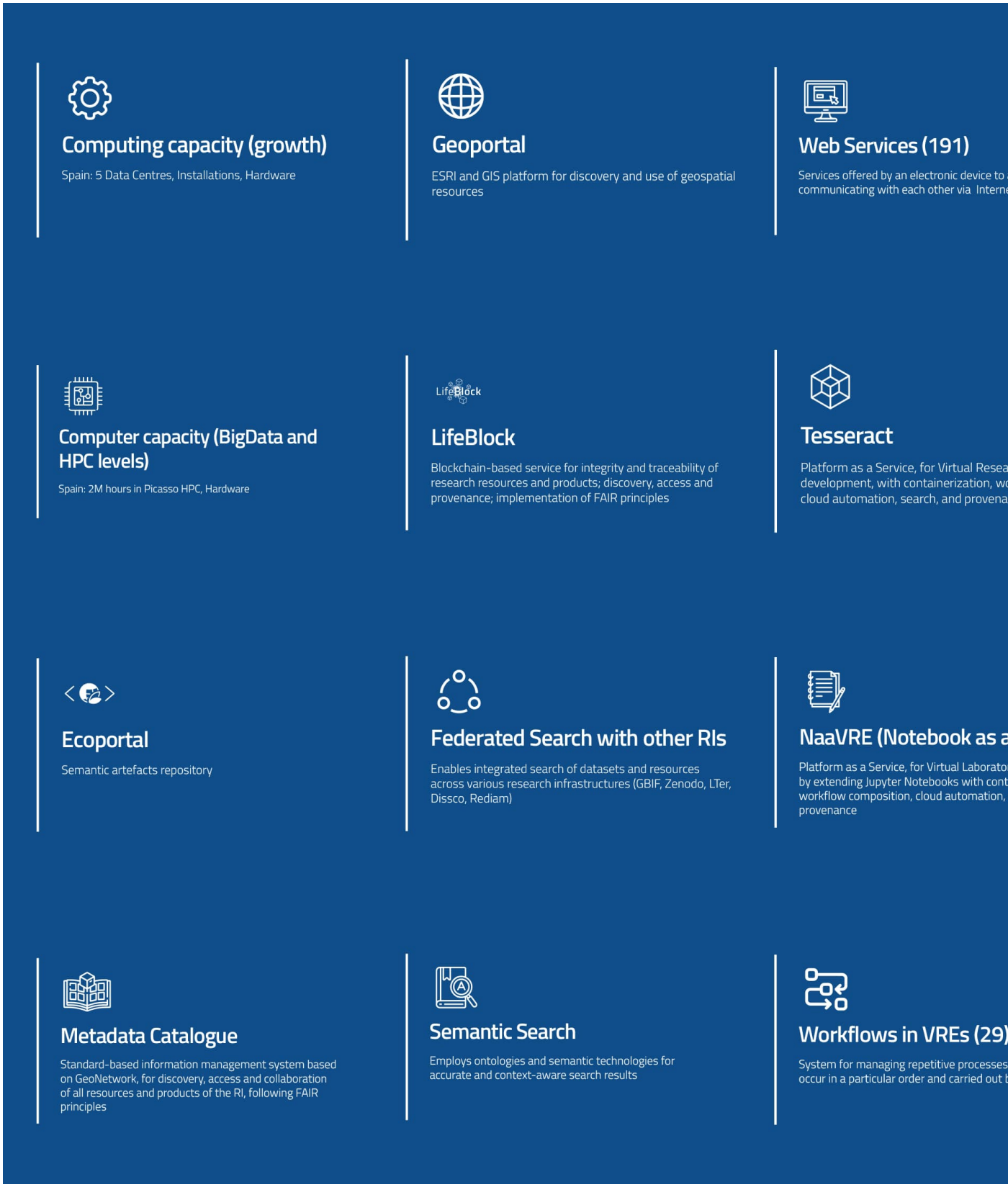

Figure 4. Overview of LifeWatch ERIC resources and services

2.3 Deliverables

Priority	Task	Deliverable	Type*	Date
LifeWatch ERIC as an Infrastructure	Task 2.1. Implementation of industrialisation plan	D2.3: Set of upgraded and new core and analytical services, commonly produced by CFs and DCs, available on the LifeWatch ERIC Infrastructure	DEM	M24
	Task 2.2. FAIR LifeWatch ERIC research data and products	D2.4: Enhanced and updated metadata and service catalogues	DEM	M24
	Task 2.4. Thematic Services	D2.5: Set of upgraded and new Thematic Services available on the LifeWatch ERIC Infrastructure	DEM	M24

*R: Document, report (excluding the periodic and final reports), DEM: Demonstrator, pilot, prototype, plan designs, DEC: Websites, patents filing, press & media actions, videos, etc., OTHER: Software, technical.

3. LifeWatch ERIC as a Community

LifeWatch ERIC continuously works to strengthen its ties and foster the engagement of relevant scientific communities, developers, stakeholders and individual scientists and citizen scientists through a co-design and co-development process.

3.1 Pan-European relevance

In 2023, LifeWatch ERIC continued to promote the development of the collaborative interfaces, or *trading zones*, both within and across the European Open Science Cloud (EOSC) Science Clusters, by coordinating the implementation, evaluation and sustainability of their ten Science Projects (SPs), all with multidisciplinary and cross-domain research activities. This leadership role of LifeWatch ERIC has continued into the

next phase of EOSC projects. LifeWatch ERIC also supported the consolidation of the European RI landscape, through a number of actions:

1) Synergistic development with other RIs and e-Infrastructures, through EU projects and proposals in the Horizon Europe Research Framework programmes, e.g.: EOSC Future, EOSC Beyond, OSCARS, OSTrails, ENVRI Plus and ENVRI Hub Next;

2) Participation in the BiCIKL project, in which ERICs, RIs, global aggregators and networks, join forces in order to create a unique European Biodiversity Knowledge Hub, as a single access point for taxonomic information;

3) Enhancing the dialogue with other ERICs, RIs, global aggregators, networks and other similar providers, towards using existing research resources and products, as well as co-designing and co-developing new ones (e.g. the ARMS workflow, jointly developed with EMBRC);

4) Installation of LifeWatch ERIC Science Knowledge Graph (SKG), which allows the integration of the infrastructure's own resources and products, as well as to federate those made available by other ERICs, RIs and global aggregators;

5) Consolidation of national efforts into the European landscape through multiple activities and their resulting deliverables, as described in the SWP, fueled by both the in-cash and in-kind contributions from the member countries within European consortium.

3.2 Institutional relationships

Memoranda of Understanding (MoUs) and Memoranda of Cooperation (MoCs), signed with other ERICs, RIs, and actors at global, European and national level, are considered by LifeWatch ERIC as one of the most effective ways to enhance the collaboration and foster the engagement of key institutional actors in the European Research Area (ERA). During 2023, seven formal agreements had been signed with globally and regionally relevant organisations, such as the International Union for Conservation of Nature (IUCN), the Latin American Cooperation of Advanced Networks (RedCLARA), OpenAIRE, the ENVRI Community, the Inter-American Institute for Cooperation on Agriculture (ICCA), the Cooperatives of the Americas (COOP), the Senckenberg Society for Nature Research (Germany), and the University of Huelva (Spain).

3.3 Scientific networking

LifeWatch ERIC acts as a partner and service provider in numerous projects which involve many users from a large variety of communities within and across RIs, organisations, projects and initiatives. These communities and beneficiaries vary from EU Member States to global scale and intergovernmental organisations, which in 2023 reached more than **250** unique partners from **46** countries worldwide. Inclusivity, equity and science diplomacy are the essential elements behind LifeWatch ERIC approach in scaling up the usability of its resources and services worldwide.

In 2023, over **700** persons were engaged either in LifeWatch ERIC own events or in events organised by others and to which the Consortium significantly contributed. The majority of these persons were researchers from the national LifeWatch ERIC Communities (e.g. BEeS Conference) or active in particularly relevant fields, like: ecologists (e.g. participation to the British Ecological Society Annual Meeting), marine biologists (e.g. involvement in EMODnet workshops) and scientists and ICT engineers, working on Data FAIRness, semantics and ontologies (e.g. Semantic Academy and workshops).

The national LifeWatch ERIC communities were further engaged in the RI activities, particularly on the Thematic Services, as defined in LifeWatch ERIC SWP. The National Distributed Centres played a pivotal role in identifying the most relevant themes among those proposed and were invited to take the lead and co-designing the future thematic services of LifeWatch ERIC along with the Commmon Facilities. The first activities of this initiative consisted in a series of workshops, co-organised with NDCs, which will be implemented in the first half of 2024.

In addition, the involvement of the new generation of scientists with LifeWatch ERIC activities is one of the cornerstones of its engagement strategy. Accordingly, four fellowships on the theme of invasive non-native species were funded for early career researchers in 2023.

Top 5 Publications

Chen, Q., Timmermans, J., Wen, W., & van Bodegom, P. M. (2023). Ecosystems threatened by intensified drought with divergent vulnerability. *Remote Sensing of Environment*, 289, 113512. https://doi.org/10.1016/j.rse.2023.113512

Arroyo-Correa, B., Jordano, P., & Bartomeus, I. (2023). Intraspecific variation in species interactions promotes the feasibility of mutualistic assemblages. *Ecology Letters*, 26(3),

448-459. https://doi.org/10.1111/ele.14163

de Koning, K., Broekhuijsen, J., Kühn, I., Ovaskainen, O., Taubert, F., Endresen, D., Schigel, D. and Grimm, V. (2023). Digital twins: dynamic model-data fusion for ecology. *Trends in Ecology & Evolution*, 38, 916-926. https://doi.org/10.1016/j.tree.2023.04.010

Forzieri, G., Dutrieux, L.P., Elia, A., Eckhardt, B., Caudullo, G., Taboada, F.Á., Andriolo, A., Bălăcenoiu, F., Bastos, A., Buzatu, A. and Dorado, F.C. (2023). The Database of European Forest Insect and Disease Disturbances: DEFID2. *Global Change Biology*, 29(21), 6040-6065. https://doi.org/10.1111/gcb.16912

Cosmo, L.G., Assis, A.P.A., de Aguiar, M.A., Pires, M.M., Valido, A., Jordano, P., Thompson, J.N., Bascompte, J. and Guimarães Jr, P.R. (2023). Indirect effects shape species fitness in coevolved mutualistic networks. *Nature*, 619(7971), 788-792. https://doi.org/10.1038/s41586-023-06319-7

IPR and User Access

LifeWatch ERIC has issued its Policy for Intellectual Property Rights, after being approved by the General Assembly in October 2023. This has been the product of a long dialogue between all interested parties in its Common Facilities and Distributed Centres. A dedicated Working Group had been appointed to complete this Policy. The rationale of the Intellectual Property Rights (IPR) policy is that the contribution of LW to scientific knowledge depends on data quality, openness and compliance with the FAIR data principles. Re-usability of FAIR scientific components is addressed through the licensing of data (CC-0; CC-BY), software and other research products. Openness and compliance with the FAIR principles significantly contribute to *innovation* and *synthetic knowledge*. The policy includes: definitions of the relevant terms, principles for the application of open licenses and related matters, principles of LW's IPR and Data Policy, responsibilities of data owners and providers, additional conditions and provisions. The policy is being reviewed in the light of the recent EU Artificial Intelligence Act.

LifeWatch ERIC has established a single access point to its resources and services, browsable through a web portal. Its help desk facilitates users to learn how to use what they need. LW currently offers open and free access, without central access programme or dedicated funding. The Authentication and Authorisation Interface (AAI) has been developed in order to be federated into EOSC to allow access to its resources and products, therefore EOSC-ready. A degree of restriction for users outside LW member

countries is likely to be introduced, as prospected in the new Business Plan draft.

3.4 Communication

The year 2023 opened with the creation of the renewed LifeWatch ERIC Communication Strategy and Plan, which was produced by following an inclusive approach, benefitting from the input of all National Distributed Centres Communicators. The renewed strategy provides a strong framework for all dissemination and outreach activities of the infrastructure for the current quinquennium. Another milestone reached during the year is the organisation of the first LifeWatch ERIC Biodiversity and Ecosystem eScience Conference (BEeS) held in Seville from 22 to 24 May. The conference opening marked the International Day for Biological Diversity, with a dedicated Round Table. The event gathered more than **120** participants from **13** different countries and hosted **60** talks, with the satisfaction rate of the attendees reaching **4.5/5**. The BEeS abstract book is available on LifeWatch ERIC's website. Among the unique events organised by LifeWatch ERIC there is the Semantic Academy. The Intensive School was built based on the successful experience of six summer and winter schools, co-organised by LifeWatch ERIC since 2018, and consolidated LifeWatch ERIC's position in the fields of data FAIRness and semantic research.

Overall, the communication performance of LifeWatch ERIC in 2023 follows the positive trend observed in previous years on online communication channels with **117,999** (+**11,53**%) website visits, **4,383** (+**23.32**%) followers on its social media channels and **6,200** newsletters delivered to users' mailboxes. The year 2023 also witnessed the launch of the new Community Platform and the consolidation of the LifeWatching Science Channel (with over **11,000** views). The narrative and high quality contents produced in-house by LifeWatch ERIC and LifeWatch Italy Multimedia Production Centre proved to be a very fruitful resource for the communication and dissemination of the infrastructure, as well as a trump card for the reinforcement of its community. The podcast Series "A window on Science", now available and browsable by topics, doubled its dissemination performance within the year, reaching **1,720** downloads. The podcast series provided a new space for scientists and researchers to join the current debate on biodiversity, ecosystems, e-science and disruptive technologies, as well as societal issues, like gender equality. Finally, LifeWatch ERIC stabilised its position as a reference RI for science communication in the ERA, playing a pivotal role in the dissemination activities of the many European projects in which the infrastructure is involved.

3.5 Training

The year 2023 represents a pivotal moment for LifeWatch ERIC training activities, as all efforts and steps made to lay the foundations of a long-term training and education strategy. The draft of the Training Strategy and Plan has been initiated and the first steps of its implementation resulted in the consolidation of the relevant services of the infrastructure. This draft was subsequently developed through an inclusive and collaborative process that integrated the perspectives of Common Facilities and National Distributed Centres. Accordingly, these consolidated services provided the infrastructure with a component that will enhance its training, education and capacity building initiatives in the years to come. It will do so also by expanding the role of LifeWatch ERIC, both as training hub and provider for biodiversity and ecosystems research communities, as well as for its staff.

In 2023, the role of LifeWatch ERIC as training provider materialised in: (a) the organisation of in-person events such as (i) the first edition of the Semantic Academy School and the Ontoportal Alliance Workshop held in September, and (ii) the EMODnet Data School held in November, that involved a total of **65** participants from Europe and beyond; (b) the delivery of virtual initiatives such as projects-related trainings, webinars and workshops (EOSC-Future, ENVRI FAIR, BioDT, DOORS and SUBMERSE); (c) the promotion, in collaboration with the Human Resources function, of internal staff capacity development sessions on gender equality (based on the LifeWatch ERIC Gender Equality Plan) and Integration of Gender Analysis into Research (IGAR).

The role of the training hub was further strengthened with the launch of a new Training Platform area dedicated to international projects, and the subsequent development of customised sections to host project-specific training resources, becoming the home of the training contents of the afore-mentioned projects.

Over the year, the infrastructure also started the consolidation of organisation-wide training standards and guidelines with the design of tailor made templates for the creation of tutorials and user support contents for LifeWatch ERIC products and services.

Finally, the Training Working Group monthly meetings ensured the coordination of all efforts with the National Distributed Centres, while renovated efforts were conducted for the internationalisation of the Master programme on e-Biodiversity and Ecosystem Sciences (eBES) with the fostering of agreements with Agricultural University Plovdiv and Pablo de Olavide University, in October.

3.6 Deliverables

Priority	Task	Deliverable	Type*	Date
LifeWatch ERIC as a Community	Task 3 .1. Co-development with the communities	D3.1: MoUs and MoCs with networks of scientific communities, other ERICs, RIs and other global actors singed	R	M24
	Task 3.2. My.LifeWatch initiative (personalised science)	D3.2: Report on the users and policy requirements: plan and process for its implementation	R	M18

*R: Document, report (excluding the periodic and final reports), DEM: Demonstrator, pilot, prototype, plan designs, DEC: Websites, patents filing, press & media actions, videos, etc., OTHER: Software, technical.

4. Industrialisation, Technology Transfer and Innovation

A sound Industrialisation strategy is a prerequisite for the promotion of LifeWatch ERIC Research and Innovation resources as a market place and for forging collaboration with the relevant public and private sector actors, including the industry, by supporting knowledge and technology transfer mechanisms.

4.1 Stakeholder commitment

Until recently, the primary effort of LifeWatch ERIC was on the development and consolidation of its research resources and products, through the construction of its infrastructure, and on reaching a proper Technology Readiness Level (TRL) to enter its industrialisation phase. During the construction phase, LifeWatch ERIC has been collaborating with key service providers from the private sector in order to complete specific tasks in various areas (IoT, Blockchain, cybersecurity, cloud computing, AI, etc.). These collaborations have generated significant intellectual property owned by LifeWatch

ERIC. Over the last months of the year, LifeWatch ERIC had initiated the work on the Technology Readiness Level (TRL) assessment framework towards identifying the technologies suitable for collaboration with the private sector and industry. The Transfer of Technology and Innovation Strategy (TTIS) forms one of the four Priorities of the SWP and will be completed in the next year. The development of an operation unit for its implementation, the market analysis to assess the maturity and reception of the technology being built, the potential market and other interested parties, as well as the contribution to the preparation of a new generation of employees for the industry, are essential parts of the Strategy. Despite the lack of its TTIS, LifeWatch ERIC has already been able to efficiently make available part of its technology to research communities and the public and private sectors for operational use. For the time being, much of the organisation intellectual property is openly distributed through publications, FAIR data and open source software, through open source licenses. Licensing of open source technologies for operational use has led to funding opportunities (EU projects, ERDF) as well as external exposure (publications).

4.2 European projects

Horizon 2020 and Horizon Europe

In 2023, LifeWatch ERIC had been involved in **21** European Projects. Seven new projects were awarded to LifeWatch ERIC and kicked-off during the year: PERMAGOV, ANERIS, eDNAquaPlan, DTO-BioFlow, ERIC-Forum 2, Path2DEA, and SUBMERSE (highlighted in orange in the image below).

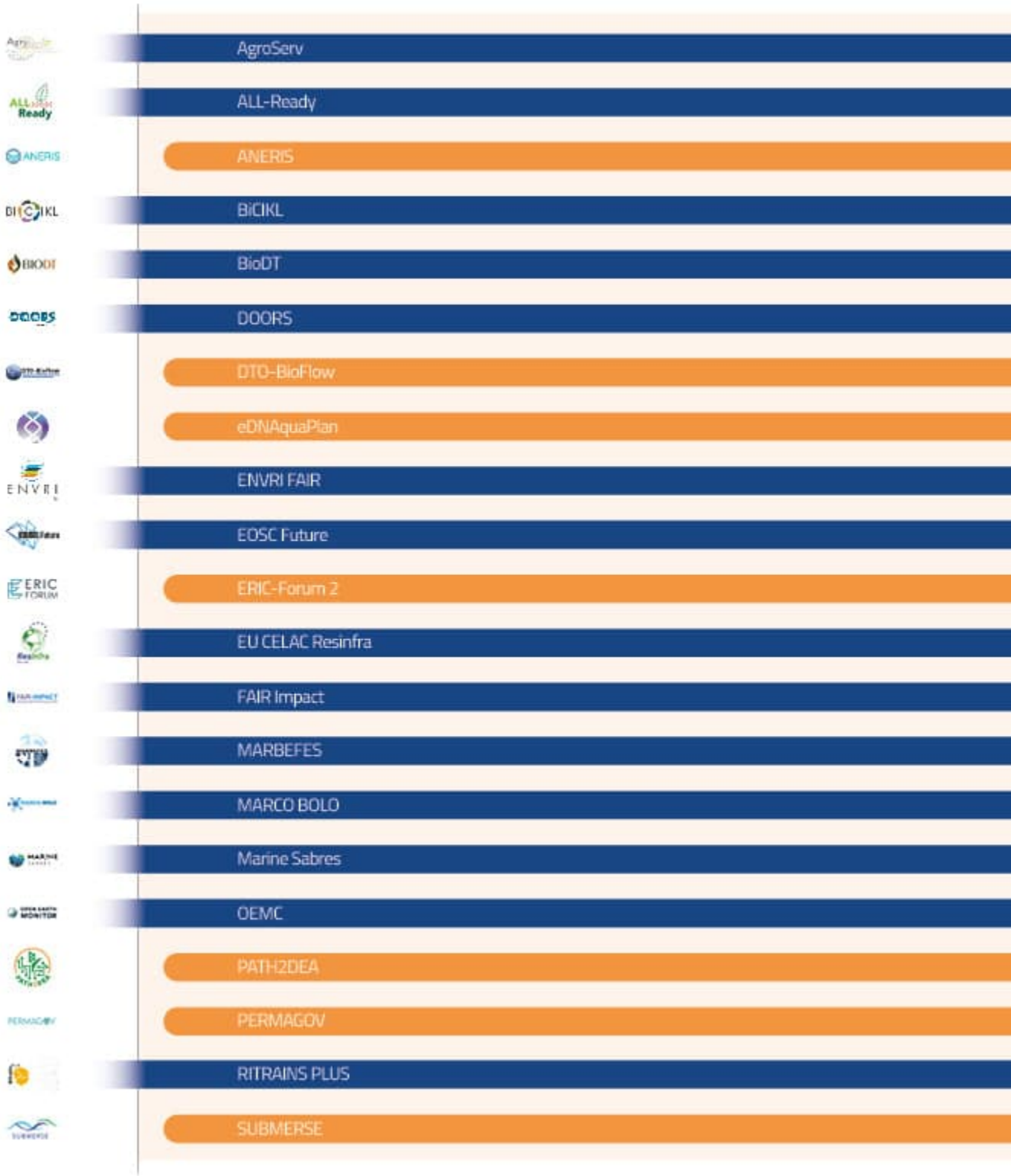

Figure 5. Overview of European Projects

ERDF

The LifeWatch ERIC action line co-financed by ERDF within the framework of the POPE-2014-2020 operational program consisted of 6 projects started between December 2021 and January 2022, all completed in the last quarter of 2023.

LifeWatch ERIC has achieved important milestones of its co-construction process within the framework of the ERDF projects such as MyLifeWatch, LifeBlock, and Fiware. They are all accessible through APIs from external applications, enhancing integration capabilities. These services are distributed across five data centres established within ERDF projects, located in Matalascañas (eBric), CICA (Sevilla), University of Granada, and Picasso and Ada-Byron (Málaga). Notably, eBric, situated in Parque Dunar (Matalascañas, Huelva), acts as the main management node for all services provided by LifeWatch ERIC, it has been completely refurbished and adapted to meet the demands of a modern data processing centre within the scope of the developed ERDF projects.

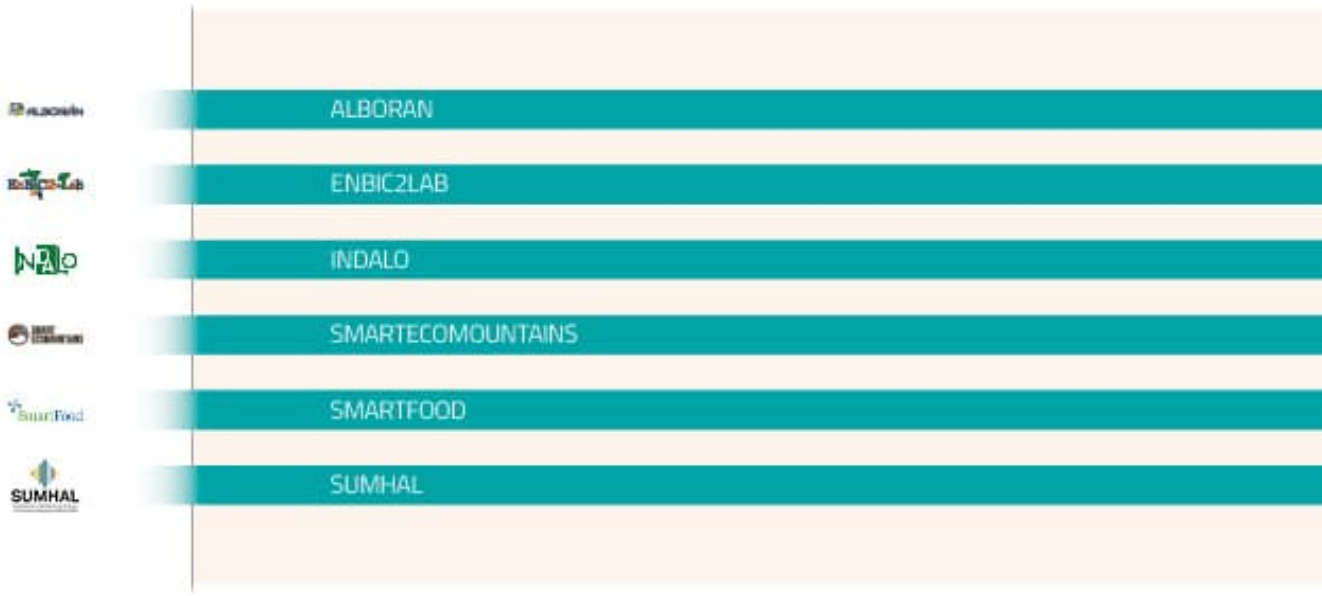

Figure 6. Overview of ERDF Projects

4.3 Deliverables

Priority	Task	Deliverable	Type*	Date
Industrialisation, Technology Transfer and Innovation	Task 4.2. Technology Transfer and Innovation Strategy (TTIS)	D.4.2: Technology Transfer and Innovation Strategy (TTIS)	R	M20
		D.4.3: Report on the assessment of transfer methods available for LifeWatch ERIC products and services	R	M24

*R: Document, report (excluding the periodic and final reports), DEM: Demonstrator, pilot, prototype, plan designs, DEC: Websites, patents filing, press & media actions, videos, etc., OTHER: Software, technical.

5. Key Performance Indicators (KPIs)

KPIs	Description	Measure
Strategic Objective1: To industrialise and support the knowledge & technology transfer mechanisms of the existing prototype LifeWatch ERIC Research Infrastructure at all levels: scientific, technical, communication, innovation, administrative and financial (from current Technology Readiness Level (TRL) 6 to TRL 9).		
KPI 1.a: Number of users per VRE	Number of downloads/studies or provisions of service. *Expected performance: On average, 30-50 users per year per VRE.*	**Workflows** executed **560** **67** users per VRE
KPI 1.b: Number of user request for access	Request for access as a function of new resources published and operated by LifeWatch ERIC per year. *Expected performance: Hundreds of users requesting access to 30-50 new resources per year.*	**Registered users** Total: **1,450** In 2023: **802** **Users** Total: **13,571**

		In 2023: **3,253** **Sessions** Total: **17,853** In 2023: **1,900**
KPI 1.c: Number of new projects and private sector partners involved in co-construction processes and percentage of revenues from contracts, economic activities in the annual accounts	Any kind of economic activities: Projects, Private Sector and Industry related services provision, common capital ventures, etc. *Expected performance: As much as 20% of the total in-cash investment on a yearly basis, with an average of 2 new activities and 5 new partners per year.*	**75** new partners, collaborating with LifeWatch ERIC in the framework of projects, in 2023. In 2023, almost 50% of the total budget of the ERIC came from projects. **Revenues** (private sector): 0, TTIS in development
Strategic Objective 2: To consolidate and broaden LifeWatch ERIC e-Infrastructure towards the integration of all content, services and other assets (e.g. installations, hardware, software, observatories), currently existing in the member states and the new ones, into a single RI which offers an open, creative and democratic space to the users.		
KPI 2.a: Number of resources managed and operated by LifeWatch ERIC (installations, hardware, software, observatories)	Web services available on LifeWatch ERIC web portal, which are fully operational. *Expected performance: On average, 30-50 new services per year, accessed by hundreds of users.*	Total: **190** web services In 2023: **66** new web services
KPI 2.b: Number of publicly available data sets (% of FAIR-compliant data)	Number of FAIR datasets produced as a percentage of the total number of data sets produced. *Expected performance: On a yearly basis, 30-50 new datasets accessed by hundreds of users.*	Total: **1,510** datasets **98.34%** of them are **FAIR** compliant) In 2023: **12** new datasets
Strategic Objective 3: To consolidate and broaden LW ERIC e-Infrastructure towards the integration of all content, services and other resources (e.g. installations, hardware, software, observatories), currently existing in the member states as well as the new ones, into a single RI which offers an open, creative and democratic space to the users.		
KPI 3 Publications	Number of publications based on the	Total number of

	research performed using concepts/facilities/resources, etc. of LifeWatch ERIC. *Expected performance: 30-50 new publications per year.*	publications: **490** Publications in 2023: **148**; out of which, **102** in the first quartile of the most impactful journals on the scientific field
Strategic Objective 4: To deepen the engagement of the scientific communities (with attention to inclusivity and equity), biodiversity and ecological observatories, stakeholders and citizens, at global scale.		
KPI 4.a Engagement achieved by direct contact (e.g. events, booths, etc.)	Outreach by public relations/direct contact with specific target groups: organisation of (e.g. summer schools, etc.) or participation to events organised by third parties. *Expected performance: On average, 100-200 persons per year engaged through the above events.*	In 2023: Totally, **712** persons engaged: - **407** persons engaged in LifeWatch ERIC own events - **305** persons engaged in events organised by others
KPI 4.b Outreach through media and LW ERIC own web and social media activities	Impact of press and communication actions in raising awareness of LifeWatch ERIC mission, activities and societal relevance of results: 1) Mentions on media 2) Website analytics 3) Social media analytics 4) Newsletter analytics. *Expected performance: Thousands of people reached through the above activities, yearly.*	In 2023: 1) Media mentions: **73** 2) www.lifewatch.eu: Users: **33,937,** Page views: **129,027** 3) Social Media: Followers: **4,883** Reach: **267,004** 6) Newsletter: Total number of subscribers: **529** New subscribers in 2023: **35** Open rate: **27%**
KPI 4.c Participation to policy related events	Number of participation cases in policy related events, working groups, committees & advisory boards.	In 2023: **44** events

	Expected performance: On average, participation of LifeWatch ERIC in at least 10 such events per year.	
Strategic Objective 5: To forge collaboration with the public, private sector and industry to guarantee sustainability of the innovation produced and to address aspects of the EU Green Deal, EU Biodiversity 2030 and EU Digitation and Innovation plans.		
KPI 5 Projects (EU, national and regional) with which LifeWatch ERIC collaborates	Number of projects funded by means external to LifeWatch ERIC and total budget as project income for LifeWatch ERIC. *Expected performance: On average, participation in 2 new projects per year with a total sum for LifeWatch ERIC of 150,000 €.*	In 2023: **7 new European projects**

6. National Distributed Centres

6.1 LifeWatch Belgium

Belgium joined LifeWatch ERIC in 2017 and it contributes to LifeWatch ERIC through its National Distributed Centre. Notwithstanding its relatively small territory, Belgium has a remarkable diversity of habitats and species, and has a rich tradition of biodiversity and ecosystem research, both within and outside of its borders. Since the start of LifeWatch ERIC, Belgium has actively contributed through a number of long-term projects managed by different research centers and universities across the country and supported by the respective political authorities.

The Belgian Node has continued the development and operation of:

- **Species information Backbone for LifeWatch ERIC** (VLIZ): a central LifeWatch service that facilitates the standardisation and integration of species data and provides access to information on species taxonomy, biogeography, genetics, traits (habitat, morphology, vulnerability, etc.) and literature.

- Regional node - **Marine, terrestrial and freshwater biodiversity observatories** (VLIZ&INBO): Integrated observation systems that generate long-term and openly

accessible biodiversity data applying innovative approaches (imaging, acoustics, genomics, tagging and tracking, artificial intelligence, citizen science).

▪ Facility for **thematic biodiversity and habitat mapping** from remote sensing and species distribution modelling (UCLouvain & ULiège): an interactive geoportal providing thematic pan-European remote sensing data. An object-based geographic data integrating the commonly used biodiversity variables is distributed for Belgium (ecotopes) and Europe (ecopatches). Moreover, biophysical variables are available for the South Pole.

Over 2023, LifeWatch Belgium achieved:

- Continuous **growth in volume and usage** of the **major data systems and biodiversity data series**.
- **Recognition** for key components **in international frameworks**. For example, the endorsement of WoRMS, Marine Regions, ETN in the United Nations Decade on Ocean Science for Sustainable Development; the usage of the data series in the reporting for the Marine Strategy Framework Directive and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR).
- **Exploitation** of the services in numerous **scientific studies and publications**. Components of the Belgian infrastructure were cited in over **1,500** publications in 2023 and several local doctoral studies were supported.
- **Valorisation** of the services and expertise through **involvement in many EU projects**. For example, within the Horizon Europe DTO-Bioflow project, coordinated by VLIZ, the developed sensor data pipelines from the LifeWatch Belgium biodiversity observatory will be upscaled in a broader European context to deliver data to the EU Digital Twin of the Ocean. Other examples are: MARBEFES, MARCO-BOLO, Marine SABRES, ANERIS, BiOcean5D, GES4SEAS, BIG_PICTURE, and HiRAD.

6.2 LifeWatch Bulgaria

Bulgaria joined LifeWatch ERIC in 2022 and contributes to LifeWatch ERIC thanks to a consortium of 14 national scientific and educational Institutions in the field of Biodiversity and Agroecology. The Agricultural University-Plovdiv is the official scientific coordinator, representing Bulgaria in LifeWatch ERIC.

LifeWatch Bulgaria performs activities in the following thematic topics:

- Plant Health Infrastructure activities.
- Research, involving laboratory and field testing and assessment.
- Analysis and assessment of the impact of agricultural practices on biodiversity.
- Analysis of ecosystem services and agroecology.
- Advanced agrobiodiversity monitoring.
- Analysis and assessment of the environmental pressures.
- Implementation of the 'multi-actor approach' engaging key stakeholders and experts for an open-source collaboration.

During 2023, the Bulgarian Node has supported LifeWatch ERIC through:

- **Participation of LifeWatch Bulgaria in International and National Events** (co-organisation of the first edition of the Plovdiv Science Festival, 23 - 26 November 2023, and of the celebration for Earth Day "The Great Return" and "The Surviving Exhibition" of the Society of Animalists, Florists and Scientific Illustrators, and participation to LifeWatch ERIC "BEeS" Conference).
- Participation in the **LifeWatch ERIC's working groups on Communication, Training and Intellectual Property Rights Policy**.
- Participation in the LifeWatch ERIC Project **Open-Earth-Monitor Cyberinfrastructure (OEMC)** for the preparation of marine/terrestrial biodiversity and landscape diversity in-situ data.
- Contribution to LifeWatch ERIC **Communication activities**, namely to the LifeWatching Science Channel, with a real time streaming of the White Stork (*Ciconia ciconia*) nests and of the Egyptian vulture in Eastern Rodopi Mountain, Bulgaria and Lesser Kestrels *(Falco naumanni).* It also contributed to several issues of LifeWatch ERIC newsletter.

6.3 LifeWatch Greece

Greece joined LifeWatch ERIC in 2017 and fulfils the vision to establish the Biodiversity Centre of Excellence for South-eastern Europe, by: (a) Allying all the Greek scientific human potential working on biodiversity data and data observatories; (b) Paving the way

for the development of complex virtual domains through a number of background e-Services; (c) Developing a number of virtual labs (vLabs) as a contribution to LifeWatch ERIC; (d) Building capacity at the national level through a network of activities; (e) Disseminating information, scientific knowledge and expertise to the public. The Greek National Distributed Centre is funded by the Greek General Secretariat of Research and Innovation and is coordinated by the Institute of Marine Biology, Biotechnology and Aquaculture of the Hellenic Centre for Marine Research (HCMR).

The Greek Node has supported LifeWatch ERIC through:

- **Advancement of the microCTvLab.** A new collection of microCT data is under development in order to be uploaded in the vLab (in the framework of the EU project MAPWORMS). An open virtual collection including annotated data and 3D models of microCT scans for marine Annelida has also initiated. These microCT scans will be used as an inspiration for the creation of bioinspired shape-morphing robots within the framework of MAPWORMS project. The storage capacity of the microCTvlab has been expanded to 63TB (within the framework of the EU project MAPWORMS and SYNTHESYS+).

- **Improvement of MedOBIS vLab**. The MedOBIS virtual laboratory (vLab) has reached further advancements, and now features an ongoing data flow into MedOBIS database of both historical and new datasets and an updated Integrated Publishing Toolkit. Moreover, this was at the heart of the Autumn Data School, co-organised by LifeWatch Greece, EMODnet Biology and LifeWatch ERIC in Lecce, Italy, 13-15 November 2023, and of the MBON and LifeWatchERIC online seminar on Data Management, 18 December 2023.

- **Development of organic links and dependencies between Common Facilities and National Distributed Centres.** The integration of LifeWatch Greece portal in the central Authentication and Authorisation Infrastructure - AAI of LifeWatch ERIC has been initiated.

- **Participation in the IJI workflow development for the analysis of Autonomous Reef Monitoring Structures (ARMS) data.** LifeWatch Greece has been actively participating in building a Virtual Research Environment (VRE) for the analysis of both community composition and community metabarcoding data from Autonomous Reef Monitoring Structures (ARMS). Informaticians at the ICT-Core in Spain, LifeWatch Greece and LifeWatch Belgium have been working on the ARMS validation case to build a data-analysis workflow to process raw genetic data from the ARMS-MBON network using the PEMA bioinformatic pipeline. ARMS-MBON

has now become part of the European Marine Omics Biodiversity Observation Network (EMO BON), a larger European initiative for the observation of genomic biodiversity.

- **Communication activities**, among which: the presentation of the MicroCTvlab in the MAPWORMS first annual meeting in Lecce (Italy), 15-16 May 2023, participation in the 2nd International Ocean Data Conference 2023 at the UNESCO headquartes in Paris, 20-21 March 2023, the EMODnet Open Conference 2023 in Brussels, (Belgium) 29-30 November 2023, the GEO BON Global Conference: Monitoring Biodiversity for Action, Montréal (Canada), October 2023 (https://www.researchgate.net/publication/379143779_ARMS-MBON_long-term_genetic_monitoring_of_marine_hard-bottom_communities). LifeWatch Greece website (Lifewatchgreece.eu) and its social media (facebook & twitter) channels have been constantly updated. Similar actions related to microCT and MicroCTvlab activities were also disseminated through the network and media of MAPWORMS project. Finally, LifeWatch Greece has contributed to LifeWatch ERIC communication and dissemination strategy and coordination through its Communicator Working Group and to its implementation, participating to four episodes of the Podcast Series "A Window on Science", and to several issues of the LifeWatch ERIC newsletter, and supporting the dissemination of LifeWatch ERIC branding in local events.

6.4 LifeWatch Italy

Italy joined LifeWatch ERIC in 2017 and hosts its Service Centre. LifeWatch ERIC has always been strongly supported by the national scientific community, as well as regional and national institutions, as Italy is a biodiversity hotspot in Europe, with over **57,400** animal and **6,500** plant species. Italian landscapes and protected areas are natural laboratories for biodiversity and ecosystem research. The LifeWatch Italy web portal provides a networking interface for the biodiversity and ecosystem community, offers learning and training opportunities, semantic resources and data, ICT services & VREs, supporting research activities and science-based policymaking.

During 2023, the National Distributed Centres of LifeWatch ERIC significantly improved the LifeWatch Italy offer of data and services, thanks to the release of new dedicated platforms.

- **The Data Centre**, with a computational power of **3,000** core on Cloud, HPC and HTC architectures and a storage capacity of **4** PetaByte, to host LifeWatch Italy data and services. The Data Centre is also part of the LifeWatch ERIC distributed

infrastructure.

- **DataLabs** is a platform for creating collaborative code to analyse biodiversity and ecosystem data. The platform allows users to create and publish scripts in R, Python and MATLAB, develop web services and structured web interfaces for services. This platform is aligned with FAIR principles and open science practices.

- **The Metadata Catalogue*** enables discovery and access to diverse resources from a variety of providers through descriptive metadata, improving and promoting the exchange and sharing of information. It is the access point to LifeWatch Italy resources.

- **The Data Portal*** is the Italian HUB of biodiversity and ecosystem data, customised to provide complete data management from data curation and validation to publication and research.

- **The Italian Taxonomic Backbone** gathers nomenclatural and distributional data on Italian biodiversity from recently published checklists by Italian taxonomists, encompassing native and alien vascular plants and lichens, as well as information on terrestrial, freshwater, and marine of the Italian metazoa.

- **The Virtual Museum** is a collaborative education platform offering visits to rooms which provide a 360-degree experience of different ecosystems including images, faunal, floristic and environmental fact-sheets, videos, interviews, specific databases, educational games, etc.

- **The bioacoustics platform*** is aimed at the recognition of species that are difficult to observe directly because they are very rare, have nocturnal habits, or are strongly camouflaged species, but can be identified through the emission of sounds.

Moreover, LifeWatch Italy participated to LifeWatch ERIC working groups on Communication and Training, and undertook own initiatives engaging over **2,500** persons in its events, publishing about **150** contributions and reaching over **32,000** views on its training platform. The Multimedia Production Centre continued its work in powering LifeWatching Science Channel productions.

*These platforms have been released in beta version, and are undergoing a final testing phase with identified groups of users prior to their final release.

6.5 LifeWatch Netherlands

The Netherlands joined LifeWatch ERIC in 2017 and hosts its Virtual Laboratories and Innovations Centre (VLIC) Common Facility. The University of Amsterdam (UvA), is the leading institution of the Dutch National Distributed Centre. The LifeWatch Netherlands Distributed Centre is hosted by the Faculty of Science of UvA.

The Dutch ecology community has a focus on the development of digital twins (DT) for enabling predictive studies on natural areas. A large research infrastructure project (LTER-Life, see below) has been funded by the Dutch research council (NWO) to this end.

In September 2023, the LTER-LIFE project started. Within LTER-LIFE the research infrastructures LTER-NL (Long Term Ecological Data), LifeWatch-NL (Virtual Research Environments and data management services) and NemNet (Dutch Abiotic Monitoring Network) joined forces to create an infrastructure to support the development of Digital Twins of Ecosystems. This support is based on three pillars: Ecological Research Communities, Shared Data and Models and Virtual Laboratories. The main partners in the project are NIOO-KNAW, NIOZ, UvA, RIVM, LifeWatch and Wageningen University. With LTER-LIFE these partners aim to provide wide access and usability to ecological models and data and support regional Ecological Research Communities to broaden the scope of their research by linking different ecological disciplines.

- In the first months of the projects some intensive explorations of the LifeWatch Virtual Research Environment (namely NaaVRE) are carried out under the name of **ProtoDTs Virtual Laboratory**. These explorations yield first tangible results, provide insight in routes for development and give ecological researchers an impression of what they can expect.

- UvA, together with Naturalis Biodiversity Center, Westerdijk Fungal Biodiversity Institute and the University of Twente have continued work in the **ARISE national large research infrastructure project**. ARISE will create a solution for rapid species detection. Any type of sample - be it a single specimen, an image, a sample of environmental DNA or a sound recording - the infrastructure will tell us which species are present.

- **NaaVRE** (Notebook-as-a-Virtual Research Environment) being developed by the LifeWatch VLIC together with University of Amsterdam has been deployed and operational on the LifeWatch infrastructures.

- The NaaVRE technologies and Virtual Lab examples have been included in the **LifeWatch ERIC summer school and EGU ENVRI training session** as part of the community training activities. Besides the ecoLidar and bird migration Virtual Labs

created by Dutch communities, the NaaVRE platform has also been used by the LifeWatch Italian community to create a customised Lab for Phytoplankton. More labs will be released in the coming phase.

- UvA, together with LifeWatch ERIC VLIC has concluded its NaaVRE and Knowledge base contributions to the **ENVRI-hub**, in the context of the ENVRI-FAIR and its follow-up ENVRI-HUB next projects. The knowledge base/search engine and the use of NaaVRE in the science cases are the most notable contributions to this cluster platform.

6.6 LifeWatch Portugal

LifeWatch Portugal joined LifeWatch ERIC in 2019 and contributes to LifeWatch ERIC through its National Distributed Centre. LifeWatch Portugal (PT) is managed at a national level by e-I PORBIOTA – the Portuguese e-Infrastructure for Information and Research on Biodiversity, led by BIOPOLIS Association/CIBIO-InBIO – the Research Centre in Biodiversity and Genetic Resources, Associated Laboratory. The e-I PORBIOTA was included in the first Portuguese Roadmap for Research Infrastructures of strategic relevance (RNIE) in 2014. This entity stores, organises and disseminates biodiversity and ecosystem data, making it available to the scientific community and society and contributes to promoting integrative taxonomy and building up knowledge of national biodiversity. It encourages progress in highly competitive cutting-edge areas, such as metabarcoding and environmental metagenomics. The e-I PORBIOTA also contributes significantly to the advancement of scientific knowledge in biodiversity, ecosystem functions, and ecosystem services by supporting the digitisation, aggregation, and dissemination of data on biodiversity and Portuguese ecosystems, as well as increasing the international impact of Portuguese research in these fields. LifeWatch PT, through e-I PORBIOTA, provides access to a wide range of biodiversity-related services, including biodiversity and environmental data resources, as well as computational and analytical tools for study, policy implementation, and assessment. During 2023, LifeWatch Portugal activities were:

- **ENVRI-FAIR** – contributon on FAIRness data implementation with **31** datasets from biodiversity and ecosystem subdomains from Portuguese data providers, related to species occurrence and including DNA barcoding sequences (IBI project) published within project life (2019-2023). Occurrence data provide primary biodiversity information of evidence identified species and InBIO Barcoding Initiative (IBI), aims to develop a reference collection of DNA barcoding sequences

primarily covering Portuguese invertebrate taxa, both of these accessible data provide a tool in ecological studies. These data and metadata are in compliance with FAIRness implementation. The datasets are available on the LifeWatch ERIC Metadata Catalogue and GBIF (Portuguese Node).

- **Open Earth Monitor Cyberinfrastructure (OEMC)** - LifeWatch Portugal is contributing with the Preparation of marine/terrestrial biodiversity and landscape diversity in-situ data. Occurrence and percentage cover of intertidal macrospecies (molluscs, crustaceans, echinoderms, algae, etc) at ~25 locations across the Atlantic coast of Europe, from Scotland to Morocco.

- **Consolidation/mobilisation of data** - Datasets from biodiversity and ecosystem subdomains from Portuguese data providers. Species occurrence/abundance and DNA barcode, abiotic variables and species trophic interactions and dietary metabarcoding datasets. The datasets are available on the LifeWatch ERIC Metadata Catalogue (linked to ENVRI-FAIR project outputs/participation). **186** datasets available through LifeWatch Portugal.

6.7 LifeWatch Slovenia

LifeWatch Slovenia is one of the National Distributed Centres composing LifeWatch ERIC, and is also included in the Slovenian National Roadmap and in the Strategy for Smart Specialisation (S4) and Horizon 2020. It is focused on the development of technological solutions in the field of biodiversity and socio-ecosystem research.

Since 2015, the Slovenian Consortium, LifeWatch-SI, has been promoting the importance of integrating and networking information & data in order to:

- coordinate biodiversity research in marine, freshwater and terrestrial ecosystems;

- plan common access to a vast array of data from various databases and observatories;

- predict computing capabilities with analytical and modelling tools in virtual laboratories;

- support training and educational programmes that will enable a proper understanding of biodiversity.

The main highlights of 2023 for the Slovenian node were:

- **Launch of the new LifeWatch-SI website** (https://lifewatch.si/), improving consistency with LifeWatch ERIC branding and technologies;

- **Participation to the LifeWatch ERIC Biodiversity & Ecosystem eScience Conference BEeS conference** in Seville, Spain, and showcase of the latest progress in the development of virtual labs (22-24 May 2023; see also the conference highlights);

- Supervision of **Doctoral thesis** by Prof. Tanja Pipan, defended as part of the research work of LifeWatch-SI: Valentić Lara. Microplastics in karst ecosystems and their impact on drinking water quality (August 2023);

- **Successful audit of the national RI-SI-LifeWatch project**, which once again demonstrates the commitment and successful work within the LifeWatch-SI consortium (October 2023);

- Continuos **updates** and **new entries** on the national **IZRK Metadata Portal**;

- **Publication of more than 25 articles, chapters and books** within LifeWatch-SI framework (https://www.zrc-sazu.si/en/strani/objave-ri-si-lifewatch).

6.8 LifeWatch Spain

Spain joined LifeWatch ERIC in 2017 and hosts the Statutory Seat and the ICT Core Offices, assisting in the day-to-day coordination and management of LifeWatch ERIC and the development and operation of the core and horizontal services, correspondingly. LifeWatch Spain Distributed Centre is currently supported by the Ministry of Science, Innovation and Universities, the Regional Government of Andalusia and the Guadalquivir River Basin Authority (Ministry for Ecological Transition-MITECO).

With its large territory, between the Mediterranean Sea and the Atlantic coast, Spain has an enormous diversity of habitats species and genes, including some of the most important natural reserves and parks in Europe (Doñana, Monfrague, Timanfaya), from the white mountains in Sierra Nevada and the Pyrenes to the volcanos in Tenerife.

In 2023, the Spanish Distributed Centre carried out the following activities:

- **Implementation and conclusion of the six large projects in Andalusia**, funded by the ERDF: SmartFood, SUMHAL, Indalo, SmartEcoMountains, EnBic2Lab and Alboran, as well as the project RESINFRA (EU funded);

- **Participation in projects designed for research and innovation in Agroecology**,

such as PATH2DEA, ALL Ready and AgroServ and also in the International Forum on Agroecosystem Living Labs in Montreal;

- **Organisation of several meetings for LilfeWatch ERIC, LALINET and ACTRIS**;
- **Kick-off of the RESINFRA+ Project**;
- **Participation to the EU-LAC knowledge Forum**;
- **Contribution to AERAP Science Forum** (Africa – Europe Knowledge transfer).

The above activities contributed to the enrichment and consolidation of the technical Infrastructure of LifeWatch ERIC, with new components, including HPC resources and data centres (e.g., the e-Biodiversity Research International Centre (e-BRIC) in Matalascañas-Doñana). They also supported the development of new tools such as *mylifewatch.eu* and the completion of the blockchain-based Science Knowldge Graph (SKG) system, LifeBlock.

7. Acknowledgements

LifeWatch ERIC is grateful to its members and representing entities for their support of its operations and achievements:

Figure 7. LifeWatch ERIC members and representing entities

Annexes

1. Financial Statements