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The ECLA R&D Centre: Scientific support for lacustrine ecosystem management

February 2026

In this report

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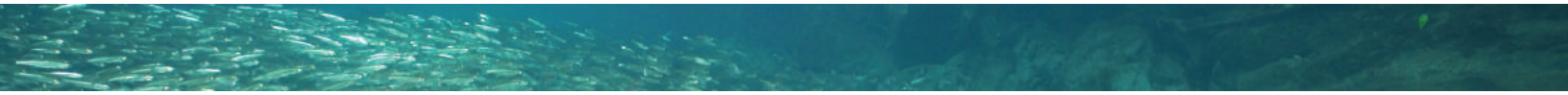

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School of cyprinids.

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The ECLA R&D Centre: Scientific support for lacustrine ecosystem management

The implementation of the 2000 European Water Framework Directive and its translation into French law (LEMA 2007) has been accompanied by extensive research. Since 2009, scientific teams from INRAE, OFB and the University of Savoie Mont-Blanc have been working together at the Lacustrine Ecosystems Research and Development Centre (ECLA) to address the many challenges posed by the Directive for the management of lake ecosystems. The ECLA R&D Centre is now identifying new management needs, coordinating the scientific work required to meet them and making the results available to public stakeholders. This report reviews the major achievements and outputs of this collaboration.

Lakes play an essential role in many respects. Covering almost 1% of the national territory, over 850,000 lakes have been registered in France (INPE, 2023). They represent major biodiversity reservoirs, around 6% of total biodiversity, as well as supporting multiple uses and providing numerous ecosystem services. Today, like countless 'natural' environments, they are subject to or even threatened by various pressures: climate change, the artificialisation of their morphology and hydrology, chemical pollution, recreational activities, energy production, invasive alien

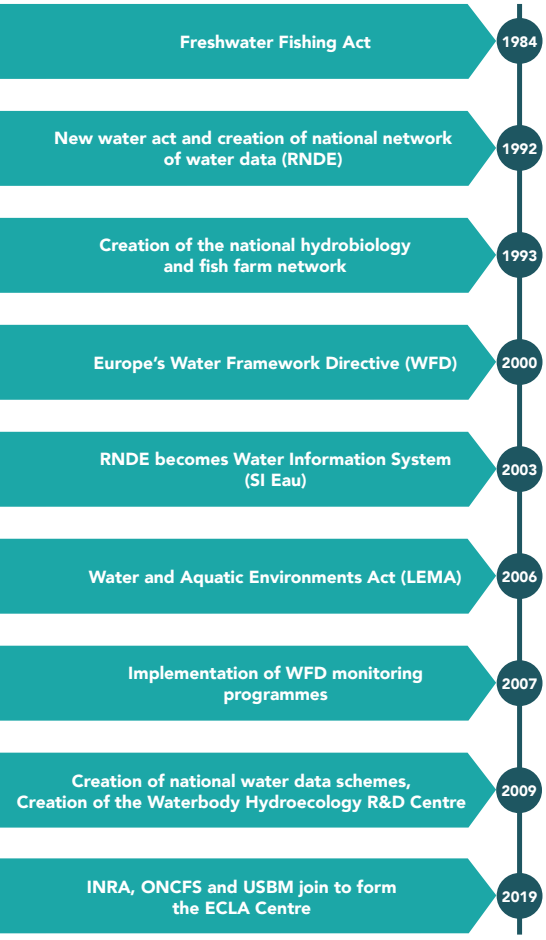
The ECLA R&D Centre – Key Figures:

- The Pôle Hydroécologie des Plans d'Eau (2009) becomes the Pôle R&D ÉCLA in 2019
- 3 institutions join forces, with 63 permanent staff and 25 contract staff
- 4 sites across France: Aix-en-Provence, Le Bourget-du-Lac, Thonon-les-Bains, and Bordeaux
- 3 research units: CARRTEL, EABX, RECOVER
- 1 website: https://poleecla.fr/
- 1 HAL documentary collection, accessible online: https://hal.science/POLE_RD_ECLA/
- 56 top-tier publications, 117 technical reports and 174 transfer/communication initiatives for the period 2019-2024

species and so on. Their sustainable management is an environmental and societal imperative.
In this context, public policies have been reinforced to set guidelines for human interventions in these environments, monitor the evolution of their ecological status and to restore them. The scientific challenges that accompany the legislative and regulatory arsenal for France's lakes is evolving with the requirements of public action. The proximity created by the ECLA R&D Centre between the scientific community and the public actors responsible for these environments encourages the consideration of these needs, facilitating management informed by science.
The ECLA R&D Centre, an innovative, collaborative research and development structure, was thus set up to produce, organise and transfer knowledge to those managing lake environments in the broadest sense: natural lakes or waterbodies, artificial reservoirs, ponds and even gravel pits. The Centre represents an interface for acculturation, providing public policymakers with pioneering and operational monitoring and management tools, knowledge summaries, high-level expertise and the capacity to anticipate changes in the pressures on these unique ecosystems.
This dossier first looks at the context of the ECLA R&D Centre's creation, especially with regard to translating the Water Framework Directive into French law, as well as its scientific contributions on the subject. We then present the ECLA R&D Centre's perspectives on the new challenges facing lake environments, which are used for public policy support.

Creating the ECLA R&D Centre: an essential collaboration

Public policies and ECLA Centre Timeline



The creation of the ECLA R&D Centre (Lacustrine Ecosystems) has made it possible to pool human and technical resources and the scientific facilities of most of the few French teams currently working on lake ecosystems. Together, the Centre's researchers are drawing up an ambitious scientific programme that meets the needs of public policymakers to manage and restore these unique environments and anticipates future challenges.

LACUSTRINE ECOSYSTEMS – FRAGILE ENVIRONMENTS

Waterbodies, whether natural or artificial, are inland stretches of stagnant water that contain water for more than two months a year, or are used for temporary storage purposes[1]. In mainland France, there are over 800,000 of them. More than 300 are waterbodies covering over 50 hectares, monitored as part of the European Water Framework Directive (WFD), and around twenty of them are classified as 'great lakes' covering over 10 km². France's lakes represent a considerable reserve of fresh water with a combined storage capacity of 18 billion cubic metres. As fragile and diverse environments, lake ecosystems are home to many challenges, uses, ecosystem services and biodiversity.
Lakes play a crucial role for the functioning of natural habitats: they are home to a wide range of often endemic animal and plant species, and supply essential ecosystem services such as climate regulation, carbon storage and drinking-water supplies. These environments are also used for human activities such as producing electricity, fishing, hunting, aquatic activities and swimming. However, lakes are under serious threat from the pollution they accumulate, climate change, invasive alien species and the artificialisation of their banks and their hydrology, requiring specific conservation or restoration measures.
Since 2009, the collaboration of several scientific teams from the collective known as the Pôle R&D ECLA (ECLA R&D Centre) has made it possible to set up research projects to supply knowledge and develop methods to tackle the various issues faced by waterbodies.

1. https://www.eaufrance.fr/les-lacs-etangs-et-autres-plans-deau

A SCIENTIFIC COLLABORATION TO SUPPORT AN AMBITIOUS PUBLIC POLICY: THE WFD

The European Water Framework Directive (WFD) announced in 2000 guides water policies in EU Member States on the issue of restoring the good ecological status of inland and coastal aquatic environments. In 2006, the Law on Water and Aquatic Environments (LEMA) translated the directive into French law.

With the lack of standardised protocols to assess lakes' ecological status, in 2009, the Ministry for the Environment, in collaboration with the Cemagref (originally Irstea then INRAE) and the Onema (originally the AFB, then the OFB), launched the creation of the Pôle Hydroécologie des Plans d'Eau (hydro-ecology centre for lakes) in Aix-en-Provence. Its objective was to accompany the Ministry for the Environment and those responsible for managing lacustrine environments to implement public policies for lakes and reservoirs. Opening up to include other research teams, it officially became the Recherche et Développement ECosystèmes LAcustres (ECLA) in 2019. The Centre gradually broadened its scope beyond the scientific questions raised by the Water Framework Directive. In 2016, the agreement protocol between Irstea and the AFB incorporated the issues of biodiversity and climate change into the Centre's scientific programme. In 2019, the Centre expanded to include specialised research units such as the Alpine Centre for Research on Trophic Networks and Limnic Ecosystems (UMR CARRTEL INRAE-USMB), the ONCFS's 'inland ponds' centre, and the Aquatic Ecosystems and Global Change Unit (EABX) in Bordeaux.

The incorporation of these new teams represented a structuring that anticipated a broader movement towards closer ties between institutions, which took concrete form in 2020 with the creation of INRAE (merger of INRA and Irstea) and the OFB (merger of AFB and ONCFS). The multidisciplinary nature of this team enables it to address a wide range of ecological and societal issues

Jean-Marc Baudoin
Head of the ECLA R&D Centre, OFB

The ECLA R&D Centre set up in 2009 brings together the skills of two research and higher education institutions – INRAE and the Université Savoie Mont Blanc – and the OFB, a state agency devoted to water and biodiversity. Initially, the centre was primarily set up to meet the Water Framework Directive's monitoring requirements. The direct links forged between scientists and public actors ensure continuity between research and action, and now facilitate the development of strategies for the sustainable management, use and restoration of these fragile environments. The Centre's diverse skills, responsiveness and ability to deploy rapidly on a national scale make it a key partner and resource centre whose expertise is essential to manage and preserve lake ecosystems.

Jean Guillard
Deputy Head of the *ECLA R&D Centre, INRAE*

The ECLA Centre facilitates the collaboration between research and public authorities to manage lacustrine ecosystems. Complementing the fundamental work carried out upstream, the finalised research supported by the Centre helps fruitful interactions among numerous researchers and water management stakeholders. We ensure the effectiveness of the projects we fund through cooperation agreements between organisations. For their part, managers who benefit from scientific findings provide researchers with new scientific questions. We are proud of the relationship of trust that has been established between scientists and the OFB, which liaises with the relevant ministries.

ECLA's missions, research themes and projects

The Centre's 4 missions

- **Research** and **Development methodologies** for **priority topics**
- **Identifying social** and **environmental issues**
- **Ensuring operational transfer**
- **Scientific support** to **implement public policies**

The Centre's 4 research themes

- **Status** and **management** of **lacustrine biodiversity**
- **Lacustrine ecosystem trajectories** and **climate change mitigation measures**
- **Lacustrine environments – uses** and **anthropisation**
- **Knowledge enhancement** and **transfer**

Non-exhaustive list of the Centre's flagship projects at DataECLA

eDNA with the **FishDNA Watch** project. Acoustic camera with the **CAMPOP** project. **Remote sensing** with the **C-LECLATE** and **TELEMAC** projects, the **Réseau National Thermie,** the **UROS** project, the **Centre d'Expertise** et de **Médiation Scientifique** (which covers, among other things, **organising networks, scientific assessments** and training proposals).

affecting lake ecosystems, as well as facilitating exchanges between science and management. The ECLA R&D Centre has become the national reference centre for research, development and innovation in the conservation and restoration of biodiversity in lake environments in the face of global change.

DIVERSE MISSIONS AND ADAPTED GOVERNANCE

The Centre's scientists carry out diverse activities such as research, expert assessments, developing innovative tools, managing and disseminating data, producing methods, setting up testing and monitoring demonstration sites, organising stakeholder networks and scientific transfer and outreach for scientists, water and aquatic environment actors and the general public. Several specific actions are carried out by the ECLA R&D Centre to accompany the implementation of public policies for lacustrine ecosystem management. Firstly, the Centre participates in scientific assessment missions, from the local to the international level, in order to provide decision makers, stakeholders and managers with scientific guidance. To promote the results of the R&D projects they conduct, the Centre's scientists publish scientific papers in international journals. They also produce and disseminate methodological standards, knowledge summaries and operational tools. Furthermore, the Centre organises communication initiatives through various channels such as various seminars and on their website (https://poleecla.fr/). Lastly, the Centre manages and disseminates the national reference database that compiles data on regulatory monitoring and research into lake environments (https ://dataecla.fr/).

The ECLA R&D Centre also participates in introductory and further training for lake environment managers, organising or contributing to the various training courses. The creation of a *Centre national d'expertise et de médiation scientifique sur les écosystèmes lacustres* (National Centre for Expertise and Scientific Outreach on Lake Ecosystems) is currently underway to ensure the widespread and long-term dissemination of the knowledge and tools developed.

The cooperation agreement between the OFB, INRAE and the USMB is renewed every 6 years, and a scientific programme is established for the duration of the agreement. Decision makers and managers in the field are actively involved in designing it to ensure that all the various issues are taken into account and the transfer of the knowledge produced is effective and adapted. Every year, the steering committee gathers together the Centre's different partners to analyse and validate a programme of priority actions.

Organised into thematic focal points, this joint scientific project enables a high level of responsiveness to emerging issues. In addition, the Centre is managed by a joint team from the OFB and INRAE, reflecting the ambition to act as an interface between public policy stakeholders and researchers.

Scientists from the three partner institutions are involved in various projects within the Centre. For effectiveness, roles are assigned based on the skills of the staff and the scientific materials and experimental facilities available.

Amélie Cossais

Coordinator of the *Pôle Acquisition de la Donnée de Surveillance* (monitoring data acquisition centre) at the Adour-Garonne Water Agency

I coordinate the team responsible for acquiring aquatic environment monitoring data from the Adour-Garonne basin. We collect, validate and make available data on aquatic environments for the OFB, the ministry and users via our Système d'Information sur l'Eau (SIE) with a view to reporting them to Europe. These data mainly concern lacustrine environments of over 50 hectares and are also shared in the Naïades and dataECLA databases. As a set, these data make it possible to draw up an overview of the quality of these waterbodies and make regional diagnostics. Furthermore, as monitoring is constantly evolving, we subsidise the acquisition of data using innovative technologies such as satellites and environmental DNA. The ECLA Centre also participates in the *groupe technique national plans d'eau* (national waterbody technical group) which brings together all waterbody monitoring stakeholders including water agencies. This group enables discussions about the strategy to be pursued and the new requirements or indicators to be developed. The Centre then answers technical questions from managers and develops our knowledge of lake environments, which evolve slowly and are complex to interpret.

© Stéphan Jacquet

Underwater observation.

General Limnology Training 2025 - sampling methods field trip.

Knowledge to inform the WFD

The creation of the ECLA R&D Centre is part of an operational requirement to support the State and its services, public institutions and managers in implementing public environmental policies affecting lake ecosystems. It all began with the transposition into French law of the 2000 Water Framework Directive (WFD), which requires European Union Member States to maintain or restore the good ecological and chemical status of their waterbodies by 2027 at the latest.

To achieve this objective, a key stage in implementing the WFD is to successfully restore the health of large-scale hydro-systems, using the identification of anthropogenic pressures and various physical, chemical and biological indicators.

This has set countless scientific challenges including drawing up a national typology of lake environments, defining 'ecological references' to achieve, designing standardised systems for diagnosing ecosystems 'at risk', developing standardised and operational sampling methods for monitoring the biological, physicochemical and hydromorphological characteristics and pollutants in lakes, and developing indicators of the status of waterbodies based on all the monitored parameters. Major challenges have also arisen in organising and managing the monitoring networks, as well as in the centralising, managing and disseminating the data produced at national level.

Since it was established, the ECLA R&D Centre has been entrusted with the crucial mission to meet these challenges for France's waterbodies. At the time, there were very few tools available to make standardised assessments of lakes' ecological status and they were mostly ill-adapted to WFD principles. The Centre therefore designed protocols to monitor lakes, employable on a large scale. The aim of this monitoring is to define the ecological quality of aquatic environments.

For this reason, the Centre concentrated on developing the majority of the bio-indicators that are currently used and whose status-class thresholds are shared and cross-calibrated among European countries. Biological communities are one of the key factors in assessing the status of the environment, monitoring aspects such as taxonomic composition, the relative abundance of different species, and biomass.

This system of scientific partnership continues today with countless studies relating to the WFD, including for waterbodies in France's overseas territories (DOM), where there are still knowledge gaps, as well as for the second key stage of the WFD involving the restoration of degraded lake environments.

Bénédicte Augeard
Head of Research and Scientific Support at the OFB

In the early 2010s, Onema, now the OFB, established a direct link between public authorities and the research community by creating research and development centres. Four centres were set up, incorporating OFB staff responsible for scientific policy support for the Ministry for Ecology, and two public science and technology and further education institutions. These interfaces between science and public initiatives encourage the transfer of knowledge for management and, in the other direction, research questions, and represent references on topics of high importance for biodiversity. In 2020, INRAE and the OFB redefined their partnership following their respective mergers. The two new institutions signed a new multi-year framework agreement, renewed on 1st March 2024, promoting the two research and development centres to which INRAE contributes. These centres aim to support policies for the conservation of water resources and aquatic environments, addressing topics related to lake ecosystems (the ECLA Centre) and diadromous species in their environment (the MIAME Centre).

© Rosalie Bruel

Grand Laus, one of the three lakes in Malrif, Queyras Regional Nature Park. The lake has been monitored as part of the « RNT plans d'eau » Program since 2013

CHARACTERISING, ASSESSING AND TAKING ACTION: FROM RESEARCH TO OPERATIONAL TOOLS

To respond to the emergency of implementing the WFD on national level, one of the Centre's first missions was to record, compile and standardise the available environmental data for France's lacustrine environments. The Centre's teams invested heavily in creating a centralised national database that meets SANDRE (Service National d'Administration des Données et Référentiels sur l'Eau) standards to ensure interoperability with all other French information systems. This database continues to be fed by a large amount of data, particularly from the WFD monitoring networks. It has gradually been expanded to become the reference centre for data on French lake ecosystems concerning data entry, control and storage, banking and dissemination: DATAECLA (https://dataecla.fr)

Using the latest international scientific knowledge, it was then necessary to devise and develop the best sampling methods in order to measure effectively biological communities, the physico-chemistry and the hydromorphology of waterbodies in monitoring networks. In addition to the essential activities of scientific creation, a large share of the work of the Centre's teams was devoted to drawing up guides and training protocols to ensure that every operator in the field could use the developed tools correctly, ensuring their training, organising national deployments to test the methods in a wide range of field conditions, improving them, validating their operationality, contributing to their standardisation, and lastly, working with the Ministry for the Environment to transcribe their application into French regulations.

This type of colossal undertaking would be a challenge for any French research team, but one of the ECLA R&D Centre's strengths is enjoying and being able to rely on close collaboration with the regional departments of the OFB, knowledge services and hydrobiology laboratories, as well as with water agencies. With the support of this national network of experts, the Centre can quickly acquire a vast amount of data across the entire country, but also deploy, test, improve and validate the methods and tools it develops on a large scale.

Lastly, as soon as a sufficient amount of monitoring data were available on a national level, the Centre's scientists devoted themselves to analysing them using statistics tools and modelling. This involved developing assessment methods and ecological status indicators, scientifically validated by international peers via publications in top-tier scientific journals to ensure the use of robust tools validated by science.

Nevertheless, the outcome of this research is not limited to considering a strictly national application. It has required complementary studies with scientists involved in implementing the WFD in all the other Member States via a process known as 'intercalibration' that makes it possible to ensure that the results obtained are harmonised on European level, whether using a method developed in France or another country.

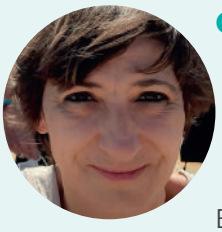
Thanks to all these studies along with the mobilisation of numerous scientists from the Centre, the following WFD indicators have been developed:

- Phytoplankton index for lakes (IPLAC)
- Macrophyte index for lakes (IBML)
- Diatom-based index for lakes (IBDL)
- Lake macroinvertebrate index (IML), in partnership with the UMR Chrono-Environnement
- Lake ichthyofauna index (ILL)
- Reservoir ichthyofauna index (IIR)
- Lake hydromorphology index (LHYMO)
- Physicochemical status thresholds

While making these methods available represented great progress, the ECLA R&D Centre's studies continue to pursue this topic. Indeed, monitoring and assessing the status of lake environments must be as accurate and scientifically robust as possible, but must also take into account the human and financial resources required for their implementation, as well as their potential impact on ecosystems.

Making use of the latest scientific developments in molecular biology such as environmental DNA, hydroacoustic and satellite remote sensing to high-frequency sensors, the Centre is currently trying to envisage the monitoring of the future. The aim is to develop innovative tools that enable more comprehensive assessments of biodiversity, are as non-invasive as possible for the environments and species

Two questions for...



Claire-Cécile Garnier

Head of the Water Resources, Aquatic Environments and Freshwater Fisheries Office (EARM3) Ministry for the Ecological Transition, Biodiversity and International Climate and Nature Negotiations

In what ways does the Water Resources, Aquatic Environments and Freshwater Fisheries Office work with the ECLA Centre?

Our office is responsible for monitoring aquatic environments, groundwater, quantitative water management and professional and recreational freshwater fishing. With regard to the Water Framework Directive (WFD), we ensure the smooth functioning of monitoring and assessing the ecological status of France's watercourses, groundwater and waterbodies. A specific WFD working group to implement waterbodies' monitoring and assessment brings together water agencies, the OFB, the ECLA Centre and the DEB. Discussions topics include managing monitoring data, developing indicators, updating sampling methods and standardising them, topics with which the Centre is very involved; for example, a large number of the WFD 'waterbody' indicators were developed by the ECLA R&D Centre, and it is responsible for acquiring data on the hydromorphology and ichthyology of WFD waterbodies. This group also provides an opportunity to share the Centre's research work with water agencies, as was recently the case with a study on the impact on lake ecosystems of floating photovoltaic panels.

Also, some experts from the ECLA Centre participate in the European group on methods to assess the status of waterbodies in order to ensure the assessment's harmonisation among the different countries and to enable discussions on common issues.

Ethel Verdier-Brémaud

Policy officer, aquatic environments and waterbodies quality Ministry for the Ecological Transition, Biodiversity and International Climate and Nature Negotiations

Beyond the WFD, in what ways can the Centre's scientists continue to guide the ministry's decisions?

The ECLA Centre collaborates with our office on numerous subjects relating to waterbodies. During the 'Technical Days' in 2024, the Centre provided its scientific expertise on the impact of fish ponds, the heritage stakes of which need to be taken into account in ecological restoration policies. We also consult the Centre in the context of national and European discussions on the effects of climate change, the hydromorphology of waterbodies, etc. The ECLA Centre also participates in the national strategy for the continuous monitoring of lakes and watercourses, ensuring temperature monitoring of the lakes in the OFB's National *Thermie* Network, as well as coordination and exchanges with various stakeholders involved in lake monitoring who are tracking or wish to track changes in their temperatures.

The Centre has also broadened its participation to a topic with more 'political' stakes by organising 'Pond Technical Days' which have made it possible to discuss the controversies surrounding the benefits and drawbacks of 'pond-waterbodies'. The Centre's expertise in all topics relating to waterbodies mean that it is our key partner for meeting our needs for knowledge and recommendations on lake ecosystem management.

We hope to expand our discussions with the ECLA Centre on questions including the effects of small artificial waterbodies on their ecosystems, their aggregate impact and best management practices.

Christophe Piana
Director of the *Syndicat Mixte d'Aménagement et de Développement de Serre-Ponçon* (Joint Development and Planning Authority - SMADESEP)

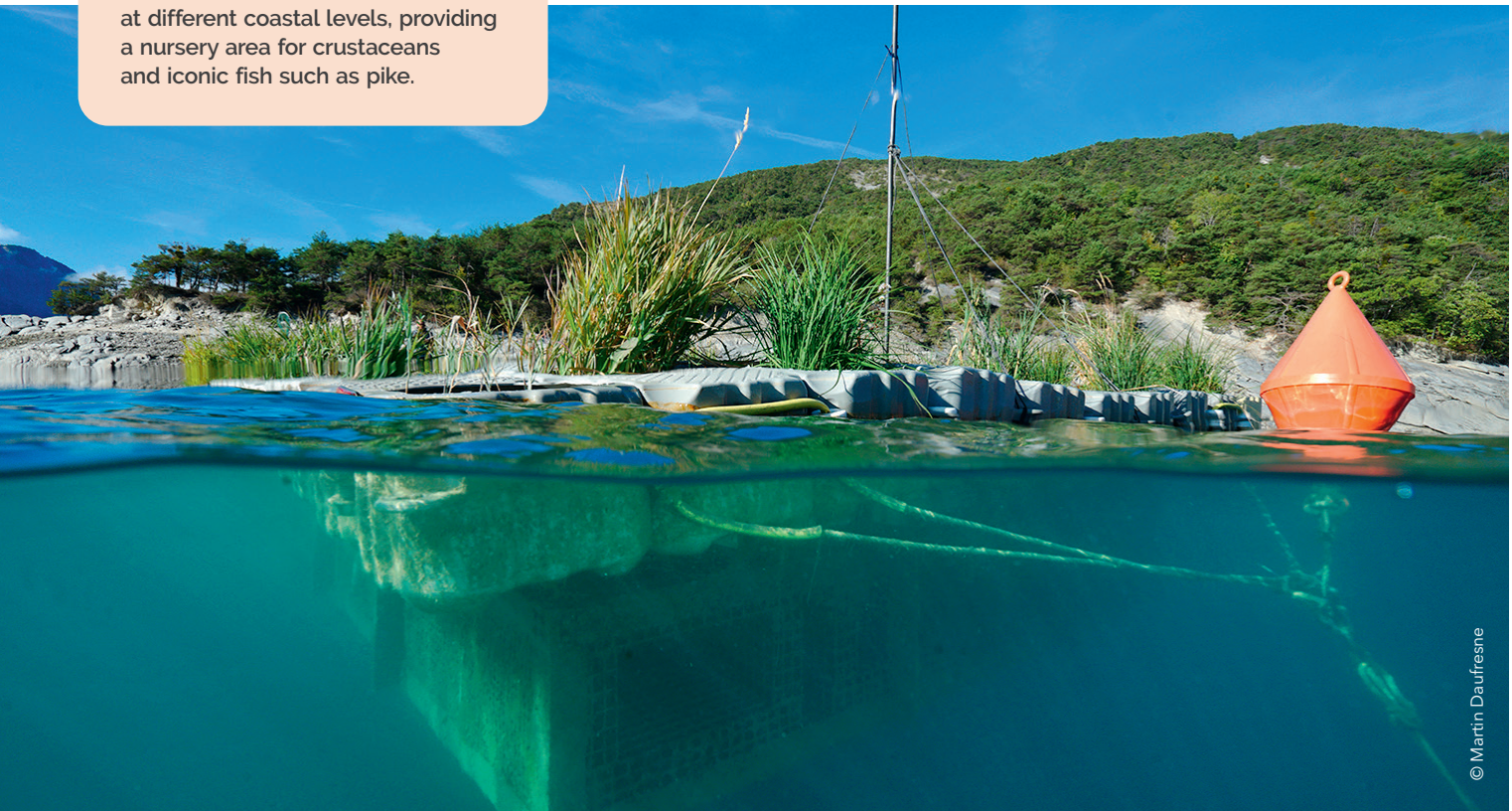
The construction of the Serre-Ponçon dam in 1959 created an artificial reservoir of over 2,800 hectares. Since 2008, our joint development and planning authority has been working on developing tourist facilities and activities on the lake, managing port facilities and ensuring the environmental quality of the ecosystem.
One of the reservoir's challenges is to do with its increased tidal range, the extent of which depends on the inflow of water upstream, energy production and hydraulic requirements downstream of the dam. These variations prevent riparian and aquatic vegetation from establishing itself and developing.
The UROS project, carried out in partnership with the ECLA Centre, focused on creating artificial floating islands covered with vegetation to support biodiversity despite the fluctuations in water levels. These structures recreate a riparian zone and underwater habitats at different coastal levels, providing a nursery area for crustaceans and iconic fish such as pike.

being monitored, improve the spatial and temporal representativeness of assessments, and simplify and reduce implementation costs.
In parallel, the Centre's research is continuing in France's overseas territories where the lack of knowledge of species' taxonomy and ecology and how their ecosystems function means that it has not yet been possible to adapt the mainland's methods or develop specific methods.

While establishing the diagnostic of environments' status is an essential prerequisite for identifying damaged ecosystems, defining and monitoring management initiatives represent the second cornerstone of the WFD to achieve good ecological status for a maximum number of waterbodies.
One of the Centre's spheres of action has therefore been to gradually take charge of the issue of lakes' ecological restoration. After summarising international knowledge, research focused on three main areas: i) the creation and testing of innovative solutions (e.g. the UROS project), ii) developing standardised monitoring protocols to assess the ecological effectiveness of the management measures implemented, iii) coordinating a network of stakeholders at national level, and gathering and analysing feedback to assess the most effective solutions (demonstration sites for waterbody restoration).

TRAINING AND KNOWLEDGE DISSEMINATION

Enhancing and transferring the knowledge produced by the Centre involves setting up training courses for decision makers, waterbody monitoring and management stakeholders and students who will become tomorrow's professionals. In this context, the Centre organises or contributes to training courses providing general knowledge in limnology or specific knowledge on certain topics such as monitoring and assessment methods or innovative methods.
Taking into consideration the issues concerning waterbodies also involves raising the general public's awareness. To achieve this, for several years, the Centre has been intensifying its scientific outreach initiatives by developing websites, organising seminars and conferences and devising educational events. This mission is currently centralised and piloted with the gradual setting up of a national centre for expertise and scientific outreach devoted to waterbodies.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New challenges for lake ecosystem management

The ECLA R&D Centre's missions have progressively broadened in scope beyond the WFD issues of ecological monitoring and diagnostics. On one hand, new environmental policies have required developing new research activities in the Centre, and on the other, it has become necessary to study a wider diversity of lake ecosystems, incorporating more fully the issues of small waterbodies and moving beyond the prism of the WFD that focuses on the ecosystems of the largest lakes, usually those covering over 50 hectares.

AIMING TO SUPPORT NEW PUBLIC POLICIES

The ECLA Centre currently helps implement several major strategies:

- The EU Nature Restoration Law

The European regulation for Nature Restoration, adopted in 2024, has benefited from this scientific expertise. This key text of the EU's biodiversity strategy sets binding objectives to restore damaged ecosystems. The regulation puts particular emphasis on environments with high carbon storage potential and reducing the impact of natural disasters. Lacustrine ecosystems are included in the targeted ecosystems along with those identified to improve and restore habitats on a large scale and ensure species' return. The regulation, which aims to restore 20% of Europe's degraded ecosystems, is directly based on the historic productions and new research carried out by the Centre.

- SNB

The SNB or National Biodiversity Strategy 2030 also requires the Centre's expertise. In accordance with France's commitment to the Convention on Biological Diversity, the SNB's objective is to reduce pressure on biodiversity, protect and restore ecosystems and to encourage profound changes to reverse the trajectory of biodiversity decline. The SNB stresses the exceptional biodiversity they are home to and the countless anthropic pressures to which they are subject. It thus suggests strengthening protection for these ecosystems, particularly present in protected areas. The ECLA R&D Centre's research priorities have thus gradually shifted to expanding knowledge on lacustrine biodiversity (status, evolution, threats, management) across the country, from protected areas to those most affected by human activity.

- Invasive species

With regard to managing invasive species, the EU Invasive Alien Species Regulation relies on the ECLA Centre's skills to assess the impacts on lacustrine biodiversity and to design management measures. Among invasive alien species, a great number have developed in lacustrine environments.

- Other public policies

The Centre strives to mobilise its skills and promote the studies it carries out to meet the numerous public policy obligations of means and results. Among these, there are also the reporting

Xavier Gayte
Deputy Director of data monitoring and assessment at the OFB

My role consists in organising and promoting monitoring data from all environments in order to meet national and European reporting obligations, particularly those of the WFD. The ECLA Centre plays a key role in banking lacustrine data. When we receive these data, we clean them and begin the reporting work in a semi-automated way. We then send these data in the correct format to the European Commission. The Centre also produces concrete knowledge and tools for management and decision making. Thanks to the close collaboration between the OFB, INRAE and the USMB, the 'nature restoration' plan for 2026 might be able to benefit from the same technical and decision-making support. One of the next challenges for managers is to continue this monitoring to maintain data in long series, bearing in mind that new pollutants are gradually being incorporated into regulatory monitoring and generating new costs.

© Jean-Marc Baudoin

Dam of the Bimont Lake.

Victor Frossard
Hydrobiologist, lecturer and researcher at the Université Savoie-Mont Blanc (USMB)

My research topics with the CARRTEL Unit, affiliated to the ECLA R&D Centre, focus on lacustrine ecosystems' responses to the pressures they suffer. I study, among other things, invasive species in large Alpine lakes, some of which represent major issues in terms of managing these ecosystems. The ECLA R&D Centre contributes to the continuity of research over the long term for applied scientific projects, enabling me to reinforce my support for lake managers. The example of the Quagga Mussel is revealing because its presence can impact water sports and drinking-water supplies. Our research on this has made it possible to expand knowledge of its reproduction and distribution dynamics.
The interactions between the ECLA R&D Centre's researchers and lake management stakeholders enable us to develop concrete tools and applications to conserve lacustrine ecosystems.

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Potamogeton (pondweed) seen from below.

obligations of the Habitats-Fauna-Flora Directive, the Birds Directive, several national action plans for endangered species, the 'prevent-reduce-offset' doctrine and various protected species. Some public policies such as the Wetlands Plan, the National Low Carbon Strategy and the National Climate Change Adaptation Plan do not explicitly quote the need for knowledge of lacustrine environments. Nevertheless, these ecosystems are directly concerned and the Centre's studies indirectly feed these approaches through assessments of their status, functioning, restoration, biodiversity and vulnerability, among other things. Very often, this work takes place prior to the legislation being introduced.

RESEARCH AHEAD OF PUBLIC POLICY

In addition to operational support activities for ongoing public policies, the Centre also initiates exploratory studies of several questions likely to be the subject of national or local strategies. While the methodological effort provided by the WFD has been a tremendous driver for the study of waterbodies, the scope of knowledge produced in the context of the Directive had to be broadened to include the needs of managing smaller waterbodies with a wide variety of characteristics. The Centre is therefore now developing solutions to better meet the needs of local managers.

- Biodiversity

In order to improve knowledge of biodiversity, the Centre's research includes conducting studies into innovative monitoring methods (environmental DNA, hydroacoustic and remote sensing), as well as developing new overview indicators to understand and highlight trends and threats, and developing functional approaches to fully integrate the role of lacustrine biodiversity into the ecosystem services provided to human societies.

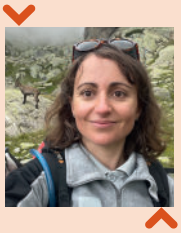
- Climate change

Temperature is a fundamental physical factor that structures the functioning of lacustrine ecosystems. Climate changes and the threats they pose to lacustrine environments are, therefore, another key topic for studies carried out by the Centre. To monitor and anticipate these upheavals, ECLA's researchers created and steered the *Réseau National de suivi de la Température des plans d'eau* (national network to monitor waterbody temperatures). This network aims to acquire knowledge of waterbodies' thermal response to climate change. It compiles measurements in the field and satellite observations in order to model the status and thermal trajectory of all France's waterbodies. The Centre will thus be able to guide the

sustainable management of these ecosystems thanks to multi-scenario prediction tools. In addition to the purely physical effects of climate change, the Centre also conducts research into the consequences on biodiversity and lakes' functioning (in particular greenhouse gas storage and emissions), species' adaptation capacities and management and restoration measures that would enable future upheavals to be mitigated. Together, these studies hope to inspire tomorrow's management policies.

- New challenges

More recently, the ECLA R&D Centre has also been studying the still-unknown effects of the intensification of certain anthropic uses of lakes. This is especially relevant for the development of renewable energies, with, for example, the creation and multiplication of floating photovoltaic power plant installations. There is also the issue of vastly increased visitor numbers to natural areas, which has intensified since the COVID-19 pandemic and people seeking cool spots during heatwaves.



Rosalie Bruel
Research Fellow, OFB

I'm a research fellow at the ECLA R&D Centre and I study the impact of climate change on lacustrine ecosystems. In particular, I'm responsible for organising the *Réseau National de suivi de la Température des plans d'eau*, a network to monitor waterbody temperatures at high frequency. Managers of natural areas (parks, reserves, conservatories, syndicates), fishing federations and other partners have been participating in this monitoring since 2013. These raw data are used in studies or to calibrate models in order to change scale. Thus, while the *in situ* network currently only includes 28 lakes, we have simulations for 401 waterbodies. These data enable us to characterise lake warming and its impact on the species present, along with greenhouse gas exchanges. In view of the challenges that threaten lakes' ecosystem services, the public authorities can rely on the network and the studies it supplies to prioritise conservation actions to be carried out.

Conversion of a gravel pit into a solar farm in Peyrolles-en-Provence.

Julien Cucherousset
Research Director, CNRS

I'm based at the CRBE and carry out research into aquatic ecology in partnership with the ECLA R&D Centre. My studies focus on emerging issues for lacustrine ecosystems, including the ecological impacts of floating solar power plants, biological invasions and the functioning of gravel pit waterbodies, which have yet to be studied extensively. Small waterbodies are rich in biodiversity and face numerous pressures, but their regulatory monitoring is not systematic. With tools such as remote sensing, we can study the relationship between the colour of a waterbody and its health status which reflects its ecological functioning. This fundamental research is enriched by interactions with other, more applied research, thanks to the ECLA Centre. This collaboration has led me to rethink waterbodies not as isolated entities, but as interdependent systems with common uses, pressures and challenges.

A key centre for the sustainable management of waterbodies

Faced with the growing complexity of environmental, climatic and societal issues affecting lake environments, the ECLA R&D Centre now occupies a central place in the French landscape of applied research and public policy support. Arising from the requirement to implement the Water Framework Directive, it has evolved over the years, integrating new partners, broadening its fields of expertise and adapting its work to emerging priorities.
Its innovative approach based on inter-institutional cooperation, the link between scientific knowledge production and operational transfer and the sharing of infrastructure and human resources makes it a model of efficiency in meeting the expectations of the State, local authorities and managers, as well as in providing information to the general public. Today, the tools developed by ECLA – whether monitoring protocols, ecological status indicators or ecological restoration – are widely used within the framework of the WFD and also in a range of public policies and in preparation for those to come. In a context of ecological transitions that will need to accelerate, the ECLA R&D Centre represents a crucial driver to ensure the sustainable, informed, science-based management of these freshwater environments that are so precious for our societies. ■

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Freshwater blenny.

Overview of the *Sciences, Eaux et Territoires* dossier

The *Sciences Eaux & Territoires* journal offers clear, comprehensible information of high scientific and technical quality to inform action and decision-making processes in local development and the environment. It covers numerous topics that are of major importance for regions.

In its latest issue, the journal focused on the work carried out by the ECLA R&D Centre as part of its 2020-2026 scientific programme. 25 papers written by the Centre's scientists are divided into 5 chapters:

- From research to producing regulatory assessment tools: situation and perspectives
- ELCA Centre innovations for advanced future monitoring
- Lacustrine ecosystems facing local and global anthropic pressures
- Ecological restoration and engineering: a key issue in the sustainable management of biodiversity
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