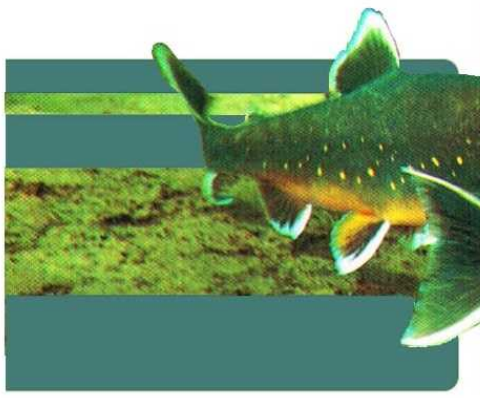
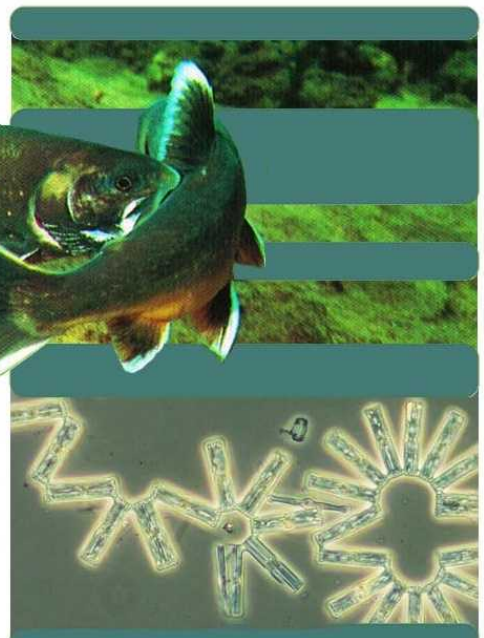
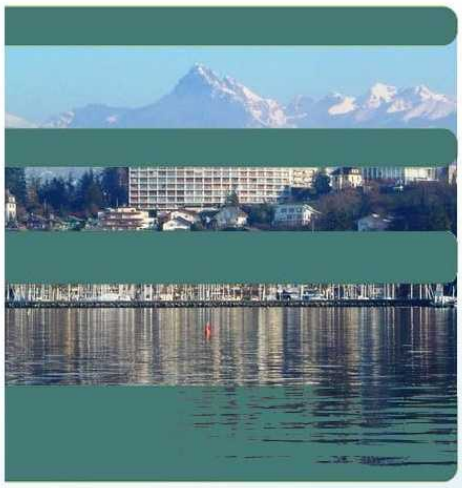






CARRTEL

Centre Alpin de Recherche sur les Réseaux Trophiques et Ecosystèmes Limniques

UMR

Joint Research Unit

(Unité Mixte de Recherche)

CARRTEL

Alpine Center for Research on Lake Ecosystems and Food Webs

(Centre Alpin de Recherche sur les Réseaux Trophiques et Ecosystèmes Limniques)

UNIVERSITÉ SAVOIE MONT BLANC

INRA SCIENCE & IMPACT

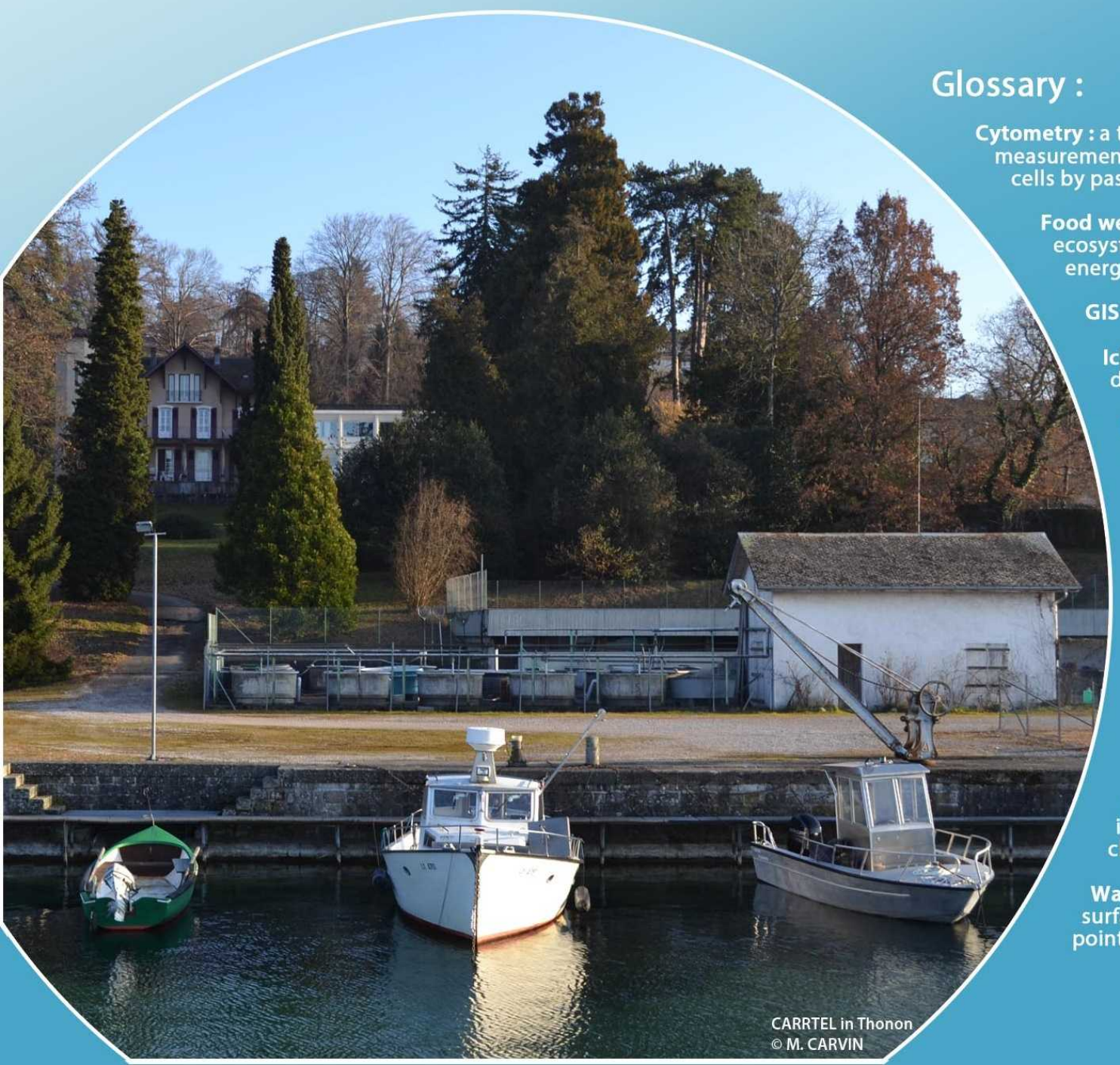
CARRTEL

Centre Alpin de Recherche sur les Réseaux Trophiques et Ecosystèmes Limniques

The CARRTEL (Alpine Center for Research on Lake Ecosystems and Food Webs*) is a Joint Research Unit that brings together the INRA and the University of Savoie Mont Blanc. It is located at both the Thonon Lake Hydrobiology Unit and at the Savoie Technolac campus in Bourget-du-Lac.

Since its creation in 1999, the CARRTEL's aim has been to gather knowledge about the functioning of lake ecosystems, in particular the deepest large peri-alpine lakes and the high altitude small lakes. These ecosystems are studied in the context of environmental and climatic changes and linked to the input from the watershed*. The CARRTEL assesses the state and evolution of the quality of aquatic environments, thereby participating in their management. The research is organised around 2 thematic lines, based on shared technical staff and facilities.

The researchers, university lecturers, engineers, technicians, PhD students and students that form the Unit (around 45 people) implement various disciplines in the fields of ecology and limnology* (ichthyology*, microbiology, ecotoxicology, molecular biology...).



CARRTEL in Thonon
© M. CARVIN

Glossary :

Cytometry : a technique enabling the measurement of some parameters of isolated cells by passing them in a laser beam.

Food webs : a set of food chains of an ecosystem through which matter and energy circulate.

GIS : Geographic Information System.

Ichthyology : the branch of biology devoted to the study of fish.

Limnology : the study of inland waters.

PCR : Polymerase Chain Reaction, a method enabling the duplication in large numbers of a DNA or RNA fragments.

SOERE : long-term observation and experimentation system for research of the environment.

Speciation : the distinction between the different chemical forms of an element.

Taxonomy : branch of science that encompasses the description, identification, nomenclature, and classification of organisms.

Watershed : an area of land where surface water converges to a single point called the outlet.

Technical Facilities

Five facilities coordinate the various technical skills of the CARRTEL. They produce and analyse the data necessary for the research. They respect the INRA quality framework which guarantees the traceability and accuracy of the results.

Samples and data

Numerous measurements are regularly carried out *in situ* in the alpine lakes using the CARRTEL's boats. This ensures the necessary parameters for the surveillance of the environment status are in place (monthly or by-monthly monitoring) and they are also used for research work. The data (phytoplankton, zooplankton, fish, physico-chemistry, etc …) resulting from this monitoring is entered into the observatory's Information System.


© C. MAITRE

Experimental Facility

They bring together several experimental systems of the CARRTEL: a harbour, boats equipped to take samples, a fish farm with multiple basins and rooms with temperature control, outdoor artificial canals and breeding rooms.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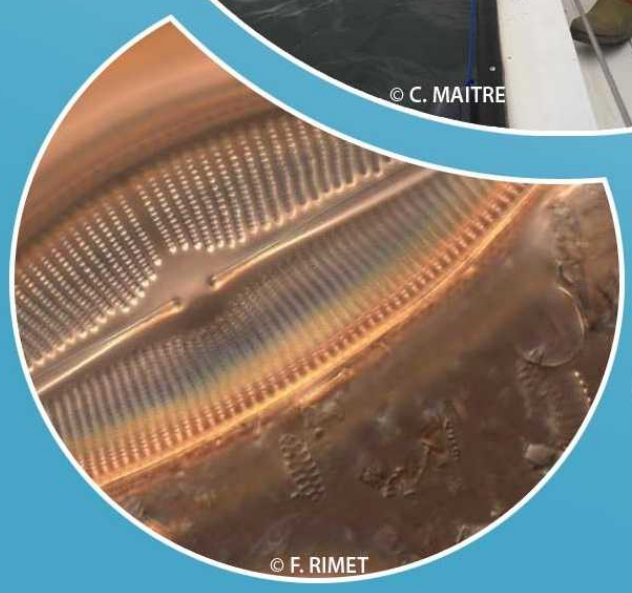
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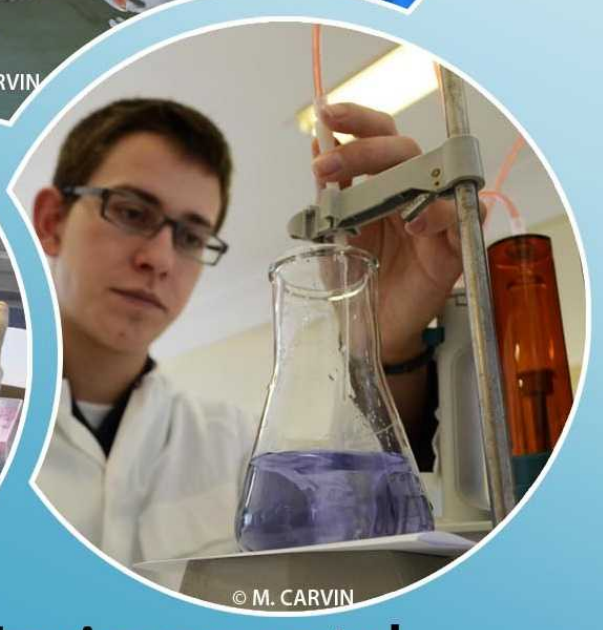
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Biodiversity

This facility brings together the laboratory's taxonomy* skills and deals with the microscopic and cytometric* analysis of samples. It involves the counting and identification of organisms (virus, bacteria, ciliate, phytoplankton and zooplankton) and the analysis of fish scales.

Molecular Biology

Using molecular tools (on DNA and RNA), this facility allows to analyse and charaterise the diversity of aquatic organisms (in particular micro-organisms). Various techniques are used: extraction of DNA and RNA, PCR*, molecular fingerprinting, cloning and preparation of samples for massive sequencing.

Environmental Chemistry

This facility covers the physical-chemical analysis of lake and river water. It quantifies the major elements, in particular carbon and nutrients such as nitrogen and phosphorus. It also traces, by speciation*, the origin of the phosphorus from the sediment and the soil samples collected in lakes' watersheds*.

Thematic Lines

BACC

(Biodiversité Aquatique: Causalités et Conséquences)

(Aquatic Biodiversity: Functional Causalities and Consequences)

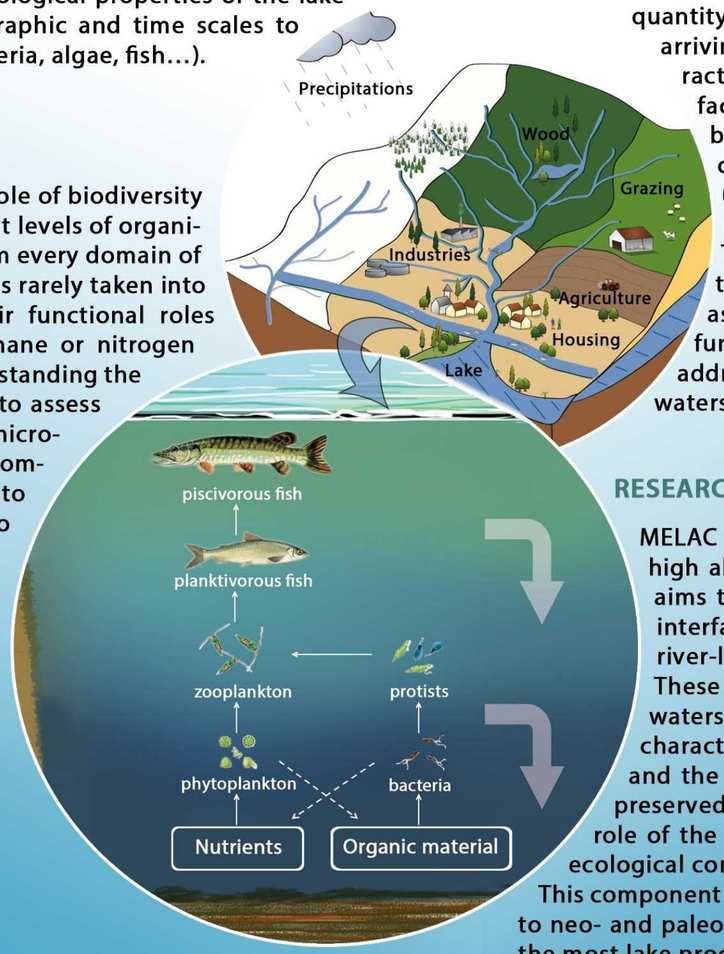
CONTEXT

The lake organisms depend on their environment. The physical and chemical characteristics of their environment are affected by changes of natural (climate evolution and variation) and human related-parameters (land use in the watershed*…). These changes can impact aquatic biodiversity, population abundances, community structures and interactions between organisms. As a consequence this could result in changes in the general functioning and ecological properties of the lake ecosystem. These properties are studied over multiple geographic and time scales to understand the different compartments of the food web* (bacteria, algae, fish…).

RESEARCH OBJECTIVES

A first objective consists in describing and understanding the role of biodiversity in the ecosystem functioning. Studies are carried out at different levels of organisation (from individuals to communities) and on organisms from every domain of life (from virus to fish). The analysis of the biodiversity of groups rarely taken into account (archaea, picocyanobacteria, macrophytes) and their functional roles (connections between micro- and macrobian networks; methane or nitrogen cycles) are carried out. The second objective will focus on understanding the impact of environmental forcings on communities. The aim is to assess the response of key organisms to these forcings (e.g. impact of micro-pollutants; multiple forcings hierarchisation), to improve the comprehension of the links between phylogeny and sensitivity, and to evaluate the importance of organisms' adaptive potential. To achieve these goals, monitoring (OLA database), *in situ* and laboratory-based approaches are implemented for time scales ranging from a few days to several decades.

European perch
©J.-L. BERTOCELLO



MELAC

(Méta Ecosystème LAcustre dans un contexte de Changement global)

(Lacustrine Meta Ecosystem in a Context of Global Change)

CONTEXT

The lake is inseparable from its watershed and the human activities that take place there (agriculture, industry, urbanisation …). In these watersheds* the bio-physical-chemical processes determine the quantity and quality of the flow arriving in the lake. In interaction with the climatic factors these flows contribute to the fundamental characteristics of the lake (thermal regime, hydrodynamics, chemical quality…). The change in the landscape of the watersheds and of the flows associated with them therefore affects the functioning of the lake ecosystem. These links are addressed in a "lake meta ecosystem" approach that explicitly connects the lake and its watershed.

Lake of La Muzelle
©M.-E. PERGA

RESEARCH OBJECTIVES

MELAC addresses the consequences of global changes in the large peri-alpine lakes and the high altitude small alpine lakes through a meta-ecosystemic approach. A first objective aims to reinforce our understanding of the earth-water mosaic, including study of the interfaces between the terrestrial and aquatic systems (transitions in watershed-swamp, river-lake and coastal regions), that are considered to be biogeochemical "hot spots". These key areas control the flow of elements (phosphorus, carbon and nitrogen) from the watershed to the receiving aquatic environments. This objective is based on spatial characterisation tools for the watersheds (GIS*, telemetry and establishment of patterns) and the development of flow tracers (phosphorus isotopes, fossil DNA) whose marks are preserved during the terrestrial-aquatic transfer. A second objective aims to understand the role of the structure of the watersheds and of their past and current land-use on the lake's ecological conditions. The studies also focus on their vulnerability in the face of climate change. This component is based on the comparison of numerous lakes on an alpine and global scale, thanks to neo- and paleo-limnology tools, in order to identify the factors, natural or human, that influence the most lake processes.

Partnerships and Scientific Networks

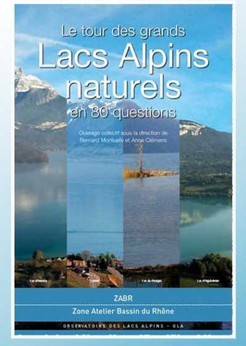
The CARRTEL's scientific actions are based on several diversified partnerships: Universities (Chambéry, Clermont-Ferrand, Lyon, Paris...), public research institutes (CNRS, IRD, IRSTEA...). Internationally the CARRTEL collaborates with Swiss teams (Geneva and Lausanne Universities) as well as teams from other countries (Austria, Canada, Germany, Italy, Poland, USA ...). The CARRTEL is a member of several worldwide and European scientific networks (FASCICLE, GLEON, NetLake). At a regional level, it is a member of an Environmental Research Federation and a Long Term Ecological Research organisation. Giving the applied nature of its works, the CARRTEL has a strong partnership with management organisations (Asters, CIPEL, CISALB, SILA ...) and stakeholders (Agence de l'Eau RMC, ONEMA).

Validation

Continual publication in international scientific journals
http://www.thonon.inra.fr/La-communication/Listes-des-publications

Regular communication with the media (print and radio)

"Open Lab Days" at the Thonon site



Co-authoring the general public book "Le tour des grands lacs alpins naturels en 80 questions"

Training

Teaching and reception of workshops from French BTS to Master 2

Coordination of limnology teaching at the ECOMONT Master

Reception and supervision of PhDs

Co-organisation of Limnology Summer School with the University of Irkoustk (Russia) and the University of Geneva (Institut Forel)

Observatory on alpine LAkes

The OLA SOERE*

Managed by the CARRTEL, the aim of the Observatory on alpine LAkes (OLA) is to provide quality scientific data to understand and *in fine* establish a pattern for the evolution of the condition and ecological functioning of lake ecosystems that are subjected to changes in human, local and global pressures.

Bringing together ten research laboratories, the observatory provides long-term monitoring of several lake ecosystems, performing both the sampling, *in situ* and laboratory measurements and the archiving of validated data in an Information System.
It also runs shorter term scientific programmes around various themes: biodiversity, functioning of trophic networks, transfer of contaminants (BPC)...

The three large natural peri-alpine lakes wich are the Annecy, Bourget and Geneva lakes, as well as high altitude small lakes are at the heart of this observatory.
Monitoring has been in place since a period ranging from 1960 to 1970, depending on the lake, therefore the OLA has a unique and regularly updated database. The observatory has been classified SOERE by the Alliance AllEnvi and is recognized by the Global Lake Ecosystem Observatory Network (GLEON).

Useful Links :

AFL (Association Française de Limnologie)
www.limnologie.fr

Agence de l'eau Rhône Méditerranée Corse
www.eaurmc.fr

AllEnvi (Alliance nationale de recherche pour l'Environnement)
www.allenvi.fr

Centre INRA ARA (Auvergne-Rhône-Alpes)
www.clermont.inra.fr

Asters (Conservatoire d'espaces naturels Haute-Savoie)
www.asters.asso.fr

CIPEL (Commission Internationale pour la Protection des Eaux du Léman)
www.cipel.org

CISALB (Comité Intersyndical pour l'Assainissement du Lac du Bourget)
www.cisalb.com

EFPA (Ecologie des Forêts, Prairies et milieux Aquatiques)
www.efpa.inra.fr

FASCICLE (French Asian Study on global Change effects through Inter-site Comparison of Limnic Ecosystems)
www.fascicle.cnrs.fr

GLEON (Global Lake Ecological Observatory Network)
www.gleon.org

ONEMA (Office National de l'Eau et des Milieux Aquatiques)
www.onema.fr

NetLake (Networking Lake Observatories in Europe)
www.cost.eu/COST_Actions/essem/Actions/ES1201

SILA (Syndicat Mixxte du Lac d'Annecy)
www.sila.fr

ZABR (Zone Atelier Bassin du Rhône)
www.zabr.org

Lake Geneva in winter ©A. BOUCHEZ

CARRTEL
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Alpine Center for Research on Lake Ecosystems and Food Webs

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www.inra.fr
www.univ-smb.fr

Observatory of alpine LAkes
www6.inra.fr/soere-ola

Information System
si-ola.inra.fr