

# CONSERVATION OF AQUATIC HABITATS AND SPECIES IN HIGH MOUNTAINS OF THE PYRENEES



## EDITORIAL



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We start a new edition of the newsletter in which we speak of the high mountain lakes in general, both in terms of their origin and the different groups of organisms that live there. More specifically, plants that live submerged in water and which characterize most of the shallowest lakes.

During the last six months we have installed two new information panels of the project in the valley of Tredòs (Val d'Aran) and we have been processing all the samples that we have collected in the monitoring surveys of the different actions. We have also organized two congresses, the first one

together with the LIFE BIOAQUAE project, will be an International Conference on the Conservation of High Mountain Lakes and will be held in early July at the national park of Gran Paradiso (Italian Alps). The second one, which we co-organize together with the LIFE POTAMOFUNA project and the Group of Specialists in Biological Invasions, is the fifth Spanish National Congress on Invasive Alien Species and will take place in Girona next October.

In the brief news section you will find a summary of the outreach activities in which LIMNOPIRINEUS has been present as well as new routes of the travelling exhibition of the project.

photo: A. Gallés

# HIGH MOUNTAIN LAKES

## SIX MONTHS IN THE DARK

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The Pyrenean lakes have a glacial origin and are characteristically subject to extreme conditions. Their waters are very cold and contain few nutrients.

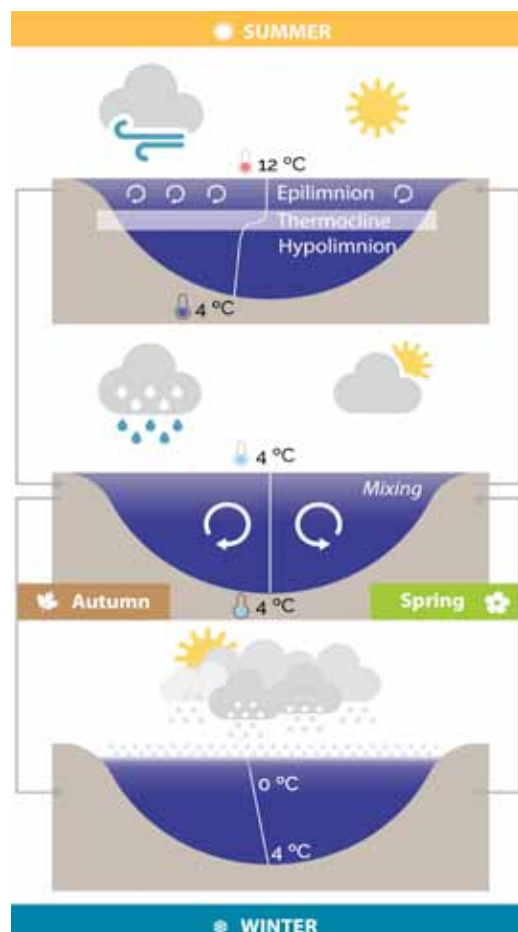
One of their distinguishing features is that in the winter their waters ice over. The snow that accumulates on the ice leaves the interior of the lakes in the dark for half of the year, which means that the species that live there must be adapted to a very marked seasonal cycle.

There is a wide diversity of species in the Pyrenean lakes, ranging from organisms that live in suspension in the water and form part of the plankton (algae, water fleas and copepods) to the plants, molluscs, worms, insects and amphibians that live on the lake bottom or the shores, to the birds and bats that feed on the insects that emerge from the water.

*Bassa de Romedós 2125 m (Pallars Sobirà). Photo: A. Miró*



*Estany de Subenuix 2194 m (Pallars Sobirà). Photo: A. Miró*



Lakes in the Pyrenees that are deep enough are dimictic; between the autumn and spring mixing lakes are covered with ice and snow for 6 months.

### Altitude

The higher the lake, the colder its water and the less organic remains enter it because there is less vegetation in the basin.

### Mineral salts

Mineral salts vary depending on the geology of the basin. The water of the lakes on granite is less mineralised.

### Size

Their size can vary from a few square metres to more than 50 hectares in the case of the largest. The ponds and small lakes completely ice over in the winter and can dry up in the summer.





Illustration: T. Llobet

## CONSERVATION RISKS

Some of the main threats to the species that live in the lakes are:

- ◆ The introduction of invasive species of fish that prey on the most conspicuous species such as invertebrates, insect larva and amphibians.
- ◆ Some lakes, especially the largest ones, have been used for hydraulic exploitation, which alters the shoreline habitat and the species that live there.
- ◆ Even though the lakes are found in remote areas diffuse contamination from the high layers of the atmosphere reaches them, which is detected mainly in the species at the top of the food chain.



The European minnow (*Phoxinus sp.*) is a small cyprinid that has been introduced in many lakes in the Pyrenees.

# AQUATIC PLANTS OF THE LAKES OF THE PYRENEES

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**A**quatic plants are organisms secondarily adapted to the aquatic environment with terrestrial ancestors. They can be ferns or flowering plants and have adaptations to live totally or partially submerged. They are also known as macrophytes and this term includes some algae from the family of Characeae. From the ecological point of view, they are important elements of estuaries, wetlands, riversides, shallow lakes and the seashore, where they can occupy wide extensions.

There are different functional typologies of aquatic plants based on their interaction with the water and eventually the air and/or the sediment. The helophytes have their roots and rhizomes in the soil, but the stems stand above the water surface in the transition between

terrestrial and aquatic ecosystems. Other species are submerged but extend their leaves to the surface to access CO<sub>2</sub> from the air (e.g. water lilies) avoiding gas diffusion limitations associated to stagnant waters. A third group of species (i.e. water lentils) grows in nutrient rich and turbid waters and float on the water lamina while have soaked roots.

The totally submersed species can have different dependence on the sediment; some of them have well-developed root system to obtain nutrients (i.e. *Potamogeton* species) or even carbon dioxide (i.e. species of *Isoetes*) from the sediment. Others such as *Myriophyllum* or *Ceratophyllum* species have non-functional roots that essentially help them to anchor, similarly to the macroalgal group of charophyte.

► **Figure 1.** *Potamogeton alpinus*. Foto: E. Ballesteros





## Aquatic plants of the lakes of the Pyrenees:

The Pyrenean district, with several thousands of lakes, is dominated by small (<3 Ha) and shallow (<12 m) systems with clear waters. Benthonic primary production is associated to microscopic organisms such as diatoms and cyanobacteria, and in many cases to meadows of submerged aquatic plants (Fig. 1).

Twenty taxa of macrophytes are known from the lakes of the Catalan Pyrenees. Its distribution, apart from historical factors of colonization, depends on the altitude with a threshold around 2400 m, which determines its absence.

The duration of the ice-free cover, which decreases with altitude, determines the window time for the species to grow and reproduce and therefore is crucial for their survival.

The species composition of the aquatic plant communities depends on the chemical composition of water and depth. Water alkalinity (mineral content) and nutrients (nitrogen and phosphorus) are universal factors to drive the composition of macrophyte communities in continental waters.

In the Pyrenees the conditions are exacerbated and the species present are characteristic of oligotrophic or ultra-oligotrophic and poorly mineralized waters, often common in the Centre and North of Europe.

The most frequent species is *Sparganium angustifolium* (Fig. 2), a natopotamid of floating leaves frequent in inlets and outlets of the lakes. *Isoetes lacustris* (Fig. 3) is also very common and develops large and dense meadows in much diluted water systems (extreme oligotrophy). *I. echinospora* and *Subularia aquatica* (Fig. 5) appear in shallow waters of moderate mineralization and nutrient content within the Pyrenean context. *Myriophyllum alterniflorum* and different species of *Potamogeton* are found in waters enriched with salts.

Finally, shallow ponds with cattle frequentation may become eutrophic thus growing species such as *C. palustris* and *P. natans*.



► Figure 2. *Sparganium angustifolium*. Foto: E. Chappuis



► Figure 3. *Isoetes lacustris*. Foto: E. Ballesteros

There is a zonation in the distribution of the different species of macrophytes in the littoral of the lakes. In a theoretical profile (Fig. 4), the *Nitella* algal group, with lower light requirements than more structured upper plants, will occupy the deepest (often below 5m) part. *I. lacustris* with a depth limit around

4 m, will follow in much diluted waters while *P. berchtoldii* in waters not so diluted. *R. aquatilis*, *S. aquatica* and *I. echinospora* are characteristic of shallow littorals often accompanied by *S. angustifolium*, always constrained above 1.5 m depth. Emerging wetlands of *C. rostrata* are found at the transition from land to the water.

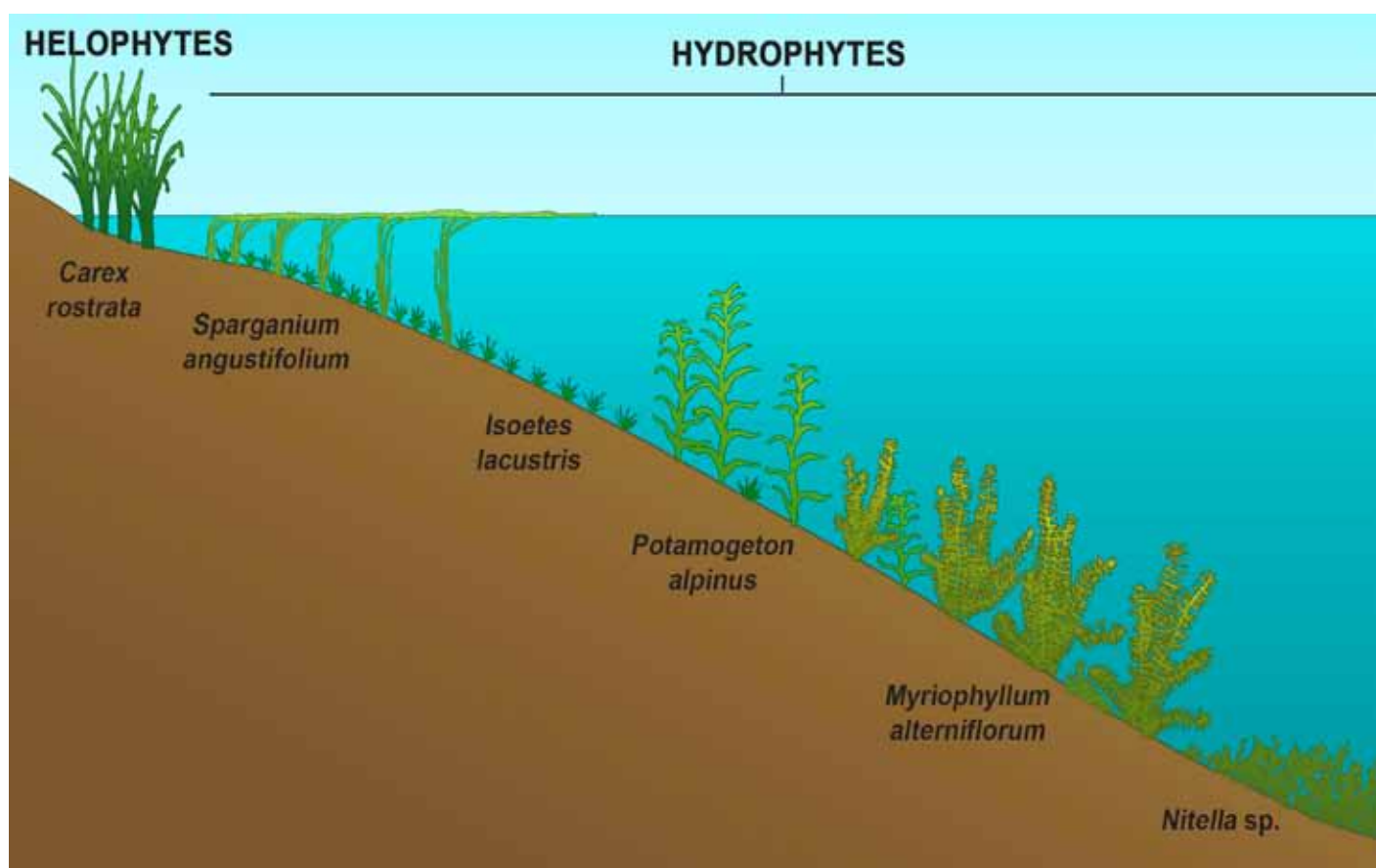


Figure 4. Theoretical profile showing zonation in the distribution of the different species of macrophytes in the littoral of the lakes. Source: original E. Chappuis.

## Primary production

The most productive aquatic plant communities from the lakes of the Pyrenees are those growing in waters relatively enriched with dissolved inorganic carbon (DIC) and situated in the lower altitudinal range. They are composed by species of *Potamogeton* (*P. berchtoldii* and *P. alpinus*) and *M. alterniflorum* and produce in the order of 200 g C m<sup>-2</sup> year<sup>-1</sup>. Species from the genera of isoetids

(*I. lacustris* and *I. echinospora*) dominate lakes with low alkalinity and nutrient content and produce up to 70 g C m<sup>-2</sup> year<sup>-1</sup>. Shallow zones with water movement are often colonized by *S. angustifolium* that produces in the order of 120 g C m<sup>-2</sup> year<sup>-1</sup> while in the deepest zones the production of the algae *Nitella* is estimated to be a 50 g C m<sup>-2</sup> year<sup>-1</sup>.

Macrophytes structure the littoral space in several directions; vertically when the species anchored to the sediment grow up looking for light, as the case of *Myriophyllum* or Characeae or horizontally with leaves covering the water surface such as in *Sparganium* or some *Ranunculus*.

They offer shelter to invertebrates, amphibians and small fish, reducing the risk of predation; and its presence often conditions daily movements and interactions between these animals.

Globally, macrophytes are little consumed directly, although they favour the growth of epiphython (periphyton) that are consumed by invertebrate herbivorous. Aquatic plants contribute significantly to the food web by fuelling the detritivore pathway thanks to macro-invertebrate shredders and microbiota.



► **Figure 5.** *Subularia aquatica*. Foto: E. Ballesteros

## Impacts

Lakes of the Pyrenees have been away from the human impact with the general exception of the construction of hydroelectric infrastructures in the middle of the XX century that resulted in the regression of underwater vegetation in the exploited systems.

Similarly, the water demand for sky resorts to produce artificial snow has generated new cases of exploited lakes such as Estany Baciver (Vall d'Aran).

The resilience and recovery of the different macrophyte communities varies substantially and ranges from close to 20 years to cover all the potential niche for the shallow *S. angustifolium* community accompanied by *S. aquatica* and *I. echinospora* to over 60 years for *I. lacustris* to colonise all its potential niche in lake Baciver.

Recently, within the last decades, the massive proliferation of the introduced fish *Phoxinus* sp. (i.e. minnows) seems to disturb substantially water and ecosystem quality, with water becoming turbid and thus potentially threatening Pyrenean submersed macrophytes.



# TREDÒS VALLEY

## INFORMATION PANELS ON LIFE LIMNOPIRINEUS

Recently two new information panels on the LIFE LIMNOPIRINEUS project have been installed in the Tredòs valley, one at the arrival point of the visitors, in the parking area of the Banhs de Tredòs, and the other at the point of arrival of the Taxis from where starts the itinerary that goes up to the glacial cirque of Colomèrs.

The panels show the natural richness of high mountain aquatic environments, lakes, rivers, peat bogs and petrifying springs, and the actions to improve the state of conservation of these environments in the National Park of Aigüestortes and Estany de Sant Maurici, the Natural Park of the Alt Pirineu and in Estanho de Vilac (Val d'Aran). Panels include descriptions in five languages, including Aranese, Catalan, Spanish, English and French.



► Panel installed at the taxis arrival point.  
Photo: M. Ventura.



► Information panel on LIFE LIMNOPIRINEUS. Photo: M. Ventura.





## THE SHORT NEWS



28/2/2017

### Travelling EXPO of the project leaves the Faculty of Biology

The exhibition has been installed during the last month and a half in the hall of the Faculty of Biology of the University of Barcelona.



24/03/2017

### A wooden footbridge protects the wetlands from the ascent path to the Pica d'Estats

The new construction aims to prevent the deterioration of these habitats due to the continuous trampling of visitors. This is a very frequented area, as 5,350 people travel through the path every year. These ecosystems of high natural value, unique and rare in the Pyrenees are protected at European level and included in the Natura 2000 Network.

20/4/2017

### The EXPO has been installed in the Aran valley

The exhibition has been seen at the Vielha Ice Palace, at the secondary education center Aran, in the schools Garona, Alejo-Casona, Sant Roc and ZER Arties. In this way we have completed the dissemination work at the Aran valley schools where students and families have learned about the location of these high mountain aquatic ecosystems so close to their place of residence.



15/05/2017

## Symposium on the ecology of the Pyrenean newt, *Calotriton Asper*

Members of the LIFE LIMNOPIRINEUS technical office have participated in the symposium on the ecology of the Pyrenean newt organized by the University of Lleida, the Centre d'Ecologie Fonctionnelle & Evolutive and the Catalan Institution of Natural History. The aim of the day was to bring together people involved and interested in the ecology and conservation status of the Pyrenean newt in order to exchange interesting data for the knowledge of the habitat that occupies the species.



02/06/2017

## Travelling EXPO of the project arrives to the National Park of Aigüestortes and Estany de Sant Maurici

Taking advantage of the summer large influx of visitors to the Aigüestortes National Park, the LIFE LIMNOPIRINEUS exhibition will move to Espot in June and to Boi in July and August.

6-8/07/2017

## International meeting on the conservation of high mountain lakes

Great participation at the international meeting on the conservation of high mountain lakes held from July 6 to 8, 2017 at the Gran Paradiso National Park in the Italian Alps. The meeting was organized in the framework of the closing events of the LIFE BIOAQUAE Project (Improvement of the biodiversity of the aquatic ecosystems of the Alps, LIFE11 BIO / IT / 000020) in collaboration with the LIFE LIMNOPIRINEUS Project (Restoration of lentic habitats and aquatic species of community interest in the high mountains of the Pyrenees, LIFE13 NAT / ES / 001210) and has focused on the role of Natura 2000 sites and protected areas, on recent advances in research, as well as on strategies management and specific experiences to achieve a long-term conservation of high mountainous ecosystems.



The meeting hosted technicians and scientists from different institutions throughout Europe and part of the United States and had 22 oral presentations and 19 posters.





The project is co-financed by the European Program LIFE+ that promotes conservation actions and restoration of habitats and species of flora and fauna at protected sites of the European Union within the Natura 2000 network.

LIFE LimnoPirineus  
LIFE13 NAT/ES/001210

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