

RIVEAL PROJECT

RIPARIAN FOREST VALUES AND ECOSYSTEM SERVICES – MACROPHYTES



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MACROPHYTES ARE...

... aquatic photosynthetic organisms large enough to see with the naked eye, that live in or near the water. Macrophytes include seven divisions, such as Pteridophyta (ferns), Spermatophyta (seed-bearing plants), and Bryophyta (mosses and liverworts), amongst other more primitive divisions, such as cyanobacteria and macroalgae (Chlorophyta, Rhodophyta, Xanthophyta).

The use of the term 'macrophyte' is not consensual and can include solely aquatic plants or aquatic and riparian species. There are some authors that include riparian trees and shrubs under the designation.

Macrophytes can be classified in:

1. hydrophytes (truly aquatic plants) anchored or free-floating, submerged or with surface leaves
2. helophytes (also called emergent plants), tolerant of periodic water drawdowns and waterlogging
3. riparian species (live in river margins in wet substrates)



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Macrophytes in a small-sized stream (hydrophytes and helophytes).

WHAT ARE THEIR FUNCTIONS?

Macrophyte assemblages are key-elements of freshwaters and act as "ecosystem engineers" of fluvial systems. They structure and create habitats, and participate in the air–water–sediments exchanges, in the regulation of water temperature and light, and in sustaining other aquatic communities, such as fish, periphyton and benthic invertebrates.



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MACROPHYTES AS BIOINDICATORS

These plant communities have the capability of incorporating the effects of successive human disturbances over long periods of time, frequently years, which can be advantageous for the assessment of the biological status of rivers.

In 2000, the European Water Framework Directive introduced macrophytes as 'Biological Quality Elements', and mandatory for its implementation (along with phytobenthos). Since then, numerous indices were developed using mostly the macrophytes' ability to detect diffuse pollution and nutrients to assess ecosystem health.

Besides trophic status, macrophytes also respond to sediment loads, hydromorphological alterations, light, water hardness, acidification, flow velocity, hydropeaking and diverse human-induced hydrological alterations, amongst other stressors.



Common duckweed (*Lemna minor*) and knotgrass (*Paspalum distichum*) in eutrophic waters downstream a dam.

MACROPHYTE INVASIVE SPECIES

Macrophytes include several alien invasive species, that cause tremendous economic and ecological damages to fluvial ecosystems.

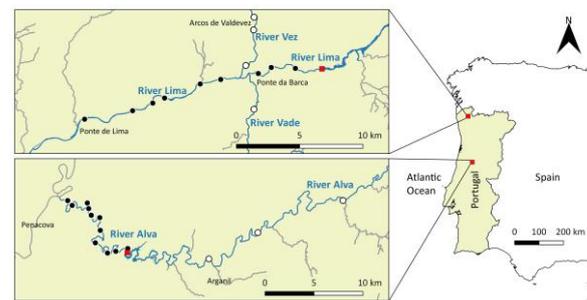
Examples in Portugal are the invasions by the free-floating aquatic species water hyacinth (*Eichhornia crassipes*), the parrot feather (*Myriophyllum aquaticum*) and the small aquatic fern *Azolla filiculoides*.

In riparian ecosystems, the giant reed (*Arundo donax*) and *Eryngium pandanifolium* can form dense stands in river margins, specially in coastal rivers.

MACROPHYTES IN RIVEAL

RIVEAL devotes to two case studies, i.e. two rivers, River Lima, and River Alva, impaired by dams with different operation rules: a run-of-river dam (Touvedo) and a reservoir dam (Fronhas). We found **78** macrophytes (excluding woody species) in the overall study area:

- **42** seed-bearing vascular plants and ferns
- **20** bryophytes (mosses and liverworts)
- **16** macroalgae



Sampling sites of the RIVEAL project in Lima and Alva Rivers; black dots are on regulated reaches and white dots are on unregulated streams. (adapted from Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616)

VASCULAR MACROPHYTES

From the more than forty macrophyte species, **11** were truly aquatic species (genera *Myriophyllum*, *Callitriche*, *Lemna*, *Elodea*, *Potamogeton* and *Ranunculus*), and the remaining were mostly emergent species (e.g. genus *Typha*, *Juncus* and *Polygonum*). The fern *Osmunda regalis* was common on river margins.

BRYOPHYTES

Bryophyte communities were composed mainly by common species of turfs and mats, many of which were not truly aquatic but hygrophilous bryophytes (e.g. *Leptodictyum riparium*, *Platyhypnidium riparioides*, *Fontinalis hypnoides* var. *duriae*, *Fontinalis antipyretica*), and only one can be truly considered a rheophilic bryophyte (*Thamnobryum alopecurum*).

MACROALGAE

The most common taxa recorded in the study area were *Spirogyra* sp. and *Oedogonium* sp., filamentous green algae, which refer slowly flowing and stagnant waters, followed by *Lemanea* sp., a red algae. The rarest macroalgae were *Batrachospermum* sp., *Klebsormidium* sp., *Tetraspora* sp. and *Ulothrix* sp., which were found on a single site.

(Data published in: Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616)

