

# ECOLOGICAL QUALITY OF LATVIAN–LITHUANIAN TRANSBOUNDARY LAKES BASED ON BENTHIC MACROINVERTEBRATES AND MACROPHYTES

Davis Ozolins<sup>1\*</sup>, Laura Grinberga<sup>1</sup>, Agnija Skuja<sup>1</sup>, Ilga Kokorite<sup>1</sup>

<sup>1</sup> University of Latvia, Institute of Biology, Jelgavas street 1, LV-1004 Riga, Latvia

\* Corresponding author: [Davis.Ozolins@lu.lv](mailto:Davis.Ozolins@lu.lv)

**Abstract:** Macroinvertebrates and macrophytes were used as indicators to assess the ecological quality of five Latvian-Lithuanian transboundary lakes. The aim of the study is to ensure joint quality assessment of trans-boundary lake water bodies, because studied lakes pose a risk for not meeting good status according to the requirements of the EU Water Framework Directive. The fieldwork was performed in May and October 2021. Macroinvertebrates demonstrated good ecological quality at all studied lakes using both Latvian and Lithuanian multimetric macroinvertebrate indices. The non-biting midges Chironomidae, as well as the mayfly species *Caenis horaria* and *Cloeon dipterum*, were dominant in macroinvertebrate communities of the studied lakes. The invasive species zebra mussel *Dreissena polymorpha* was present in four lakes while the spiny-cheek crayfish *Orconectes limosus* was observed in two out of five lakes. In addition, the medical leech *Hirudo medicinalis* was found in Lake Lielais Kumpinišķu; it is a species protected under the Habitats directive (Annex V) and under the Latvian Regulation of the Cabinet of Ministers No 396.

**Key words:** lentic habitats, aquatic vegetation, benthic invertebrates, ecological status

## Introduction

River basins are not restricted to administrative or political boundaries; therefore, some countries can affect the water quality of their neighbours. A variety of threats, e.g., invasive species, diffuse and point source pollution, water abstraction, etc., can affect waterbodies. Trans-boundary cooperation in managing and maintaining a healthy aquatic environment is required to ensure sustainable water resources (Correia and da Silva, 1999).

In the European Union, the Water framework directive (WFD) is the most powerful tool of environmental policy to ensure good ecological status of all waterbodies. The WFD determines the approach of waterbody ecological quality assessment for EU member states, including which biological quality elements to use and the usage of appropriate assessment methods (Directive 2000/60/EC). Despite the WFD being in effect for more than two decades, there are still too many uncertainties concerning it.

The first-time goal for EU member states to ensure good status of their waterbodies was 2015, however, the deadline was extended to 2027 due to the slow process of WFD implementation. Still, for some countries, assessment methods are not yet intercalibrated and new countries might join the EU without intercalibrated methods. Also, transboundary pollution is a serious issue to deal with in terms of river basin management.

In 2021, macrophyte surveys and macroinvertebrate sampling was carried out in five Latvian-Lithuanian transboundary lakes – Lake Ilzu/Garais, Lake Kumpinišku, Lake Galiņu, Lake Skirnas and Lake Laucesas. The lakes were chosen as posing a risk for not meeting good status according to requirements of the EU Water Framework Directive, and the aim was to ensure joint quality assessment of these trans-boundary waterbodies.

## Material and methods

### Macrophytes

Latvian macrophyte assessment method (Daugavas upju baseinu ..., 2015) for lakes is primarily based on dominating indicator taxa and the addition of two more parameters: species composition and the depth limit of submerged plants. Passing the littoral of the whole lake by boat, relative abundance of the macrophyte species of all belts (emergent, floating-leaved etc.) and all taxonomic groups were estimated for the lake on the 7-point scale. Using the plant hook with a marked rope (or stock), the zonation and depth limits of macrophytes were determined on transects. The frequency of transects depends on the character of the lake; they have been made after every 100–500 m. In Lithuania, the modified German Reference Index is used for macrophyte-based assessment of the ecological status of lakes (Valstybės žinios, 2013).

### Macroinvertebrates

For the sampling, a 50 m-long representative lake littoral zone stretch was chosen at each lake. Sampling was done in proportion to the coverage of dominant habitat types. Kick and sweep approaches were used with 5 replicates collected at each site. All replicates are merged in to one sample and also analyzed as one sample. Further samples were processed at the laboratory – taxa identified, and indices calculated using ASTERICS 4.04 software. For each lake, two multi-metric indices were calculated – the Latvian Lake Macroinvertebrate Multimetric Index (Skuja and Ozoliņš, 2016) and the Lithuanian Lake Macroinvertebrate Index (Šidagytė et al., 2013).

## Results and discussion

### Macrophytes

In Lake Ilzu (Garais)/Ilge, growth of macrophytes is limited by low water transparency caused by algae blooming or other suspended material. Species diversity is low – only 18 species were found. The dominating macrophyte species in the lake are *Phragmites australis*, *Nuphar lutea* and *Ceratophyllum demersum*.

In Lake Kumpinišku, the diversity and abundance of macrophyte species differ in the northern and southern parts. The northern part is shallow, and its whole area is overgrown with macrophytes; species diversity in this part of the lake is high, with 32 species found in total. The southern part of the lake is deeper and the colonization depth of submerged macrophytes is 4 m. *Myriophyllum verticillatum*, charophyte and Potamogetonacea species are most frequent in the lake. Dense halophyte stands grow all along the shore.

In Lake Galiņu, the composition of macrophyte species is typical for slightly eutrophic lakes. The colonization depth of macrophytes is high (3.9 m), and species diversity is also high, however, it is without any charophyte species, thereby indicating a good ecological status. Species typical for eutrophic lakes, e.g. *Ceratophyllum demersum*, *Sagittaria sagittifolia*, and *Myriophyllum verticillatum*, occur frequently. Overgrowth with macrophytes is characteristic for bays where water exchange rate is lower, sediments are deeper, and macrophyte stands are dense.

In Lake Skirnas the ecological quality is high and species richness is also high (34 macrophyte species). Water transparency is high, therefore the colonization depth of submerged macrophytes is also high – 5 m. Macrophyte development is limited by the steep bottom, but in the shallow parts of the lake, species composition is characteristic of low-impacted lakes. The dominating macrophyte species in Lake Skirnas are *Fontinalis antipyretica*, *Phragmites australis*, *Nuphar lutea*, *Potamogeton lucens*, *Scirpus lacustris* and charophyte species.

In Lake Laucesas, macrophyte species composition is consistent for eutrophic lakes. The diversity of macrophyte species in most parts of the lake is moderate, and submerged species occur rarer due to low water transparency. The species *Phragmites australis*, *Nuphar lutea*, *Ceratophyllum demersum*, as well as *Typha latifolia*, dominate in the whole lake. The last two species are typical for eutrophic and polluted waters.

## Macroinvertebrates

In Lake Ilzu/Garais, the overall benthic invertebrate taxonomic composition in the littoral zone is characteristic of a eutrophic lake. In spring, altogether 55 macroinvertebrate taxa were identified. Larvae of Chironomidae were the most abundant taxa at all sampling sites. Mayfly nymphs *Caenis horaria* and water mites Hydrachnidia were also common. Having the highest taxonomic diversity was characteristic for caddisfly Trichoptera larvae (14 taxa).

In Lake Kumpinišku, the invasive species zebra mussel *Dreissena polymorpha* and spiny-cheek crayfish *Orconectes limosus* were observed. Also, a legally protected medical leech *Hirudo medicinalis* was observed in the shallow part of the lake (Council Directive 92/43/EEC Annex V, Regulations of the Cabinet of Ministers No. 396). The overgrown northern part of the lake is more eutrophic and the number of macroinvertebrate taxa and their abundance there is lower than in the deeper southern part. Gastropoda was the species richest in taxa in both seasons.

Table 1. Ecological status of five Latvian-Lithuanian transboundary lakes according to the macrophyte and macroinvertebrate assessment methods of both countries

Lake	Macrophytes		Macroinvertebrates	
	Latvia	Lithuania	Latvia	Lithuania
Lake Ilzu/Garais	0.4 (poor)	0.25 (moderate)	0.67 (good)	0.58 (good)
Lake Kumpinišķu	0.8 (good)	0.51 (good)	0.71 (good)	0.71 (good)
Lake Galiņu	0.6 (good)	0.55 (good)	0.67 (good)	0.53 (good)
Lake Skirnas	1 (high)	0.52 (good)	0.82 (good)	0.69 (good)
Lake Laucesas	0.6 (moderate)	0.18 (poor)	0.88 (good)	0.59 (good)

In Lake Galiņu, the water louse *Asellus aquaticus*, mayfly nymphs from the family Leptophlebiidae, and the species *Caenis horaria* dominate the littoral macroinvertebrate communities. Their abundance varied from 156 to 387 specimens per sample, while the number of taxa was 22 in spring and 34 in autumn. The invasive mussel species *Dreissena polymorpha* and crayfish *Orconectes limosus* were found in the lake.

In Lake Skirnas, the abundance of macroinvertebrates varied from 189 to 509 specimens per sample. The most abundant taxa were Chironomidae larvae, pea clams *Pisidium* sp., and the invasive zebra mussel *Dreissena polymorpha*; the mayfly species *Cloeon dipterum* was also common. In spring, altogether 55 taxa of macroinvertebrates were identified from the littoral samples, while in autumn only 40 taxa were recorded. The highest number of species were represented by aquatic snails Gastropoda and caddisflies Trichoptera.

In Lake Laucesas, the abundance of macroinvertebrates varied from 561 to 2369 specimens. The most abundant taxa were Chironomidae larvae, aquatic Oligochaeta worms, and mayflies *Caenis horaria*. The invasive zebra mussel *Dreissena polymorpha* is also common in Lake Laucesas. A nationally protected species in Latvia – a river nerite, *Theodoxus fluviatilis*, is also common in the lake (Regulations of the Cabinet of Ministers No. 396). In spring, altogether 48 benthic invertebrate taxa were found, while in autumn, 60 taxa were found in the littoral samples.

The results of ecological quality corresponding to macrophyte and macroinvertebrate abundance, according to the assessment methods of Latvia and Lithuania, are comprised in Table 1.

All five studied transboundary lakes were assessed at good ecological status according to the benthic macroinvertebrate methods of both countries, though differences of macrophyte quality classes between both countries were observed. The main differences in the macrophyte methods of both countries are found in the poor/moderate and good/high class boundaries.

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