Project Water Bodies Without Borders (EstLat 66)

JOINT MONITORING PROGRAM FOR KOIVA/GAUJA AND SALATSI/SALACA RIVER BASIN

Activity T3. Joint monitoring program for Gauja/Koiva and Salaca/Salatsi river basins

REPORT

2020

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Introduction

Principles for monitoring in the member states of European Union are in compliance with EU Water Framework Directive (WFD) specified in article 8 and Annex V. Although the principles are the same for all EU countries, common practises can be quite different depending on the amount of resources available, expert opinions, and also on the size and number of managed water bodies. For instance, in Estonia (EE) water bodies and catchment areas were small in size while they were rather big in Latvia (LV) during river basin management period 2016—2021. Mainly for that reason, all water bodies in Latvia were included in monitoring programs but in Estonia only a selection of river water bodies have been chosen into monitoring program (all lake water bodies are monitored). Delineation of river water bodies with catchment areas starting from 10 km^2 and grouping of water bodies is intended in Latvia in the next river basin district management period.

General principles for monitoring planning in Estonia for new Water Management Plan period (2022—2027) are described in **paragraph 2** and the ones for Latvia in **paragraph 3**.

Estonia and Latvia have transboundary water bodies, but their names, codes, lengths, catchment areas, sometimes also hydrological catchment areas, were not harmonised. Transboundary water bodies used to end on the state border and have only national characterisation, status, and pressures described. Creation of harmonised transboundary water bodies, their status, and pressures assessment was described in WBWB Description of water bodies in the project area report. This report complements the description report by presenting the harmonised principles of monitoring transboundary water bodies (**paragraph 4**).

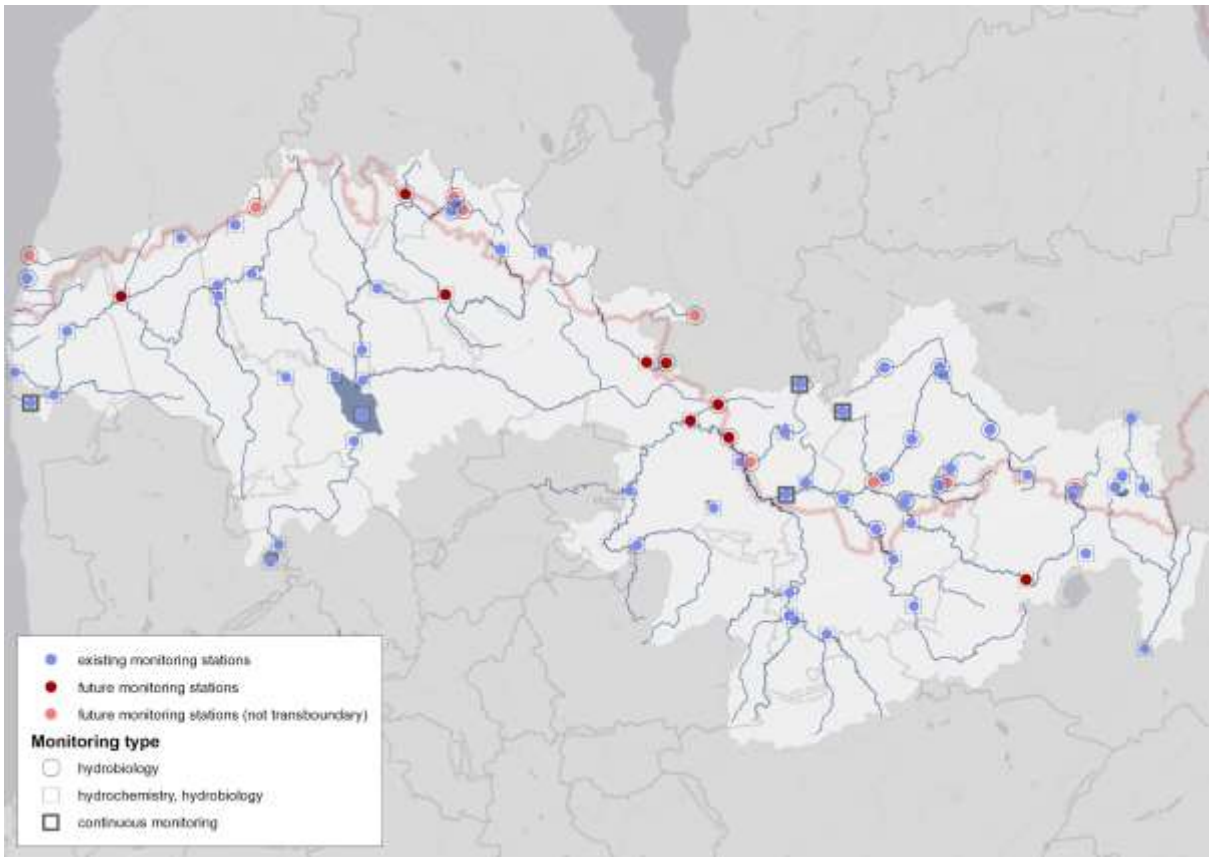

Figure 1. Monitoring stations in project area

1. Principles of monitoring for surface water status assessment in Estonia

1.1. Monitoring network in Estonia

Surface water inland waterbodies monitoring network in Estonia is divided into monitoring of large lakes (Lake Peipus and Lake Võrtsjärv; not relevant for WBWB project), small lakes and rivers.

The monitoring network in Estonia is further divided into a continuous monitoring network that is monitored yearly and a surveillance monitoring network that is monitored less often, usually once within the water management plan period. Both monitoring networks take into account territorial coverage and types of waterbodies. In addition, investigative and operational monitoring is used where necessary.

Continuous monitoring allows determination of status class borders for quality elements and indicators and predict natural fluctuations and long term changes in water bodies. There are in total 10 continuous hydrobiology monitoring stations in river water bodies of Estonia and 11 continuous hydrobiology/hydrochemistry monitoring stations for lake water bodies (Lake Ahijärv in project area) (Figure 1). In addition, there are 52 continuous hydrochemistry monitoring stations in river waterbodies (Mustjõgi_5: Tsirgumäe in project area) (Figure 1). There are no transboundary water bodies belonging to continuous monitoring network in the project area but Mustjõgi_5 waterbody station Mustjõgi_5: Tsirgumäe is part of continuous monitoring network and flows directly into a transboundary water body also having the highest water volume in the transboundary area.

The **surveillance monitoring** network covers at least 50% of waterbodies with higher human pressure and ~30% of waterbodies with lower human pressure (Figure 1). For optimising costs on logistics and assessing inter-waterbody correlations, waterbodies of one district are usually monitored within the same year. If possible, connected surface water bodies (lakes, rivers, coastal waters) should also be monitored in the same year. River Basin Management Plan monitoring cycle starts from Koiva river basin district (next expected monitoring round is in year 2022). In case significant pressures are missing, hydromorphology status shows low risks and nutrients level are good based on EstModel calculation, there is no real need for monitoring (to consider 18 year monitoring cycle in the future).

The aim of **investigative monitoring** is to determine the cause of moderate or lower status of the waterbody and propose potential measures for status improvement. Based on the monitoring report there are three lake water bodies in Estonian side of the project area (Ähijärv, Kirikumäe järv, and Pullijärv) where investigative study have been suggested. Non of these are transboundary water bodies and in all three, investigative study has already been planned for 2019 and 2020. Additionally, there are two water bodies in the project area (Lake Hino and Lake Kirikumäe), which status is not good, but based on expert opinion the reason is not a pressure but inaccurate status class borders. There is also a need to study the appropriate class borders for type V lake water bodies in Estonia (lake Kirikumäe and Pullijärv in the project area).

The aim of **operational monitoring** is:

1) to evaluate the effect of implemented measures (e.g., fish passes) and to inspect the verify compliance with environmental permits (e.g., efficiency of measures for wastewater discharge)

2) to get input for finding measures to improve the moderate, poor, and bad status of waterbodies and to determine pressures to the waterbodies.

Monitoring of **hydrobiology** (ecological status assessment) and **chemistry** (chemical status assessment) is regulated separately. Hydrobiology monitoring includes biological elements, physico-chemical elements, river basin specific pollutants, and hydromorphology. Chemistry monitoring includes monitoring of hazardous substances (priority substances and priority hazardous substances) in water, sediment, and biota.

1.1.1. Monitoring network for ecological status assessment

Ecological status is based on four quality elements (biological, physico-chemical, hydromorphological, and river basin specific pollutants) which are monitored in continuous and surveillance monitoring stations. Physico-chemical elements are monitored in continuous hydrochemistry monitoring stations (Figure 1) and along with biological samples in surveillance monitoring. Some river basin specific substances are monitored in continuous hydrochemistry monitoring stations (Figure 1), otherwise only in those water bodies where the impact of these substances can be suspected based on the best available knowledge. Hydromorphology in lakes is monitored in the biological monitoring stations and map analysis is performed for all river water bodies.

1.1.2. Monitoring network for chemical status assessment

Chemical monitoring will be designed in the selection of waterbodies, which are influenced significantly by human pressures and which status is not good. Since the list of waterbodies meet this requirement is rather long, additional principles such as size, location and transboundary status of the waterbody is considered. Some hazardous substances (mainly metals) used for chemical status assessment are also monitored in continuous hydrochemistry monitoring stations.

1.2. Monitoring cycle in Estonia

1.2.1. Monitoring cycle for ecological status assessment

Water bodies in **surveillance monitoring network** are monitored once every six year (water management plan period; Lake Köstrejärv in project area twice) or once every 18 years (three water management plan periods) if the status of the waterbody is good and stable and pressures have not increased compare to previous water management plan period. The results of remote sense monitoring[1] (transparency, chlorophyll a) and of EstModel[2] (N, P) could be used as addition information for deciding about monitoring cycle length.

Water bodies in **continuous monitoring network** are monitored every year (Lake Ahijärv in project area).

[1] A pilot study was conducted on the example of small lakes in the Koiva river basin district to analyze the possibilities of prioritizing small lakes for review monitoring, using changes in land use and water quality as measured by remote sensing data and volunteer company monitoring data. An overview and results of this pilot study can be found in **Annex 1**

[2] An overview of the EstModel model can be found in the **Annex** at the Action Plan document

Some **biological** elements -Fish, macrophytes, and phytobenthos in all small lakes (and Lake Võrtsjärv) can also be monitored every 3 years due to slower changes in these communities as a response to change gin the environment and longer life cycle length of these organisms. Macroinvertebrates should be monitored every year.

In rivers (and in Lake Peipus) all hydrobiology quality elements are monitored every year due to lack of long data series for deciding otherwise.

Hydromorphology of water bodies is assessed once every 18 years (three water management plan periods). On lake water bodies it is a part of hydrobiological monitoring, on river water bodies it is based on map analysis. Continuity of river water bodies is still assessed once every 6 years (one water management plan period).

Physio-chemical quality elements are monitored as part of the ecological monitoring but also as part of hydrochemistry monitoring in continuous monitoring sites. The monitoring in the continuous monitoring network is carried out annually.

River basin specific pollutants are monitored as part of the ecological monitoring once during RBMP and in such places where the occurrence of such substances is likely.

1.2.2. Monitoring cycle for chemical status assessment

Water bodies in **surveillance monitoring network** are monitored once every six year (water management plan period) or once every 18 years (three water management plan periods) if the status of the waterbody is good and stable and pressures have not increased compared to previous water management plan period. Accumulation assessment of hazardous substances in sediment and biota should be performed once every three years (Annex 3).

Water bodies in **continuous monitoring network** are monitored every year. Not all substances are monitored in all water bodies. In project area, Mustjõgi_5: Tsirgumäe is monitored for metal content.

1.3. Quality elements in Estonia

1.3.1. Quality elements for ecological status assessment

Quality elements for ecological status assessment are: biological, physico-chemical, river basin specific pollutants, and hydromorphological.

Biological quality elements in lakes are phytoplankton, zooplankton, bacterioplankton (only in Lake Võrtsjärv), phytobenthos, zoobenthos, macrophytes, fish.

Biological quality elements **in rivers** are phytoplankton (only in big rivers – Emajõgi, Narva jõgi), macroinvertebrates, phytobenthos, macrophytes, and fish. Fish is not monitored in KaVo-type rivers and in Emajõgi and Narva jõgi, where natural conditions do not support development of a stable fish community.

All biological quality elements are usually monitored (even those which are not requested by directive or not intercalibrated yet). If resources are very limited, only most sensitive quality elements to the known pressure source can be monitored. Fish, macrophytes and phytobenthos at continuous monitoring lakes are monitored only once every three years.

List of biological indices used for ecological classification:

- phytoplankton - Chl a (water surface and water column), FKI (aggregated index), FPK (community index), Pielou species evenness index, diatom biomass, phytoplankton biomass, proportion of cyanobacteria
- phytobenthos - Rivers: IPS, WAT, TDI; Lakes: coverage of green macroalgae in lakes
- zoobenthos - Rivers and lakes: T, EPT, H', ASPT; Rivers only: DSFI, Lakes only: acidity index A in lake types II, III, IV ja V
- macrophytes - Rivers: MIR; Lakes: community index, abundance of *Potamogeton perfoliatus*, proportion of Chara, proportion of Ceratophyllum or Zannichellia or proportion of floating aquatic plants, abundance of Isoetes or *Lobelia Dortmanna*, abundance of *Myriophyllum alterniflorum*, abundance of Elodea or *Potamogeton*, abundance of *Utricularia vulgaris*, abundance *Cladium mariscus*, distribution depth of aquatic mosses
- fish - Rivers: JKI (based on German fish index for rivers); Lakes: LaFiEE

Physico-chemical quality elements monitored in the surface layer of **small lakes** are: Secchi depth, pH, temperature, O_2, conductivity, N-tot , NH_4^{4+}, NO_3^-, P-tot, PO_4^{3-}, COD-Cr, BOD_5, yellow substance, colour (Pt-Co) scale, SO_4^{2-},Cl^- (in type VIII lakes), HCO_3, oxygen saturation degree, total content of dissolved substances; and in thermocline: HCO_3, N-tot, P-tot, yellow substance;

In Lake Ähijärv (type V – a lake with sensitive ecosystem) COD-Cr is replaced by more sensitive element TOC.

Physico-chemical quality elements **in rivers** monitored as part of surveillance monitoring are pH, temperature, O_2, conductivity, N-tot, NH^{3+}, NO_3^-, P-tot, PO_4^{3-}, COD-Mn, colour (Pt-Co scale), BOD_5, transparency, suspended solids, SO_4^{2-}, Cl^- and HCO_3;

In Mustjõgi_5: Tsirgumäe (part of hydrochemical continuous monitoring network in the project area) the following additional indicators are measured: Ca, Mg, Na, K, Si, Cu, Cd, Pb, Zn, Hg, Ni, Cr-tot, Ba, hardness, TOC and DOC.

Some **river basin specific substances** (Annex 3 in Excel format) are measured along with physico-chemical monitoring at continuous monitoring stations. Otherwise the substances are chosen based on the pressures. Study for reviewing environmental quality boundaries for river basin specific substances is currently in progress ("Update of the list of river basin-specific pollutants and of the environmental quality thresholds", deadline 2020).

The assessment of **hydromorphology** for rivers is carried out as a map and statistical analysis. The current methodology does not require field work. River water levels are monitored continuously at 55 hydrological monitoring stations.

1.3.2. Quality elements for chemical status assessment

Substances monitored for chemical status assessment and for accumulation assessment in biota and sediment are given in Annex 3 in Excel format. As a first priority, hazardous substances used and released into the environment in the river basin district are monitored. Preferred matrix (water/sediment/biota) for each substance is chosen based on EU guidance no 25 Chemical Monitoring of Sediment and Biota under WFD. If monitoring from biota or sediments refers to pollution, next monitoring round must include water. For accumulation

assessment, sediment and/or biota need to be measured. If limits for biota have been established (in Directive 2013/39/EC), biota need to be monitored. Otherwise sediment is monitored for accumulation assessment. Species used for accumulation assessment are salmon, trout or perch and bivalves *Dreissena polymorpha* or not endangered species of Unionidae.

1.4. Monitoring frequency and field work time in Estonia

1.4.1. Monitoring frequency and field work time for ecological status assessment

Table 1. Monitoring frequency and field work time for ecological status assessment.

Quality element	River waterbodies	Lake waterbodies
Phytoplankton	Only in Emajõgi and Narva River, 6 times/ year (May to October)	4 times/ year (May to October)
Zooplankton	-	2 times/ year (July and September)
Bacterioplankton	-	Only in Võrtsjärv, 12 times/ year
Macroinvertebrates	Once a year (spring or autumn)	
Macrophytes	Once a year (July to September)	
Phytobentos	Once a year (middle of June to the end of August)	
Fish	Once a year (June to September)	Once a year (July to September
Physical-chemical quality indicators	4 times/ year (February to October)	4 times/ year (May to September)
Hydromorphology	Once a year (in summer)	

1.4.2. Monitoring frequency and filed work time for chemical status assessment

Water matrix is monitored 4 times a year (rivers – February, April, August, October; lakes – May, July, August, September). In very small water bodies or reference water bodies hazardous substances monitoring can take place twice a year (during low water level and high water level period). Sediment (August) and biota (July to October) are monitored once a year.

2. Principles of monitoring planning for surface water status assessment in Latvia

2.1. Monitoring network in Latvia

Currently surface water monitoring is implemented in accordance with Environmental Monitoring Programme 2015 - 2020 (approved by orders of the Minister for the Environment and Regional Development Nr. 67 of 26.02.2015. and Nr. 344 of 24.11.2015. and Nr. 75 of 24.03.2016.), Surface water monitoring sub-programme. According to programme, there are 3 types of monitoring:

- surveillance;
- operational;
- investigative.

Surveillance monitoring stations according to programme is designed to

- include the number of surface water bodies so that the resulting data characterize the status of surface water in each RBD; within the catchment area or sub-basin of the WB;
- to provide information on the amount of transboundary pollution and load to the sea;
- large surface water bodies of importance for the whole river basin district;
- at points where significant surface waterborne transboundary flows occur;
- monitoring stations for information exchange of surface fresh water quality in the EU.

Intensive surveillance monitoring stations (Figure 1) belong to surveillance monitoring. In project area this is 1 monitoring station: Salaca, 0.5 km above Salacgrīva. These are transboundary water bodies for big rivers, big rivers flowing to the sea.

Operational monitoring stations according to programme is selected to obtain information for assessing:

- the status of their surface water bodies and the ecological potential of their artificial or heavily modified water bodies, in which monitoring risks or anthropogenic loads have identified a risk of not being reached the set environmental quality objectives;
- on changes in the status of the surface water body at risk following the implementation of the program of measures.

Sensitive quality elements should be selected based on a type of load. Operational monitoring programme may be adjusted on a base of results of annual monitoring, as well as river basin district management plans.
As operative monitoring could be defined monitoring in surface water monitoring stations in cases of exceedances of environmental quality standard of nitrates.

During this monitoring cycle every water body is monitored once for a six year period to assess ecological quality, and intensive surveillance monitoring is performed every year for such parameters: physico-chemical parameters, biogens, cadmium, mercury, lead, nickel, zinc, copper. Additionally in ICP Waters monitoring stations (not in project area) monitored parameters for every year are benthos, organochlorine pesticides: priority substances (endosulfan α and β, hexachlorocyclohexane (α, β, and γ (Lindane), pentachlorobenzene) and

hazardous substances (aldrin, dieldrin, endrin, isodrin, DDT, p,p', DDT, o,p', DDE, p,p', DDD, p,p', DDE, o,p', DDD, o,p').

During a monitoring cycle there is monitored at least such biological quality elements as phytoplankton and chlorophyll a (lakes), macrophytes and macroinvertebrates (all). Priority is for stations with last sample taking of 5 years or more and/or with rare type with less count of taken samples.

Investigative monitoring stations according to programme is planned to assess

- the reasons for exceeding the environmental quality standards;
- the causes that prevent the achievement of the environmental quality objectives, if it has been established in the course of surveillance monitoring and operational monitoring has not yet been started;
- the impact of accidental pollution on surface water and to obtain relevant data to enable the development of recommendations for emergency response measures.

During this monitoring cycle there have not been performed investigative monitoring by Latvian Environment, Geology and Meteorology Centre. There are no investigative monitoring stations in project area.

2.1.1. Monitoring network for ecological status assessment

There are no continuous hydrobiology monitoring stations in Latvia, where all biological quality elements are monitored every year. Only in ICP Waters monitoring stations macroinvertebrates are monitored every year (these stations are not in project area).
In total there are 488 ecological status assessment monitoring stations according to Environmental Monitoring Programme 2015 - 2020, that are not continuous (37 in project area). River basin specific pollutants - zinc and copper - are monitored in all stations for ecological status assessment.

2.1.2. Monitoring network for chemical status assessment

There are 19 continuous hydrochemistry monitoring stations in river waterbodies (1 in project area: Salaca, 0.5 km above Salacgrīva) and 1 in lake (no in project area).
In total there are 488 hydrochemistry monitoring stations according to Environmental Monitoring Programme 2015 - 2020, that are not continuous (37 in project area).

Chemical monitoring

- in water is planned in 67 monitoring stations (4 in project area: Augstrozes Lielezers, vidusdaļa; Briede, grīva; Burtnieku ezers, vidusdaļa; Pededze, augšpus Alūksnes);
- in biota - 60 monitoring stations (4 in project area: Pededze, augšpus Alūksnes; Burtnieku ezers, vidusdaļa; Burtnieku ezers, pie Salacas iztekas; Dauguļu ezers, vidusdaļa);
- in sediments - 57 monitoring stations (4 in project area: Pededze, augšpus Alūksnes; Burtnieku ezers, vidusdaļa; Burtnieku ezers, pie Salacas iztekas; Dauguļu ezers, vidusdaļa).

2.2. Monitoring cycle in Latvia

2.2.1. Monitoring cycle for ecological status assessment

Surveillance monitoring is planned to be performed 4 - 12 times per year (hydrochemical parameters – 4-12 x, macrophytes, zoobenthos – 1-2 x, phytoplankton – 2 x, chlorophyll – 2 or 6 x, fish, phytobenthos – 1 x), 1 time in period of 6 years.
Intensive surveillance monitoring stations - monitoring samples are taken for 12 times a year (hydrochemical parameters).
Operational monitoring stations - operational monitoring is planned to be performed 4 times per year.
For **investigative** monitoring sample taking frequency is not specified.

2.2.2. Monitoring cycle for chemical status assessment

For priority and hazardous substances monitoring in biota (fish, molluscs) and sediment - samples are taken one time in 3 years period, but in water - there was extensive monitoring for priority substances in period 2017 - 2018 for needs of inventory of priority substances. Priority substances in water in project territory were measured in year 2018, 2 water bodies: Burtnieku lake (E225), at monitoring station *Burtnieki lake, at the source of river Salaca* and *Salaca, 0.5 km above Salacgrīva*. Priority substances in biota in project territory were measured in year 2015 and 2018 in water body Salaca_3, at monitoring station *Salaca, 0.5 km above Salacgrīva*, in Burtnieku lake (E225) in year 2016, at monitoring station *Burtnieki lake, middle part;* in water body *Dauguļi lake* (E226) in year 2017, at monitoring station *Dauguļi lake, middle part*.
After this survey there was concluded, that regarding priority substances all measurements were below limit of quantification (LOQ) for substances named in table 2.

Table 2: All measurements below limit of quantification (LOQ) in water and biota

Water	**Biota**
1,2-dichloroethane	dicofol
Alachlor	hexachlorobenzene
Anthracene	hexachlorobutadiene
Atrazine	heptachlor and heptachlor epoxide
Benzene	

benzo(k)fluoranthene	
Bifenox	
C10-13 chloroalkanes	
chlorfenvinfoss	
Chlorpyrifos	
Cibutrin	
Cypermethrin	
di(2-ethylhexyl)-phthalate (DEHP)	
Dichloromethane	
Dichlorphos	
Dicofol	
Diuron	
Endosulfan	
Hexachlorocyclohexane	
Isoproturon	
Naphthalene	
Nickel	
Pentachlorobenzene	
Quinoxyfen	
Quinoxyfen	
Simazine	

Terbutrin	
tributyltin cation	
Trichlorobenzene	
trifluralin	

Table 3: Substances for which the EQS were exceeded

Water	Biota
benzo (a) pyrene (AA EQS exceedance in E225, G303SP)	mercury (all measured water bodies, all samples)
fluoranthene (AA EQS exceedance in E225)	sum of bromodiphenyl ethers (all measured water bodies, all samples)
heptachlor (AA, MAC EQS exceedance in E225, G303SP)	
heptachlor epoxide (AA, MAC EQS exceedance in G303SP)	

Priority substances in water are monitored together with hazardous substances in the same frequency as it is for needs of ecological status assessment.

2.3. Quality elements in Latvia

2.3.1. Quality elements for ecological status assessment

Quality elements for ecological status assessment are: biological, physico-chemical (including river basin specific pollutants zinc and copper), and hydromorphological.

Only **biological quality elements** requested by WFD and intercalibrated are included. If resources (including funding) are very limited, only the most sensitive quality elements to the known pressure source can be monitored. These (never excluded) are phytoplankton for lakes and macroinvertebrates for rivers. Table 4 shows the biological quality element sensitivity to different pressures.

Table 4. Biological quality element sensitivity to different pressures.

	Macrophytes		**Macroinvertebrates**		**Fish**		**Phytoplankton**	
	Rivers	Lakes	Rivers	Lakes	Rivers	Lakes	Rivers	Lakes
Eutrophication	Yes	yes	Yes	yes	Yes	Yes	yes	yes
Organic pollution	No	n.a.	No	no	Yes	Yes	yes	yes
General degradation	No	n.a.	Yes	yes	Yes	Yes	no	yes
Hydromorphological degradation	No	n.a.	No	yes	Yes	Yes	no	no
Acidification	No	n.a.	No	yes	No	No	no	no

*yes - sensitive, no - not sensitive

Biological quality elements **in rivers** are phytoplankton (only in big rivers – Daugava, Gauja (at mouth), Lielupe, Venta), macroinvertebrates, phytobenthos, macrophytes, fish (Table 5). Macroinvertebrates in small rivers with catchment area < 100 km^2 are monitored, but not included in total ecological assessment. The use of benthos in small rivers requires revision of existing boundaries.

Table 5. Monitored biological quality elements in Latvian rivers.

River size	Macrophytes	Macroinvertebrates	Fish	Phytoplankton	Phytobenthos
<100 km^2	Yes	no boundaries	yes	no	yes
100-1000 km^2	Yes	Yes	yes	no	yes

1000-10000 km^2	yes	Yes	yes	no	yes
>10000 km^2	no	Yes	yes	yes	yes

Biological quality elements **in lakes** are phytoplankton, zoobenthos, macrophytes, fish, phytophentos (Table 6). Macrophytes are not monitored in dystrophic peat lakes with high water color and low alkalinity where the development of macrophyte communities is impossible due to natural conditions. Softwater (brown water and clear water) lakes don't have phytoplankton class boundaries.

Table 6. Monitored biological quality elements in Latvian lakes.

Lake type	Macrophytes	Macroinvertebrates	Fish	Phytoplankton	Phytobenthos
L1	Yes	Yes	yes	yes	supporting
L2	Yes	Yes	yes	yes	supporting
L3	Yes	Yes	yes	no boundaries	supporting
L4	pH>6	Yes	pH>6	no boundaries	supporting
L5	Yes	Yes	yes	yes	supporting
L6	Yes	Yes	yes	yes	supporting
L7	Yes	Yes	yes	no boundaries	supporting
L8	pH>6	Yes	pH>6	no boundaries	supporting
L9	Yes	Yes	yes	yes	supporting

Physico-chemical quality elements for ecological quality in lakes are: Secchi depth, P-tot, N-tot. Lakes are not divided by area and all lakes are monitored for the same quality elements.

Physico-chemical quality elements for ecological quality in rivers are: O_2, N-tot, P-tot, BOD_5, $N\text{-}NH_4$.

In monitoring other physico-chemical parameters are tested, but they are not included in ecological quality assessment and don't have quality class boundaries. These parameters are: oxygen saturation, conductivity, pH, Ca, Mg, Na, K, HCO3, SO_4, Cl, total hardness, suspended solids, TOC, DOC, alkalinity, $P\text{-}PO_4$, $N\text{-}NO_2$, $N\text{-}NO_3$, Si.

Hydromorphological assessment is done using field works and maps.

Hydromorphological quality elements used in rivers:

- River longitudinal profile and cross-section alterations (channel planform (sinuosity and type changes, shortening), river width variations).
- River bed structure (bed elements (side bars...), flow types, river bed substrate (natural and artificial materials, large woody debris).
- Banks and riparian zone (bank profile: stabilisation, artificial bank structures).
- Floodplain: vegetation, flooded area
- River continuity
- River hydrological quality elements (reduction in mean flow, reduction in low flow, frequent flow fluctuations, water level range).

Hydromorphological quality elements used in lakes:

- Shore zone structure (modification);
- Shore zone condition (e.g. intensive use);
- In-lake use (human activities);
- Hydrological regime;
- Sediment regime;
- Physicochemical conditions (stratification, oxygen, temperature);
- Catchment pressures (percentage of urban and total non-natural land-use).

2.3.2. Quality elements for chemical status assessment

In surface **water** there are monitored priority substances according to Directive 2013/39/EC (the same substances as for Estonia - see Annex 3), except brominated diphenyl ethers, hexachlorobenzene, hexachlorobutadiene, dioxins and dioxin-like compounds, hexabromocyclododecane (HBCDD).
In **biota** there are monitored such parameters:

- mercury;
- sum of bromodiphenyl ethers;
- dicofol;
- sum of hexabromcyclododecanes;
- hexachlorobenzene;
- heksachlorobutadiene;
- heptachlor and heptaclor epoxide;
- PFOS;
- dioxins (previous substances are monitored in fish);
- benzo (a) pyrene
- fluoranthene (previous substances are monitored in molluscs).

According to the concentrations of the priority substances there is evaluated chemical status in matrix of water and in matrix of biota.

Additionally to chemical monitoring hazardous substances are monitored (defined in Cabinet Regulation No. 118 “Regulations Regarding the Quality of Surface Waters and Groundwaters” (12.03.2002.), annex Nr. 2. This annex is being reviewed this year.
At this stage as hazardous substances for surface waters are defined substances (Annex 3). zinc and its compounds, copper and its compounds are monitored in all stations as river basin specific pollutants.

2.4. Monitoring frequency and field work time in Latvia

2.4.1. Monitoring frequency and field work time for ecological status assessment

Only biological quality elements, directly required by WFD, are monitored in Latvia. Phytoplankton is most important (sensitive) quality element in lakes and macroinvertebrates are most important (sensitive) quality element in rivers. Phytoplankton is monitored only in very large rivers with catchment area > 10000 km^2. In very large rivers macrophytes are monitored to extend knowledge (and get data for possible development of new method in future), but usually they are not included in ecological classification. Phytobenthos (diatoms) is monitored in lakes, but not directly included in ecological classification (justification was made that phytobenthos is already included in macrophyte assessment). Physical-chemical quality indicators are monitored in all seasons, including winter, Secchi transparency is monitored and taken into account only in summer. Dystrophica lakes have seperate macroinvertebrate assessment method.

Table 7. Monitoring frequency and field work time in Latvia.

Quality element	River waterbodies	Lake waterbodies
Phytoplankton	2 times/ year (May to September)	2 times/ year (May to September)
Macroinvertebrates	2 times/ year (May and October)	Mostly once per year (May or October)
Macrophytes	Once a year (late June to early September)	
Phytobentos	Once a year (middle of June to the end of August)	
Fish	July-middle of September	

Physical-chemical quality indicators	4 (12) times/ year in all seasons
Hydromorphology	May-October, depending on hydrological regime

List of biological indices used for ecological classification:

- Indices used for **river macroinvertebrates** (catchment area < 10.000 km^2): T, ASPT, DSFI, EPT.
- Indices used for **river macroinvertebrates** (catchment area > 10.000 km^2): T, ASPT, EPT, H'.
- Indices used for **lake macroinvertebrates** (pH > 6): T, ASPT, EPTCBO, H', Acid index and lake macroinvertebrates (pH<6): T, ASPT, H', ETCO..
- Indices used for **lake macroinvertebrates** (pH < 6): T, ASPT, ETCO, H'.
- Index used for **river macrophytes**: MIR (with scores adapted for local conditions).
- Indices used for **lake macrophytes** (type-specific): typical taxa, number of total taxa, presence of type-specific indicatorspecies (*Chara sp., Isoetes sp., Lobelia dortmana*...), occurrence (scale from 1 to 7) of different plant groups: charophytes, free-floating, emergent, submerger, filamentous green algae, Maximum depth to which taxa are present.
- Indices used for **lake phytoplankton**: chlorophyll-a, Pielou evenness J, Nygaard modified compound Quotient (PCQ), Description of a community (PCD).
- Indices used for **river phytoplankton**: LatRPI (adapted *Hungarian Large River Potamoplankton Index*), chlorophyll-a and species diversity index Q.
- Indices used for **river and lake phytobenthos**: IPS.
- Indices used for **river fish**: *N100m2INTOLO2* (Number of individuals in first electrofishing run/100 m^2 for species intolerant to oxygen depletion), *LITHspecies%* (Number of species in % form total number of species requiring lithophilic reproduction habitat (gravel spawners)); *Stspecies* (Number of species belonging to salmonid waters); *N100m2LITH* (Number of individuals in first electrofishing run/100 m^2 requiring lithophilic reproduction habitat (gravel spawners)); *Rheopars* (Number of rheopar species).
- Indices used for **lake fish**: *WPUE*– weight per unit of effort; *RoachWavg* – roach average weight (g) in a catch using nets with a mesh size of 20-35 mm; *Bream/RoachW%*– roach and bream percentage by weight in a gill net with a mesh size 20-35 mm; *PerchW%*– percentage of perch by weight in gill nets with a mesh size of 20-35 mm.

2.4.2. Monitoring frequency and field work time for chemical status assessment

Chemical status is assessed starting from 1 x in biota or trend assessment in sediments, to 12 times (every month) in water. There can be cases, when in water samples are being taken 4 times a year (once every season), if other parameters for ecological quality are taken 4 times.

3. Harmonised principles for monitoring of transboundary water bodies in Koiva/Gauja and Salatsi/Salaca river basin

3.1. Overview of the main differences between the monitoring principles

Significant differences:

- Due to the lack of a dam database (with descriptive information) in Latvia, HPP are given more importance in disruption of river continuity, but other dams are often ignored. This may lead to an inadequate assessment of the status of the upstream water body in Latvia.
- When the water body is divided into two parts due to the impact of the HPP, Latvia considers the lower quality to be in water body below HPP, while Estonia considers the lower quality to be upstream from the hydroelectric power station.
- Estonia considers fish as the most sensitive indicator to hydromorphological alterations, while Latvia also considers macroinvertebrates as sensitive enough to detect habitat alterations.
- Studies on the Latvian side have shown that the Natura 2000 sites have no impact on the biodiversity of protected fish species and thus Latvian experts do not pay special attention to protected sites.

Less significant differences:

- In the assessment of ecological quality/potential Estonia uses the mean concentration of vegetation season, while Latvia uses annual average concentrations. After a small calculatation experiment, it was clear that this mismatch doesn't have a significant effect on overall ecological status, because hydrochemical quality elements have only supporting role.
- Latvia still does not have an officially used, intercalibrated phytobenthos method. As this biological quality element almost always shows at least good quality, it has low impact on final ecological quality class.
- Different monitoring frequency (seasons are the same) for several biological quality elements. Estonia collects lake and river macroinvertebrates once per year, while Latvia collects river macroinvertebrates 2 times per year. Estonia assesses lake phytoplankton 4 times per year, but Latvia only 2 times per year. Latvia does not use zooplankton and does not plan to do it (although it may be useful in dystrophic lakes).

3.2. Harmonised monitoring network

3.2.1. Harmonised monitoring network for ecological status assessment

Hydrobiology of transboundary water bodies could be monitored on one or other side of the border, depending on location of pressure and flow direction. Preferred monitoring site(s) are at the end of the waterbody or after the pressure source (regarding the dams, this means that fish need to be monitored upstream from the dams and hydropower plants (HPP)).

Transboundary water bodies which status is lower than good need to be monitored before and after pressure source. At least the most sensitive element to the pressure source and physical-chemical element need to be monitored in two sites.

Unless the monitoring site is unsuitable based on expert opinion, it should not be changed to create comparable time series for hydrochemical parameters. Monitoring station for biological parameters may be changed on a base of expert opinion, so that samples are taken in a representative section (according to its typology) of water body. In general, monitoring sites which are suitable for fish are suitable for all other quality elements as well. All elements should be monitored inside 500 m from measured monitoring site.

3.2.2. Harmonised monitoring network for chemical status assessment

The water bodies with highest chemical pollution risk are Pedele_2/Pedeli_2 and Õhne_2/Omuļupe and these water bodies will be monitored as part of the harmonised chemical status assessment if there are available resources. At present the continuous monitoring point in Õhne_2 water body is located outside the project area. Upon entry into force of the new regulation, it will remain in the Õhne_3 water body. Hazardour substances will be monitored in the Õhne_2 water body in 2020. PBDE has been found to exceed maximum permissible values in fish tissue in Murati järv/Muratu Ezers and Gauja_8/Koiva_1 river, thus monitoring is also planned in those water bodies for future trend analysis. Mustjõgi_5: Tsirgumäe continuous monitoring station will be monitored in Estonia instead of Gauja_8/Koiva_1 because it gives the best possible indication about pressure load from Estonia to Gauja_8/Koiva_1.

In addition to the Gauja/Koiva and Salaca/Salatsi river basins, water bodies which are not directly part of these river basins, but which are hydrologically part of them, were taken into account, planning the harmonised monitoring plan, in order to better assess and harmonize the status of transboundary water bodies. This work was done outside the project.

3.3. Harmonised monitoring cycle

3.3.1. Harmonised monitoring cycle for ecological status assessment

Harmonised monitoring cycle of Koiva/Gauja river basin district and other project area water bodies will start in 2022. There is only one transboundary lake water body (Murati järv/Muratu ezers) which is going to be monitored by Estonia.

All transboundary water bodies, which status is less than good are monitored once per river basin management plan (RBMP) period. Three water bodies will not be monitored due to absence of significant pressures: Atse/Acupīte_1, Läteteperä/Akaviņa, and Pedeli_1/Pedele_1. If status of transboundary river waterbodies is “good” and stable based on monitoring results and pressures have not increased, monitoring for ecological status assessment will be performed once within three water management plan periods.

In the proceedings of relevant regulation, an additional proposal about Ikla 1152600_1* water body was made, namely not to consider this water body as separate water body and as known, the proposal has been taken into account. According to experts and locals, Ikla* water body has been excavated in the past in the Latvian side and water has been partially misdirected. Therefore the water body is waterless in the Estonian side and it is not reasonable to consider Ikla* water body as separate water body and there is no need to include it to the monitoring plan.

Hydromorphological sub-categories (natural/heavily modified/artificial waterbody) and statuses of the following water bodies will be reviewed in the coming years: Pedele_2/Pedeli_2 (both countries), Puupe/Pužupe (Estonian side), Raamatu/Ramata (Estonian side), and Pērļupīte/Pärlijõgi_1 (Estonian side).

3.3.2. Harmonised monitoring cycle for chemical status assessment

Harmonised chemical status assessment will start with monitoring of 3 to 4 transboundary water bodies in 2022. The rest of the water bodies will be included in the monitoring programmes or each country based on the state monitoring plan.

3.4. Harmonised quality elements

3.4.1. Harmonised quality elements for ecological status assessment

Lakes: Estonia will carry out monitoring the following elements (see Annex2) in Lake Murati/Muratu: phytoplankton, zooplankton, fish, zoobenthos/macroinvertebrates, phytobenthos, macrophytes, physical-chemical elements, hydromorphology. Latvia will not be monitoring this transboundary lake.

Rivers: Estonia will carry out monitoring the following elements (see Annex 2): fish, zoobenthos/macroinvertebrates, phytobenthos, macrophytes, physical-chemical elements. Latvia will carry out monitoring the following elements: macroinvertebrates, macrophytes, phytobenthos, fish, physical-chemical elements.

Physico-chemical quality indicators for monitoring:

Lakes

Secchi depth, pH, temperature, O_2, conductivity, N-tot , NH_4^{4+}, NO_3^-, P-tot, PO_4^{3-}, COD-Cr, BOD_5, yellow substance (Estonia), colour (Pt-Co) scale, SO_4^{2-},Cl^- (in type VIII lakes), HCO_3, oxygen saturation degree, total content of dissolved substances; and in thermocline: HCO_3, N-tot, P-tot, yellow substance (Estonia);

Rivers

pH, temperature, O_2, conductivity, N-tot, NH^{3+}, NO_3^-, P-tot, PO_4^{3-}, COD-Mn, colour (Pt-Co scale), BOD_5, transparency, suspended solids, SO_4^{2-}, Cl^- and HCO_3;

In **Mustjõgi_5: Tsirgumäe** (part of hydrochemical continuous monitoring network) the following additional indicators are measured: Ca, Mg, Na, K, Si, Cu, Cd, Pb, Zn, Hg, Ni, Cr-tot, Ba, hardness, TOC and DOC.

Based on pressures information and previous monitoring results we do not expect **river basin specific substances** above the quality standards in the project area, except Ba, which has been found in Mustjõgi_5 water body (possibly due to natural causes).

3.3.2. Harmonised quality elements for chemical status assessment

Both countries will continue monitoring hazardous substances chosen by the state but all hazardous chemicals monitored by both countries will be considered in the common status assessment of the water body.

3.4. Harmonised monitoring frequency and field work time

3.4.1. Harmonised monitoring frequency and field work time for ecological status assessment

All quality elements should be monitored within the same year, except fish, which could be monitored also 1–2 years later than other elements.

Monitoring frequency will be in accordance with the national monitoring planning.

3.4.2. Harmonised monitoring frequency and field work time for chemical status assessment

Mustjõgi_5 is the only waterbody in the project area yearly monitored for chemical status assessment. Estonia will continue yearly monitoring of Musjõgi_5: Tsirgumäe for some hazardous substances and once in six years for extended list of hazardous substances, also once in three years for accumulation assessment. Other water bodies where monitoring for chemical status assessment is planned (see Annex 2) will be monitored once in 2022 and the following monitoring cycle will be decided based on the results of that monitoring.

3.5. Joint monitoring plan for Koiva/Gauja and Salatci/Salaca river basin (Annex 2, table in Excle format)

3.6. Harmonised status assessment

As a result of the project, the exchange of monitoring and status data for transboundary water bodies was identified. Data will be shared between Estonia and Latvia in the year following the monitoring year, by 31 May at the latest. All types of monitoring data (including operational and investigative monitoring) will be shared.
All available monitoring data shall be used to assess the status. The ecological status assessment shall be carried out in accordance with guidance document no. 13 of the Common Implementation Strategy for the Water Framework Directive (2000/60 / EC). The assessment of the chemical status takes into account all substances that are regulated as hazardous substances in each country. Both countries will continue using national status assessment methods (even though they are different) and later calculate either average status or use the status that characterises pressures better.

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