



The environmental quality evaluation and monitoring in Šilutė and Saldus public water bodies (Šyša's river oxbow lake and Nakotnės ponds)

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The Interim report

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1. INTRODUCTION

The total area of inland water in Lithuania is about 4% of the territory of the country. There are 2827 lakes in Lithuania (bigger than 0.5 ha), 1589 ponds and 733 rivers longer than 10 km. These water bodies form the basis for the development of recreational activities in inland waters and municipal public spaces. The rivers, lakes and ponds is main factor for the development of recreational fishery activities in Lithuania. In accordance with the requirements of the rules for evaluation of the ecological status, recreational fishery possibilities and fish stock survey procedure, which regulates the organization and implementation of research on the ecological status, recreational potential and assessment of the status of fish stocks in water bodies, this applied research work has been carried out. The aim of these works is to assess the ecological status of the water bodies of Šyša's river old valley (Šilutė) and Nakotnes pond (Saldus) before and after performing the work on the restoration of these water bodies.

Work tasks:

1. Evaluation of the indicators of the physico-chemical quality elements of rehabilitated surface water (Šyša river and Šyša's river oxbow lake old in Šilutė and Nakotnės ponds in Saldus) bodies;
2. Assessment of the ecological status of surface water bodies (Šyša river and Šyša's river oxbow lake valley in Šilutė and Nakotnės ponds in Saldus) according to the Macroinvertebrates index and the Lithuanian River Fish Index before and after the implementation of restoration measures, evaluation of the effectiveness of implemented restoration measures.
3. Presentation to the public of data on the status of rehabilitated surface water bodies (Šyša's river oxbow lake valley in Šilutė and Nakotnės ponds in Saldus).

2. MATERIAL AND METHODS

Study was performed in the Šyša Oxbow Lake located in Šilutė Town (Figure 1).



Figure 1. Sampling place in the Šyša Oxbow Lake.

Macroinvertebrate samples were collected on September 21, 2018. Study was performed applying a semi-quantitative method (O'Hare et al., 2007), which is designed for evaluation of status of limnic waters (lake, reservoir, etc.) (Šidagytė et al., 2013). This method currently is accepted as official method for evaluation of status of lakes and reservoirs in Lithuania.

Collected macroinvertebrates were identified to species level, excluding Oligochaeta (class level), dipterans (family or genus level) and some beetles (genus level).

Ecological status of the oxbow lake was assessed by Lithuanian Lake Macroinvertebrate Index – LLMI (Šidagytė et al., 2013). This multimetric index is an average of the four

macroinvertebrate metrics calculated as ecological quality ratios (EQR). These metrics are ASPT, first Hill's number H_1 , the total number of Ephemeroptera and Plecoptera species and Coleoptera genus #CEP, and the proportion of Coleoptera, Odonata and Plecoptera individuals in the macroinvertebrate assemblage %COP. This method complies with requirements of the EU Water Framework Directive and has been intercalibrated in the Central-Baltic GIG. The five quality classes with respect to LLMI method are as follows:

- 0.75 – 1.00 – high;
- 0.51 – 0.74 – good;
- 0.41 – 0.50 – moderate;
- 0.21 – 0.40 – bad;
- 0.00 – 0.20 – poor.

Additionally, macroinvertebrates were assessed with respect to BMWP (*Biological Monitoring Working Party score system*), ASPT (*Average Score Per Taxon*), BMWP-PL and ASPT-PL (BMWP and ASPT modifications for Poland). Diversity was evaluated by Shannon- Wiener's and Simpson's indices.

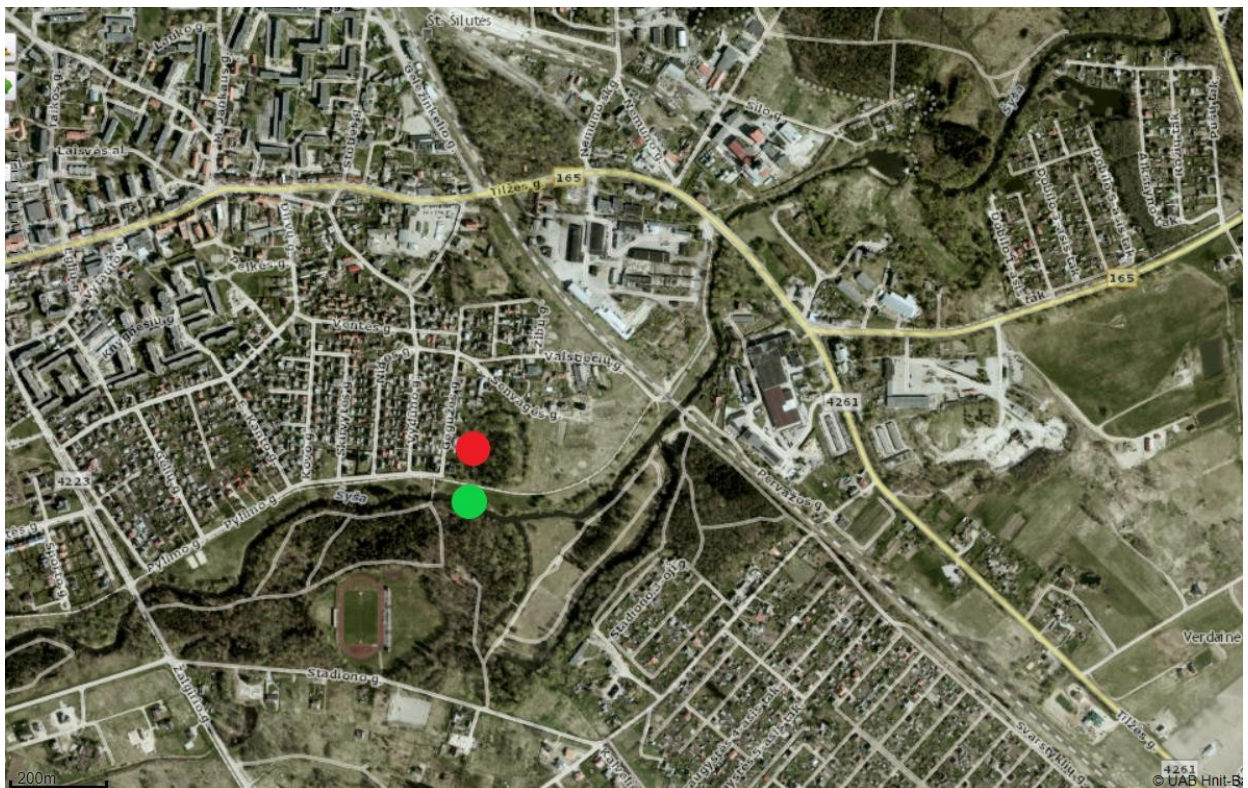


Figure 2. Sampling location in Šilutė town: red color – Šyša Oxbow Lake, green color – Šyša river (www.maps.lt).

The ichthyological research was carried out at two stations in the Šyša river and Šyša Oxbow Lake on 2018 September 19 (Fig. 2). In river, fish were caught using electrofishing gear and in Šyša Oxbow Lake – combination of electrofishing gear and fishing nets. Fish density and biomass (Zippin (1958)) were recalculated for a unit of area (ind./100m^2 and g/100m^2). The caught fish were divided into groups by their species; number of individuals of each species (N), their lengths (L and l, cm), weight (Q and q, g). Age of fish was determined from scales in a laboratory using a binocular according to the appropriate methodology (Bukelskis, Kubilickas, 1988; Pravdin, 1966). Depending on fish abundance, fish sampling was performed 1–2 times. The abundance (N) and biomass (B) of each fish were calculated from formulae (Seber et al. 1967).

The ecological status of Šyša river was evaluated using the ecological status index LFI (Lithuanian fish index) of rivers in Lithuania based on fish community (LŽI; LAND 85-2007). According to its hydro morphological parameters, the Šyša's oxbow lake is classified as shallow, polymictic water bodies with an average depth < 3 meters. The Lithuanian lake fish index - LLFI - was used for ecological status assessment (Virbickas, 2016).

2.1. Characteristics and physical-chemical parameters of the study site

2.1.1. Šyša river

Šyša is the right-bank tributary of the river Nemunas and situated in Šilutė district. The length of Šyša is 61 km, and the basin area is 410 km². In upstream the average width reach 2 – 3 m., depth – 0,5 m. Below, in Šilutė town river width is about 15 m, deep 0,8 – 1,5 m., and closer to the mouth, width – 20 – 25 m., depth – 2 m. Every year sea trout and lamprey migrate to this river to spawn, also in lower reaches of Šyša vimba bream are found. In the study area of the Šyša River in the Šilutė town, trees cover up to 25% of river bank, and the microphytes coverage of the river bed was about 5%. Study were carried out on September 19, when the average water level in the river reached 0,7 m, and in the pit maximum – 1,5 m. The water current was weak, about 0,15 m/s. Average river width – 12 m, maximum – 16 m. The dominant sediment types were sand – 85%, boulders – 8% and sludge – 7%. The water temperature was measured at 13°C, oxygen

saturation was high – 92% and 9,6 mg/l. The water conductivity was 399 $\mu\text{S} / \text{cm}$ and the water pH – 7,85.

2.1.2. Šyša's oxbowlake

Šyša' oxbow lake is a small 0,971 ha horse shoe forms water body formed after the installation of a flood-protecting barrier for Šilute. The length is 367 m, width up to 20 m. The shoreoftheoxbowlakeisovergrownwithtrees,intheouterwesternpartoftheoxbowlakethere is a private home quarter, in the eastern part – meadows. During the study (September 19th), the surface of the water was completely covered with free-floating aquatic plants – duckweeds, the water odor was similar rotten sludge, also pink in shade, but fairly clear. The water body bottom covered with underwater macrophytes also abundant tree branches and rubbish on water surface. Average water depth in the study area reached about 1,2 m, deeper – soft sludge. Saturation of oxygen, was very low – only 0,3 mg/l and 3,2%, while the temperature was 14,3 ° C. The water conductivity was 446 $\mu\text{S} / \text{cm}$ and pH7,38.

3. RESULTS

3.1. Macroinvertebrate

3.1.1. Macroinvertebrate diversity

In the collected material from the Šyša Oxbow Lake there were 40 macroinvertebrate taxa (Table 1). The largest richness was the characteristic of beetles. There were 13 identified taxa of adults and larvae. There was representative of 7 Diptera families, 5 Mollusca species, 4 Hemiptera species and invertebrates from other taxonomic groups (Table 1). Recorded macroinvertebrate species are typical for stagnant and limnic waters. Rare or protected in Lithuania or Europe species were not recorded. Biodiversity was moderate; Shannon-Wiener's index was estimated at 1.68, Simpson's index was equal to 0.66.

Although some macroinvertebrate groups were represented by single species, abundance of these species was rather high. The most abundant was the representative of Ephemeroptera *Cloeon dipterum*, which abundance in the sample comprised about 1800 specimens. Among Mollusca dominated *Radix balthica* and *Anisus vortex* with abundances at 430 and 400 specimens per sample, correspondingly. Of interest is that the amphipod *Sinurella ambulans* from family Crangonyctidae was rather abundant in the oxbow lake. Although this amphipod is rather plastic to various environmental factors, usually it is rarely seen in Lithuanian waters.

Table 1. Recorded macroinvertebrate taxa; N – number of sampled specimens; Ad. – adults, Lv. - larvae

Group	Family	Identified taxon	N
1	2	3	4
Oligochaeta	Oligochaeta	Oligochaeta Gen. sp.	48
Hirudinea	Erpobdellidae	<i>Erpobdella octoculata</i>	130
	Glossiphoniidae	<i>Hemiclepsis marginata</i>	2
Crustacea	Asellidae	<i>Asellus aquaticus</i>	14
	Crangonyctidae	<i>Synurella ambulans</i>	140
Gastropoda	Lymnaeidae	<i>Radix balthica</i>	434
	Planorbidae	<i>Anisus vortex</i>	400
		<i>Gyraulus crista</i>	4
		<i>Gyraulus albus</i>	20
	Succineidae	<i>Succineasp.</i>	2
Hemiptera	Naucoridae	<i>Ilyocoris cimicoidesssp.</i>	10
	Notonectidae	<i>Notonecta glaucassp.</i>	2
	Pleidae	<i>Plea minutissimassp.</i>	4
	Corixidae	<i>Hesperocorixa linnaei</i>	2
Lepidoptera	Pyralidae	<i>Parapoynx stratiotata</i>	2
		<i>Cataclysta lemnata</i>	36
Turbellaria	Planariidae	<i>Planariasp.</i>	2
Ephemeroptera	Baetidae	<i>Cloeon dipterum</i>	1838
Odonata	Coenagrionidae	<i>Coenagrion puella/pulchellum</i>	52
Coleoptera	Haliplidae	<i>Haliplussp. Ad.</i>	10
	Dytiscidae	<i>Agabus undulatusAd.</i>	8
		<i>Ilybiussp. Ad.</i>	4
		<i>Ilybiussp. Lv.</i>	2
		<i>Hydroporussp. Ad.</i>	14
		<i>Hyphydrus ovatusAd.</i>	6
		<i>Hygrotus inaequalisAd.</i>	4
		<i>Hygrotus versicolorAd.</i>	2
	Hydraenidae	<i>Hydraenasp. Ad.</i>	4
	Helophoridae	<i>Helophorussp. Ad.</i>	4
	Hydrophilidae	<i>Enochrussp. Ad.</i>	4
		<i>Coelostomasp. Ad.</i>	2
		<i>Anacaenasp. Ad.</i>	2
	Scirtidae	<i>Elodessp. Lv.</i>	4
Diptera	Chaoboridae	<i>Chaoborus crystallinus</i>	68
	Ceratopogonidae	Ceratopogonidae Gen. sp.	18
	Culicidae	Culicidae Gen. sp.	2
	Limoniidae	Limoniidae Gen. sp.	4
	Chironomidae	Chironomidae Gen. sp.	10

	Ephydriidae	<i>Hydrelliasp.</i>	4
	Sciomyzidae	<i>Elgivasp.</i>	2
Total specimens			3320
Total taxa			40

3.1.2. Ecological status

With respect to conventional metric of quality status, the total number of species of Ephemeroptera, Plecoptera and Trichoptera (EPT) in particular, the ecological status of the oxbow lake was poor, as Plecoptera and Trichoptera were absent and only one Ephemeroptera species was present. However, the LLMI in which beetles have considerable weight indicated the good status. LLMI was estimated at 0.57, and this value corresponds good quality (Table 2).

Other macroinvertebrate metrics also suggest good or moderate quality classes (BMWP = 84, BMWP-PI = 80, ASPT = 4.20 and ASPT-PL = 4.21) (see Table 2).

Table 2. Quality classes according to listed macroinvertebrate metrics of ecological status. Grey cells indicate which quality class corresponds estimate for the Šyša Oxbow Lake

Classes	LLMI	BMWP	BMWP-PL	ASPT	ASPT-PL
High	0.75 – 1.00	>150	>100	> 4.81	> 4.81
Good	0.51 - 0.74	101 – 150	70 – 100	4.21 – 4.80	4.21 – 4.80
Moderate	0.41 - 0.50	51 – 100	40 – 69	3.61 – 4.20	3.61 – 4.20
Bad	0.21 - 0.40	16 – 50	10 – 39	3.01 – 3.60	3.01 – 3.60
Poor	0.00 - 0.20	0 - 15	< 10	< 3.0	< 3.0

3.2. Fish abundance and biomass

During the monitoring survey 8 fish species were caught in the Šyša River, one of which (Gudgeon - *Gobio gobio L.*) is in the list of protected species of the Berne Convention. The total fish biomass in Šyša River was 0.834 kg/100m² and density was 65 ind./100m². Compared to other rivers, this is a low number for the biomass and density of fish society. Only 3 fish species with a biomass of 0.02 kg/100m² and a density of 0.56 ind./100m² were recovered in the Šyša's oxbow lake. (Table 3). Compared to Lithuanian lake and pond average data on fish biomass and densities, this is a very low numbers.

3 table. Fish species caught, their weight (B, kg), abundance (N, pcs.), calculated biomass (kg/100m²) and density (pcs./ 100m²) in Šyša and Šyša's oxbow lake.

Šyša river				
Species	B	N	B/100m ²	N/100m ²
Bleak (<i>Alburnus alburnus</i>)	1,401	429	0,174	53,4
Gudgeon (<i>Gobio gobio</i>)	0,038	3	0,005	0,4
Perch (<i>Perca fluviatilis</i>)	0,488	34,8	0,061	4,3
Roach (<i>Rutilus rutilus</i>)	2,988	42	0,372	5,2
Pike (<i>Esox lucius</i>)	0,644	4	0,08	0,5
Chub (<i>Leuciscus cephalus</i>)	1,085	4	0,135	0,5

Silver bream(<i>Blicca bjoerkna</i>)	0,05	4	0,006	0,5
Spined loach(<i>Cobitis taenia</i>)	0,011	2	0,001	0,2
TOTAL:	6,705	522,8	0,834	65
Šyša's oxbow lake				
Pike(<i>Esox lucius</i>)	0,381	2	0,03	0,16
Roach(<i>Rutilus rutilus</i>)	0,69	3	0,05	0,24
Perch(<i>Perca fluviatilis</i>)	0,19	2	0,02	0,16
TOTAL:	1,261	7	0,1	0,56

3.2.1. Ecological status of Šyša

The ecological status of Šyša river was evaluated using the ecological status index LFI (Lithuanian fish index) of rivers in Lithuania based on fish community (LŽI; LAND85-2007). For the application of LFI, the studied river section according to the hydro morphological parameters is classed as a 2-nd type of river (4 table).

Ecological river state evaluated according to specific river-type LFI indicators (LAND85-2007). Different ecological status classes are given in Table 4 for the variation of the values of LFI. For LFI estimation, the species caught in the study are classified into ecological groups in accordance with the classification of European fish species classification (5 table).

4 table. Types of Lithuanian rivers.

Characteristics:	Categories of rivers				
	1	2	3	4	5
Watershed area, km ² :	<100	100-1000		>1000	
Riverbed slope, m/km:	–	<0,7	>0,7	<0,3	>0,3

5 table. Apportionment of fish species detected in the research to ecological groups for the estimation of values of LFI indices.

Specie	Ecological groups*				
	NTOLE	TOLE	OMNI	RH	LITH
Bleak		TOLE	OMNI		
Perch		TOLE			
Gudgeon				RH	
Spined loach					
Roach		TOLE	OMNI		
Pike					
Silver bream		TOLE	OMNI		
Chub			OMNI	RH	LITH

* NTOLE – particularly sensitive to fish; TOLE – insensitive fish; OMNI – omnivorous fish; RH – rheophilic (riverine) fish living only in running water; LITH – lithophilous fishes (spawning only on the stones and pebbles).

6 table. Indicative value of indicators reflecting ecological groups (R), reference index value (RC), the estimated value of the indicator, in scale 0-1 (NR) and the value of the river status indicator -LFI.

	R	NR	RC
NTOLE n%	0	0	22
NTOLE sp pcs.	-	-	-
TOLE n%	97,5	0,037	33
TOLE sp%	50	0,61	18
OMNI n%	91,6	0,133	37
RH n%	1,3	0,023	58
LITH n%	0,8	0,015	52
LITH sp %	12,5	0,305	41
LFI	0,16 (bad)		

- NTOLE, (N %)- Relative abundance (%) of intolerant (especially sensitive) fish in thecommunity;
- LITH, (N %)- Relative abundance (%) of lithophilous fish in thecommunity;
- LITH, (sp. %)- Relative abundance (%) of lithophilous fish in thecommunity;
- NTOLE sp. Number of non-tolerant fishspecies;
- RH, (N %)- Relative abundance (%) of rheophylic fish in thecommunity;
- TOLE, (N %)- Relative abundance (%) of tolerant (non-sensitive) fish in thecommunity;
- OMNI, (N %)- Relative abundance (%) of individuals of omnivorous fish in thecommunity;
- TOLE, (sp. %)- The relative number of tolerant fish species (% of all species) in thecommunity.

The calculated indicator values on the 0-1 scale represent the ecological status of the corresponding indicator. The actual ecological status of the relevant research area in the river is determined by deducting the average of all the required LFI indices for the calculation of the indicator values according to the formulas:

$$NR=R/RC$$

$$NR(OMNI \text{ ir } TOLE)=(R-100)/(RC-100)$$

$$L\check{Z}I=(NR_1+NR_2+\dots+NR_n)/N$$

here:

NR – the value of the indicator set at the relevant study area on the scale 0-1;

R – the value of the indicator determined at the relevant study area;

RC – the reference value of the indicator for the type concerned (3.3 table).

NR₁+...+NR_n– values ratio of the various ecological groups of fishes to their reference values;N – number of indicators reflecting different ecological groups of fish.

7 table. Ecological status of class 2 type rivers according to LFI

River type	Ecological status according LFI				
	Very good	Good	Average	Bad	Very bad
2	>0,936	0,936-0,716	0,715-0,401	0,400-0,109	<0,109

The ecological status of the studied area in Šyša River, according to the Lithuanian ecological status index LFI, is considered as **bad** (6 table). Such value of the indicator was determined by the fact that during the study fish species intolerant (INTOLE) to pollution and anthropogenic human activities wasn't detected. Extremely high relative abundance of tolerant (TOLE) and omnivorous fish (OMNI) (especially of common heights), had influence to lower values of indicator. Low relative abundance and species diversity of lithophilic fish (only chub) was found and insignificant abundance of rheophilic fish, had huge impact for a better indicator values.

The identified poor ecological status of the Šyša river below the dam may be related to the wastewater discharged by "Biofuture" bioethanol plant at the research station, which was repeatedly associated with the fall of the fish in the Šyša River. As the river flows through the city of Šilute, it suffers a great anthropogenic pressure.

8 table. Comparison of the ecological status of Šyša river with previous studies.

2011	LFI	0,349
	The river sections condition	Bad
2012	LFI	0,659
	The river sections condition	Average
2018	LFI	0,16
	The river sections condition	Bad

The results of research carried out in 2018 compared with the previous year indicate that the ecological status was significantly better in 2012 and was rated as average. Meanwhile, in 2011, the research area was characterized by poor ecological status, but the LF index in 2011 was almost twice as high and closer to the average condition. This change in ecological status may be related to the anthropogenic impact of the city and pollution in the river basin itself, as the dyke located above the study area is equipped with fish ladders, which minimizes the impact of the dyke on the migration of fish.

3.2.2. Ecological status of Šyša's oxbow lake

According to its hydro morphological parameters, the Šyša's oxbow lake is classified as shallow, polymictic water bodies with an average depth <3 meters (9 table). The Lithuanian lake fish index-LLFI-was used for ecological status assessment (Virbickas, 2016). During the study, only three fish species were caught in this water body: pike, perch and roach (5 table). A large amount of sludge and dead organic matter at the bottom of the oxbow lake and the continuous duckweed cover of the water surface could have led to an extremely small amount of fixed dissolved oxygen in the water. With such a small amount of dissolved oxygen, only the most oxygen-deficient species survive, and its abundance (as shown by the results of the research) is very low.

9 table. Criteria for the distinction of lakes, ponds and quarries ≤ 3

Types of water bodies in the lake category				
Criterion:	Poly Polymictic		S Stratified	DS Deep stratified
Average depth (m)	≤ 3	> 3	> 3	n^*
Maximum depth (m)	n^*	< 11	11-30	> 30

* „ n^* “ - criterion not used

10 table. Fish indicators and their changes in the state of the class.

Type of lake	Indicators	Reference value	Class status				
			V. good	good	Average	Poor	V. bad
1 (POLY)	Benthivora Sp Q% ¹	10	<20	20-34	35-46	47-60	>60 (0)
	Perch N% ²	30	>25	25-18	17-10	9-5	<5
	Obligatory species ³	6	6	5	4	<4	<4
	Non-indigenous, translocated species Q% ⁴	0	-	-	<1	1-5	>5

Description of the LLPI Indicators:

1 Benthivora_Sp Q% - relative biomass of bream, silver bream and ruff;

2 Perch N% – relative abundance of perch;

3 Obligatory species: POLY lake – bleak, rudd, pike, tench, perch, roach;

4 Non-indigenous, translocated species Q% - total relative biomass (%) of the individuals of pike perch, common carp, prussian carp and other non-indigenous species in the community

11 table. The values of the variables (except for obligatory species and relative biomass of non-place-translocated species) are transformed into the EKS scale ("1" is a good state, "0" is in poor condition).

Type of lake	Indicators	(maximum value)	Class status				
			V. good	Good	Average	Poor	V. bad
1 (POLY)	Benthivor_Sp Q%_EKS	(70)	1.0-0.834	0.833-0.600	0.599-0.400	0.399-0.167	0.166-0.0
	Perch N%_EKS		1.0-0.834	0.833-0.600	0.599-0.333	0.332-0.167	0.166-0.0

The transformation of the indicators presented in table 11 into the ecological quality ratio (EQS) follows the formulas below.

1 - Benthivor_Sp Q% indicators:

$EKS = (X - X_{max}) / (X_{et} - X_{max})$, kur X – calculated value, X_{et} – reference valued (10 table), X_{max} – theoretical maximal value (11 table);

When EKS indicator value >1 or <0 , the value of the indicator is equaled accordingly „1“ or „0“.

12 table. The value of the obligatory species in the EKS depends on the number of obligatory species found in the lake.

Type of lake	1 (POLY)	Number of obligatory species			
		6	5	4	<4
Obligatory species EKS		1	-	0,2	0

Note: If any of the obligatory species of fish is wasn't caught, but it is known that it actually lives in the lake, it is added to the other types when determining the EKS indicator for obligatory fish species

13 table. Relative biomass of non-native and translocated species (Q%) of the EKS value

Indicator of relative biomass (Q%) of non-indigenous and translocated species				
Q%	0%, or only 1 individual in a SFE catch	<1%	1-5%	$\geq 5\%$
EKS	- (indicator not used)*	0,5	0,2	0

* - the indicator is only used when more than 1 individual is caught with 8 selective gillnets through standardized fishing effort.

SFE – standardized fishing effort

The LLFI is the average of all EKS indicators. The limits of LLFI variation in different state classes are presented in Table 14.

14 table. Ecological status of lakes according to LLFI values

Type of lake	Ecological status class				
	V. good	Good	Average	Poor	V. bad
1-3	1,00-0,87	0,86-0,61	0,60-0,37	0,36-0,18	0,17-0,00

15 table Calculated fish indicators, reference values, ecological quality ratios and their status classes.

Indicators	Calculated value	Ecological quality ratio	Reference value	Status
Benthivor_Sp Q% ¹	0	0	10	Very bad
Perch N% ²	28,6	0,95	30	Very good
Obligatory species ³	2	0	6	Very bad

Non-indigenous, translocated species Q% ⁴	0	-	-	-
LLFI	0,32			Poor

According to the estimated LLFI value – 0,32, ecological status of the Šyša's oxbow lake is **poor (table 15)**. This value was determined by the fact that the water body is completely absent of benthivorous fish, and from obligatory fish species (that are naturally occurring in this type of water body) only pike was caught. Although the relative abundance of perch is quite high (28.6%), however, according to table 5, it is seen that the total fish abundance is very low (only 0.56 pcs. /100m²). Due to the very low overall abundance of fish in this water body, poor ecological status of the LLFI shouldn't be considered as corrective, the ecological status of this water body should be considered as **very bad**.

4. Conclusions

1. Although visually the Šyša Oxbow Lake seems as heavily silted water body of low ecological quality, its macroinvertebrate fauna is rather rich.
2. There were 40 macroinvertebrate taxa in the collected sweep sample, however, community diversity was rather low due to dominance of separate species.
3. According to Lithuanian Lake Macroinvertebrate Index the Šyša Oxbow Lake was assessed as water body of good status.
4. According to BMWP and ASPT metrics the Šyša Oxbow Lake was also assessed as water body of good or moderate status.
5. Obtained estimates should be read with caution as LLMI was designed for Lithuanian lakes while the metrics usually applied for rivers or lakes. Specific metrics for quality assessment of small segment water bodies such as oxbow lakes or ponds are not available.
6. Clearing of the Šyša Oxbow lake, removal of silt, debris and communal wastes in particular, should improve the ecological status of the oxbow lake and may increase biological diversity.
7. When implementing the management of the oxbow lake, we recommend to retain some natural habitats and avoid transformation of the oxbow lake into an artificial pond with altered shores. Such modifications may reduce the biological diversity of the oxbow lake.
8. The ecological status of the studied area in Šyša River, according to the Lithuanian ecological status index LFI, is considered as **bad**.
9. The identified poor ecological status of the Šyša river below the dam may be related to the wastewater discharged by “Biofuture” bioethanol plant in the past, which was repeatedly associated with the fall of the fish in the Šyša River. As the river flows through the city of Šilutė, it suffers a great anthropogenic pressure.
10. According to the estimated LLFI value – 0,32, ecological status of the Šyša's oxbow lake is **poor**. The total fish abundance is very low (only 0.56 pcs. /100m²). Due to the very low overall abundance of fish in this water body, poor ecological status of the LLFI shouldn't be considered as corrective, the ecological status of this water body should be considered as **very bad**.

5. Literature

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