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Główny Inspektorat Ochrony Środowiska

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Redakcja zaktualizowanych metodyk monitoringu biologicznych elementów oceny stanu ekologicznego wód powierzchniowych wraz z recenzją naukową i publikacją

ZAŁĄCZNIK DO SPRAWOZDANIA

ANGLOJĘZYCZNE STRESZCZENIA METODYK

Warszawa, 30 października 2020 r.

Praca wykonana przez Instytut Ochrony Środowiska – Państwowy Instytut Badawczy, na zamówienie Głównego Inspektoratu Ochrony Środowiska zgodnie z umową nr DOF/40/2020 z dnia 4 marca 2020 r. i sfinansowana ze środków unijnych w ramach Programu Operacyjnego Infrastruktura i Środowisko 2014-2020

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SPIS TREŚCI

1. Phytoplankton in rivers

Method: Multimetric phytoplankton index for river and dam reservoir classification (IFPL)

1. General information

1.01 GIG: Central-Baltic;

Relevant intercalibration types: large rivers

1.02 Category: Rivers, dam reservoirs

1.03 BQE: Phytoplankton

1.04 Country: Poland

1.05 Specification:

Lowland rivers with catchment area larger than 5000 km^2; dam reservoirs of different types

1.06 Method name:

Multimetric phytoplankton index for river and dam reservoir classification (IFPL)

1.07 Original name:

Multimetriks fitoplanktonowy dla dużych rzek i zbiorników zaporowych Polski

1.08 Status: Finalized, intercalibrated, formally agreed national method; applied in the state monitoring since 2013

1.09 Detected pressure(s):

Eutrophication

Has the pressure-impact-relationship been tested?

Yes, ecological data from 102 river sites were examined to establish pressure-impact relationship between phytoplankton metric and eutrophication gradient. The relationship between phytoplankton metric and TP (average from vegetation season) showed significant correlation (R^2=0,451); between phytoplankton metric and PO4; TN and nitrate correlation was weak (R^2 respected 0,206; 0,288 and 0,146).

1.10 Internet reference:

https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/FPL_RZ_WYTYCZNE_METODYCZNE_2012.pdf

https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/Metodyki_biologiczne_zbiorniki_zaporowe_wer_2010_2.pdf

1.11 Pertinent literature of mandatory character:

Picińska-Faltynowicz J., Błachuta J., 2012. Wytyczne metodyczne do przeprowadzenia badań fitoplanktonu i oceny stanu ekologicznego rzek na jego podstawie Warszawa, Chief Inspector of Environmental Protection (manuscript, in Polish).

Picińska-Faltynowicz J., Błachuta J., 2012. Wytyczne metodyczne do przeprowadzenia monitoringu i oceny potencjału ekologicznego zbiorników zaporowych w Polsce. Warszawa, Chief Inspector of Environmental Protection, (manuscript, in Polish).

1.12 Scientific literature: not available

1.13 Method developed by:

Joanna Picińska-Fałtynowicz, e-mail: joanna.faltynowicz@imgw.pl, Institute of Meteorology and Water Managament – National Research Institute

Jan Błachuta, e-mail: jan.blachuta@imgw.pl, Institute of Meteorology and Water Managament – National Research Institute

1.14 Method reported by:

Joanna Picińska-Fałtynowicz, e-mail: joanna.faltynowicz@imgw.pl, Institute of Meteorology and Water Managament – National Research Institute

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska: e-mail: sekretariatdm@gios.gov.pl

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Picińska-Fałtynowicz J., Błachuta J., 2012. Wytyczne metodyczne do przeprowadzenia badań fitoplanktonu i oceny stanu ekologicznego rzek na jego podstawie. Warszawa, Chief Inspector of Environmental Protection (manuscript, in Polish). https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/FPL_RZ_WYTYCZNE_METODYCZNE_2012.pdf

Picińska-Fałtynowicz J., Błachuta J., 2012. Wytyczne metodyczne do przeprowadzenia monitoringu i oceny potencjału ekologicznego zbiorników zaporowych w Polsce. Warszawa, Chief Inspector of Environmental Protection (manuscript, in Polish). https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/Metodyki_biologiczne_zbiorniki_zaporowe_wer_2010_2.pdf

2.02 Short description:

River: samples are taken from 0,5 m water depth from the mainstream of the main channel.

Dam reservoir: samples are taken from 0,5 m water depth at least several dozen meters from the shoreline.

2.03 Method to select the sampling/survey site or area:

Sampling site should be located at the terminal section of the river (in its lower part). The sampling site for phytoplankton should represent the predominant river habitat type. If possible, phytoplankton sampling site should be located near the bridge to facilitate the correct midstream sampling.

2.04 Sampling/survey device: Water sampler, Plankton net

2.05 Specification:e. g. Ruttner-type water sampler

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: see 2.02

Sampled habitat: Single habitat

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): March - November

2.09 Number of sampling/survey occasions (in time) to classify site or area:

River: at least six samplings per vegetation period

Dam reservoir: at least three samplings per vegetation period

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

One representative sampling point is located at a waterbody.

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

Samples for phytoplankton quantitative analysis (total biomass and diatoms identification)–from 200 ml to 100 ml, sample for chlorophyll *a* analysis - at least 0,5 l (max. taken volume 5 l).

Sample processing

2.12 Minimum size of organisms sampled and processed:2 µm

2.13 Sample treatment:

Sub-samples are analyzed in inverted microscope by Utermöhl-technique. Fo the reference to the method see:

PN-EN 15204:2006, Jakość wody – Wytyczne do oznaczania ilościowego fitoplanktonu z użyciem odwróconego mikroskopu (metoda Utermöhla);

PB-BL-07/BS wydanie 1 z dnia 15.03.2013 r., Analiza i biomasa fitoplanktonu - Metoda mikroskopowa, jakościowa i ilościowa;

PN-EN 16695: 2016-01, Jakość wody - Wytyczne do określania bioobjętości fitoplanktonu (English version);

2.14 Level of taxonomical identification:

Level: Family, Genus, Species/species groups

Specification of level of determination: The level of required indicator taxa determination is presented in the method.

2.15 Record of abundance:

Determination of abundance: Individual counts

Abundance is related to: Volume

Unit of the record of abundance: Biomass of individuals (mg) per liter (mg/l)

2.16 Quantification of biomass: Utermöhl technique

2.17 Other biological data: Size of organisms

2.18 Special cases, exceptions, additions: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

The phytoplankton multimetric IFPL is composed of two obligatory metrics:

- chlorophyll index- CH;
- trophy index – IT.

Chlorophyll *a* index CH: The chlorophyll index is calculated in five categories based on the seasonal mean of chlorophyll *a* concentration. The chlorophyll index CH is standardized (ZCH) before the IFPL index calculation:

ZCH = 1 – ((CH – 1) x 0.25)

Trophy index IT: The IT trophy index is based on taxa found in the phytoplankton community, indicative for the fertility level of the river. Each taxon is assigned a trophic and weight value; while calculating the IT index, the percentage share of a given indicator taxon in the total biovolume of all indicator taxa is taken into account. The IT is calculated in five categories. The trophy index IT is standardized (ZIT) before the IFPL index calculation:

ZIT = 1 – ((IT – 1) x x0.25)

The IFPL index is an average of the two component metrics:

IFPL = (ZIT + ZCH)/2

The IFPL values range from 0 (most disturbed) to 1 (least disturbed conditions).

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: Average metric score.

3.04 From which biological data are the metrics calculated:

Aggregated data from multiple sampling/survey occasions in time and reference conditions

Reference conditions

3.05 Scope of reference conditions: Specific for abiotic type

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: 18 rivers with least disturbed conditions were selected. The boundary criterion was not to exceed the value of 0.13 mgP/L for the average seasonal concentration of total phosphorus.

3.07 Reference site characterization:

Biebrzański National Park, Narwiański Landscape Park, and Protected Birds Area The Lower San Valley

3.08 Reference community description: Not provided

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries:

In the first version of the method, the equidistant intervals of class boundaries were applied. In the years 2009-2011, more than 80 localities on large rivers were examined. Those with average values (from vegetation season) of TP concentration not higher than 0.13 mgP/l were selected and 95 percentile of IFPL index data set was calculated to obtain the boundary value between high and good status classes. The 95 percentile equaled 0.812 and therefore the value 0.8 of H/G boundary was accepted. The G/M, M/P and P/B boundaries were indicated by dividing the remaining value on equidistant intervals.

The IFPL class boundaries for large rivers and dam reservoirs:

Ecological status/potential	IFPL value
HIGH/MAXIMUM	≥0.96
GOOD	≥0.79
MODERATE	≥0.47
POOR	≥0.16
BAD	<0.16

3.11 'Good status' community description: Not provided

Uncertainty

3.12 Consideration of uncertainty: No, to be done

2. Phytobenthos in rivers

Method: Diatom index for river and dam reservoir classification (IO)

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: n.a.

1.02 Category: Rivers

1.03 BQE: Benthic Diatoms

1.04 Country: Poland

1.05 Specification:

1.06 Method name: Classification system based on diatoms for rivers and dam reservoirs – diatom index (IF)

1.07 Original name: Ocena stanu ekologicznego rzek w oparciu o Multimetryczny Indeks Okrzemkowy IO

1.08 Status: Finalized, intercalibrated, formally agreed national method

1.09 Detected pressure(s):

Catchment land use, Eutrophication, Pollution with organic matter, General degradation

Pressure-impact-relationship: n.a.

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Zgrundo A., Peszek Ł., Poradowska A., 2018a. Podręcznik do monitoringu i oceny rzecznych jednolitych części wód powierzchniowych na podstawie fitobentosu. GIOŚ, Gdańsk (manuscript, in Polish).

Zgrundo A., Peszek Ł., Poradowska A., 2018b. Aneks do wytycznych metodycznych do przeprowadzenia monitoringu i oceny potencjału ekologicznego zbiorników zaporowych w Polsce na podstawie fitobentosu. GIOŚ, Gdańsk (manuscript, in Polish).

1.12 Scientific literature: not available

1.13 Method developed by:

Joanna Picińska-Fałtynowicz, e-mail: joanna.faltynowicz@imgw.pl, Institute of Meteorology and Water Managament – National Research Institute (first version, 2010)

Aleksandra Zgrundo, e-mail: aleksandra.zgrundo@ug.edu.pl; University of Gdansk, Faculty of Oceanography and Geography (verified version, 2018)

1.14 Method reported by:

Aleksandra Zgrundo, e-mail: aleksandra.zgrundo@ug.edu.pl

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

EN-PN 13946:2014-05 „Jakość wody – Wytyczne do rutynowego pobierania próbek oraz wstępnego przygotowania do analiz okrzemek bentosowych z rzek i jezior"

EN-PN 14407:2014-05 „Jakość wody – Wytyczne dotyczące identyfikacji i oznaczania ilościowego próbek okrzemek bentosowych z rzek i jezior".

Zgrundo i in. 2018. Podręcznik do monitoringu i oceny rzecznych jednolitych części wód powierzchniowych na podstawie fitobentosu

Zgrundo i in. 2018. Annex. Wytyczne metodyczne do przeprowadzenia monitoringu i oceny potencjału ekologicznego zbiorników zaporowych w Polsce

2.02 Short description:

The method is consistent with EN 13946 Water quality - Guidance for the routine sampling and preparation of benthic diatoms from rivers and lakes and EN 14407:2014 Water quality - Guidance for the identification and enumeration of benthic diatom samples from rivers and lakes

2.03 Method to select the sampling/survey site or area:

Sites most representative of waterbody and associated with sampling sites used for other biota

2.04 Sampling/survey device: Toothbrush or scraper

2.05 Specification:

Toothbrush, knife, scraper, strong scissors, plastic tray, plastic sample bottles with watertight lids, waterproof permanent marker pen or another means of labelling samples, artificial substrate

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: Generally hard substrates of natural (as cobbles, boulders) and anthropogenic origin but also other as macrophytes and macroalgae when former are not present. Sample habitat is chosen based on that which is appropriate for optimising the presence of diatoms at a site.

Sampled habitat: Single habitat

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): Spring and autumn

2.09 Number of sampling/survey occasions (in time) to classify site or area:

One occasion per sampling season

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

Minimum 5 replicates per sampling occasion

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area: At least 10 cm^2.

Sample processing

2.12 Minimum size of organisms sampled and processed: n.a.

2.13 Sample treatment:

Sample is divided (sub-sampling) and organisms of a sub-sample are identified.

2.14 Level of taxonomical identification:

Level: Species/species groups

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: Relative abundance

Abundance is related to: n.a.

Unit of the record of abundance: Number of valves

Other record of abundance: a total of at least 300 diatom valves counted per sample

2.16 Quantification of biomass: n.a.

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Diatom Index IO is composed of three component metrics:

- GR = Sum of relative abundance of reference taxa;
- TI = Trophic Index (Rott et al. 1999);
- SI = Saprobic Index (Rott et al. 1997);

TI and SI are calculated using a weighted formula of Zelinka & Marvan (1961).

The multimetric IO is a weighted average of the three component metrics calculated as:

IO = (ZTI + ZSI + GR)/3;

Where:

ZTI = 1-(TI x 0.25);

ZSI = 1-[(SI-1) x 0.33]

The IO values range from 0 (most disturbed) to 1 (least disturbed conditions).

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: Average metric scores

3.04 From which biological data are the metrics calculated:

Data from single sampling/survey occasion

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: Existing near-natural reference sites, Expert knowledge, Least Disturbed Conditions

3.07 Reference site characterisation:

Number of sites: A total of 30 sites for different abiotic river types

Geographical coverage: Reference zones in natural and landscape parks in Central Highlands, Carpathians, Central Plains, Baltic Province and Eastern Plains

Location of sites: Karkonosze, Tatry, Bieszczady, Magurski, Drawienski and Biebrzanski Natural Parks, Chojnicki, Wdzydzki, Suwalski Landscape Parks

Data time period: February - April and September - November 2004-2009

Criteria: Absence of point pollution sources, watershed dominated by natural forests, meadows and wetlands; slight hydromorphological changes have not been taken into account as they do not affect benthic diatom communities

3.08 Reference community description:

Epilithic diatom communities dominated by reference species, i.e. oligo-mesotrophilous and oligosaprobic depending on a stream/river type

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries: n.a.

3.11 Boundary setting procedure:

The class boundaries were set for different groups of river types separately (type-specific classification). For dam reservoirs, class boundaries are unified irrespective of the retention time.

River type (1st and 2nd RBMP)*	River type (3rd RBMP)*	Ecological status/potential				
		HIGH	GOOD	MOD	POOR	BAD
1, 2, 3	PGT, PGS	>0.75	≥0.55	≥0.35	≥0.15	<0.15
4, 5, 8,10,	RWK, RFK, RSK	>0.69	≥0.50	≥0.30	≥0.15	<0.15
6, 7, 9, 12, 14, 15	RWW, RFW, RSW	>0.66	≥0.48	≥0.30	≥0.15	<0.15
16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26	PN, PNp, RN, RT, RP, RWN, PU, RU	>0.54	≥0.39	≥0.30	≥0.15	<0.15
0	R, P, L	>0.75	≥0.65	≥0.45	≥0.20	<0.20

*For river types see: Hobot A. (red.), Banaszak K., Ciupak E., Kraśniewski W., Kolada A., Komosa M., Kunert M., Kutyła S., Krzymiński W., Mutryn J., Stachura-Węgierek A., Pasak D., Pasztaleniec A., Soszka H., 2015. Aktualizacja wykazu JCWP i SCWP dla potrzeb kolejnej aktualizacji planów w latach 2015-2021 wraz z weryfikacją typów wód 22 części wód. Etapy I-II. Praca wykonana w ramach konsorcjum Pectore-Eco Sp. z o.o. oraz Instytutu Ochrony Środowiska – Państwowego Instytutu Badawczego na zlecenie KZGW. Pectore-Eco – IOŚ-PIB, Gliwice - Warszawa (manuscript, in Polish).

3.12 "Good status" community: Not provided

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none

3. Macrophytes in rivers

Method: Macrophyte Index for Rivers (MIR)

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: R-C1, R-C3, R-C4

1.02 Category: Rivers

1.03 BQE: Macrophytes

1.04 Country: Poland

1.05 Specification: n.a.

1.06 Method name: Macrophyte Index for Rivers

1.07 Original name: Makrofitowa Metoda Oceny Rzek

1.08 Status: The method has been used since 2007 in the State Environmental Monitoring

1.09 Detected pressure(s):

Eutrophication, General degradation, Pollution by organic matter

Specification of pressure-impact-relationship: Nutrient concentration, land use

Pressure-impact-relationship: Yes, with quantitative data (e.g. against range of sites reflecting continuous gradient of pressure).

1.10 Internet reference: https://makrofity.wordpress.com/

1.11 Pertinent literature of mandatory character:

Jusik S., Szoszkiewicz K., Gebler D. 2020. Makrofity w rzekach – metoda MMOR. W: Kolada A. (red.) Podręcznik do monitoringu elementów biologicznych i klasyfikacji stanu ekologicznego wód powierzchniowych. Aktualizacja metod. Biblioteka Monitoringu Środowiska, Warszawa.

Szoszkiewicz K., Zbierska J., Jusik S., Zgoła T. 2010. Makrofitowa Metoda Oceny Rzek. Podręcznik metodyczny do oceny i klasyfikacji stanu ekologicznego wód płynących w oparciu o rośliny wodne, Bogucki Wydawnictwo Naukowe, Poznań, ss. 81.

1.12 Scientific literature:

Gebler D., Szoszkiewicz K., Pietruczuk K. 2017. Modeling of the river ecological status with macrophytes using artificial neural networks. Limnologica, 65: 46-54.

Jusik S., Szoszkiewicz K., Kupiec J.M., Lewin I., Samecka-Cymerman A. 2015. Development of comprehensive river typology based on macrophytes in the mountain-lowland gradient of different Central European ecoregions, Hydrobiologia, 745 (1): 241-262.

Szoszkiewicz K., Ławniczak A.E., Jusik S., Zgoła T. 2010. Macrophyte development in unimpacted lowland rivers. Hydrobiologia, 656 (1): 117-131.

Szoszkiewicz K., Budka A., Pietruczuk K., Kayzer D., Gebler D. 2017a. Is the macrophyte diversification along the trophic gradient distinct enough for river monitoring? Environmental Monitoring and Assessment, 189 (1): #4.

Szoszkiewicz K., Jusik S., Lewin I., Czerniawska-Kusza I., Kupiec J.M., Szostak M. 2018. Macrophyte and macroinvertebrate patterns in unimpacted mountain rivers of two European ecoregions, Hydrobiologia, 808: 327-342

Szoszkiewicz K., Jusik S., Pietruczuk K., Gebler D. 2020. The Macrophyte Index for Rivers (MIR) as an advantageous approach to running water assessment in local geographical conditions, Water, 12 (1): 108.

1.13 Method developed by:

Krzysztof Szoszkiewicz (e-mail: krzysztof.szoszkiewicz@up.poznan.pl), Szymon Jusik, Janina Zbierska, Tomasz Zgoła in 2006;

Method updated by: Szymon Jusik, Krzysztof Szoszkiewicz, Daniel Gebler in 2020. Department of Ecology and Environmental Protection, Poznan University of Life Sciences

1.14 Method reported by:

Krzysztof Szoszkiewicz; e-mail: krzysztof.szoszkiewicz@up.poznan.pl

Szymon Jusik; e-mail: szymon.jusik@up.poznan.pl

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines: Botanical observations in the river

2.02 Short description:

In the MIR method, the survey reach is a 100 m length of river, where all submerged, free-floating, amphibious and emergent monocotyledonous and dicotyledonous plants, as well as filamentous algae, liverworts, mosses, and pteridophytes are identified. Field studies are based on botanical observations carried out during the double passage of the research section. At first, it takes a zig-zag course, upstream, from bank to bank. The second pass of the research section should be made down the watercourse, even partially along the bank, as a different observation perspective allows for the observation of additional elements. The assessment also includes macrophytes attached or rooted in parts of the river bank that are likely to be submerged for more than 75% of the year. The cover of each species is recorded using the following nine-point scale according to Holmes et al.: <0.1%, 0.1-1%, 1-2.5%, 2.5-5%, 5-10%, 10-25%, 25-50%, 50-75%, and >75%.

2.03 Method to select the sampling/survey site or area:

Representativeness of the river section estimated, abundance of aquatic plants

2.04 Sampling/survey device: Grapnel, Rake, Aquascope (bathyscope)

2.05 Specification: none

2.06 Sampled/surveyed habitat:

Sampled habitat: All available habitats per site (Multi-habitat)

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): mid June to mid-September

2.09 Number of sampling/survey occasions (in time) to classify site or area:

Generally one occasion per sampling season. Second occasion required to catch different vegetation forms.

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

One

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area: 100 m of the river section

Sample processing

2.12 Minimum size of organisms sampled and processed: Naked eye visible

2.13 Sample treatment:

Most of macrophytes are identified in the field. Some difficult taxa (i.e. macroalgae, bryophytes, *Potamogeton*, *Batrachium*) are collected and identified in the biological laboratory.

2.14 Level of taxonomical identification:

Level: Mostly species, several taxa to genus level

Specification of level of determination: Most of macrophytes are identified to species level. Genus level is limited to macroalgae and some liverworts.

2.15 Record of abundance:

Determination of abundance: Abundance classes - nine-point scale according to Holmes et al.: <0.1%, 0.1-1%, 1-2.5%, 2.5-5%, 5-10%, 10-25%, 25-50%, 50-75%, and >75%

Abundance is related to: Area (water surface coverage within survey stretch of a river)

Unit of the record of abundance: Area covered by species

2.16 Quantification of biomass: n.a.

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics: Macrophyte Index for Rivers - MIR

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: n.a.

3.04 From which biological data are the metrics calculated:

The Macrophyte Index for Rivers uses 189 indicator taxa. The calculation of the index is based on the abundance of the taxon (assessed in the field) and two indicators values (trophy number L and weighting factor W).

The trophy number (L) is related to the average annual concentration of biogenic compounds in the water (especially phosphorus) and indicates the optimal water trophy level in which a given taxon develops best. The values ranges from 1 for hypereutrophic indicators to 10 for oligotrophy.

The weighting factor (W) is a measure of the ecological tolerance of a taxon to the water trophy and indicates the range of variability of nutrient concentrations in water in which a given taxon occurs. The weighting factor ranges from 1 for eurytrophic species to 3 for stenotrophic species.

The MIR index is calculated as:

$$MIR = [\sum(L_i \times W_i \times P_i) / \sum(W_i \times P_i)] \times 10$$

Where:

L – trophy number for a taxon;

W – weighting factor (ecological tolerance);

P =- coverage factor in 9-point scale.

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: Existing seminatural reference sites

3.07 Reference site characterisation:

Number of sites: 109

Geographical coverage: Whole country; reference sites distributed throughout the four ecoregions found in Poland: (Central Plains), 16 (Eastern Plains), 9 (Central Highlands) and 10 (the Carpathians).

Location of sites: Reference sites were located in the most strictly protected parts of Poland, i.e., World Biosphere Reserves, National Parks, Nature Reserves, Landscape Parks, and Natural Parks, as well as Special Areas of Conservation under the Habitats Directive . Several sites were located in areas subjected to numerous forms of nature conservation, e.g., the Roztoka River is protected as the Tatra Biosphere Reserve, the Tatra National Park, the Tatra Special Protection Area and the Tatra Special Areas of Conservation (PLC120001).

Data time period: 2005-2013

Criteria: The reference site selection was based on four criteria: (1) catchment land use, (2) hydromorphological conditions, (3) physical and chemical parameters of water, (4) nature protection. Regarding the catchment land use, >60% of forests, wetlands or extensive grasslands, <25% of arable land and <1% of urban area were required for the reference sites. Moreover, exclusively natural and semi-natural forms of land use were restricted to the nearest vicinity of the selected reference river sites (250 m upstream and downstream) as a strip of 50 m from the bank top. These were forests, wetlands, extensive grasslands, and in high mountains − shrubs of *Pinus mugo* and rock debris. The reference hydromorphological conditions were characterised by a significant heterogeneity of the channel morphological structure according to the RHS criteria (HQA ≥45), a lack of anthropogenic alteration of river systems and the absence of any water structures (HMS ≤5, most often HMS = 0). Concerning the physical and chemical parameters of water, a low nutrient concentration was required: reactive phosphorus <0.1 mg P·l^{-1}, total phosphorus <0.2 mg P·l^{-1}, nitrate nitrogen <1.0 mg N·l^{-1}, ammonium nitrogen <0.2 mg N·l^{-1}, conductivity <0.7 mS·cm^{-1} and a lack of anthropogenic acidification and salinisation. Most of the parameters correspond to a very good (1st class) physical and chemical status of water (for reactive phosphorus - good) according to the official Polish standards.

3.08 Reference community description:

Yes, description in: Jusik S., Szoszkiewicz K., Kupiec J., Lewin I., Samecka-Cymerman A. 2015. Development of comprehensive river typology based on macrophytes in the mountain-lowland gradient of different Central European ecoregions. Hydrobiologia, 745: 241-262, DOI: 10.1007/s10750-014-2111-2.

3.09 Results expressed as EQR: Yes

Specification if results are not expressed as EQR: MIR based assessment is indirect EQR classification

Boundary setting

3.10 Setting of ecological status boundaries:

Calibrated against pre-classified sampling sites; equidistant division of the EQR gradient. The class boundaries for MIR are type-specific:

River type (1st and 2nd RBMP)*	River type (3rd RBMP)*	Ecological status/potential				
		HIGH	GOOD	MOD	POOR	BAD
1,2	PGT	≥76.6	≥58.5	≥40.4	≥25.9	<25.9
3	PGS	≥78.8	≥60.0	≥41.3	≥26.3	<26.3
4, 5, 8	RW_krz	≥68.8	≥52.9	≥37.1	≥24.5	<24.5
6, 7, 9	RW_wap	≥64.2	≥49.7	≥35.2	≥23.7	<23.7
12, 14	RWf_krz	≥68.8	≥52.9	≥37.1	≥24.5	<24.5
12, 14	RWf_wap	≥64.2	≥49.7	≥35.2	≥23.7	<23.7
10	RsW_krz	≥52.6	≥41.5	≥30.5	≥21.6	<21.6
15	RsW_wap	≥52.6	≥41.5	≥30.5	≥21.6	<21.6
16, 18, 26	PN	≥48.3	≥37.6	≥27.0	≥16.4	<16.4
17	PNp	≥46.7	≥36.8	≥27.0	≥16.3	<16.3
19, 20	RzN	≥45.4	≥36.9	≥28.5	≥20.1	<20.1
21	RwN	Excluded from the macrophyte monitoring				
22	PN_uj	≥46.7	≥36.8	≥27.0	≥16.3	<16.3
22	RzN_uj	≥45.4	≥36.9	≥28.5	≥20.1	<20.1
23	P_org	≥45.6	≥35.7	≥25.8	≥15.9	<15.9
24	Rz_org	≥43.2	≥35.4	≥27.5	≥19.7	<19.7
25	P_poj	≥45.6	≥35.7	≥25.8	≥15.9	<15.9
25	Pl_poj	≥48.3	≥37.6	≥27	≥16.4	<16.4
25	R_poj	≥43.2	≥35.4	≥27.5	≥19.7	<19.7
25	Rl_poj	≥45.4	≥36.9	≥28.5	≥20.1	<20.1

*For river types see: Hobot A. (red.), Banaszak K., Ciupak E., Kraśniewski W., Kolada A., Komosa M., Kunert M., Kutyła S., Krzymiński W., Mutryn J., Stachura-Węgierek A., Pasak D., Pasztaleniec A., Soszka H., 2015. Aktualizacja wykazu JCWP i SCWP dla potrzeb kolejnej aktualizacji planów w latach 2015-2021 wraz z weryfikacją typów wód 22 części wód. Etapy I-II. Praca wykonana w ramach konsorcjum Pectore-Eco Sp. z o.o. oraz Instytutu Ochrony Środowiska – Państwowego Instytutu Badawczego na zlecenie KZGW. Pectore-Eco – IOŚ-PIB, Gliwice - Warszawa (manuscript, in Polish).

3.11 Boundary setting procedure:

MIR index was calibrated against nutrient content of rivers. Indicative scores of macrophyte species were calculated analysing against nutrient gradient.

3.12 "Good status" community:

At good status stands indicators of high status play an important role in the area-cover overgrown by vegetation.

Uncertainty

3.13 Consideration of uncertainty: Yes

Specification of uncertainty consideration: Multi sampling campaign, visiting sites by various surveyors, comparing hydromorphologically impacted and unimpacted sites, shaded and unshaded, testing different section length

3.14 Comments: none

4. Macroinvertebrates in rivers

Method: Polish Multimetric Index MMI PL

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: RC1, RC2, RC3, RC4, RC5, RC6 and very large rivers

1.02 Category: Rivers

1.03 BQE: Benthic Invertebrates

1.04 Country: Poland

1.05 Specification: All types of rivers

1.06 Method name: Polish Multimetric Index MMI PL

1.07 Original name: Polski Wielometryczny Wskaźnik MMI PL

1.08 Status: Officially accepted, intercalibrated, used in the state monitoring for the second and third RBMP (since 2014)

1.09 Detected pressure(s):

eutrophication, salinity, saprobization

Specification of pressure-impact-relationship: total nitrogen (TN), nitrates (NO3), conductivity (Cond), chlorides (Cl), Biochemical oxygen demand (BOD5)

Pressure-impact-relationship: for large rivers: TN ($r=-0,326$; $p<0,05$) and NO3 ($r=-0,328$; $p<0,05$), Cond ($r=-0,505$; $p<0,05$) and CL ($r=-0,390$; $p<0,05$), BOD5 ($r=-0,526$; $p<0,05$)

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Bis B., Mikulec A. (eds.). 2013. Przewodnik do oceny stanu ekologicznego rzek na podstawie makrobezkręgowców bentosowych. Inspekcja Ochrony Środowiska, Biblioteka Monitoringu Środowiska. Warszawa, 127pp., ISBN 978-83-61227-21-2. (in Polish)

1.12 Scientific literature: not available

1.13 Method developed by:

Barbara Bis, Faculty of Biology and Environmental Protection, University of Lodz;

Artur Mikulec,Faculty of Economics and Sociology, University of Lodz

1.14 Method reported by:

Aleksandra Bielczyńska, e-mail: a.bielczynska@ios.edu.pl;

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Bis B., Mikulec A. (eds.). 2013. Przewodnik do oceny stanu ekologicznego rzek na podstawie makrobezkręgowców bentosowych. Inspekcja Ochrony Środowiska, Biblioteka Monitoringu Środowiska. Warszawa, 127pp., ISBN 978-83-61227-21-2. (in Polish)

2.02 Short description:

Multi-habitat sampling is performed. Samples consists of 20 subsamples from different habitats (mineral and organic), sample should be preserved with 96% ethanol.

2.03 Method to select the sampling/survey site or area:

Sampling area is a section of a river (20-100 m, length depends on the size of its catchment), preferably wadeable. Sampling site should be safe to examine and representative in terms of hydrology and morphology of the river.

2.04 Sampling/survey device:

hydrobiological net/Surber sampler for kick sampling, bottom sampler/ benthic dredge for sampling from boat

2.05 Specification:

hydrobiological net/Surber sampler of 500 µm mesh-size, bottom sampler (Günther or Ekman-Birge)

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: all habitats that represents over 5% of sampling site

Sampled habitat: multi-habitat sampling

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): Spring/Autumn

2.09 Number of sampling/survey occasions (in time) to classify site or area: once per year

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

One site per waterbody.

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

1,25 m^2 of sampled area (20 subsamples, 625 cm^2 each)

Sample processing

2.12 Minimum size of organisms sampled and processed: 500 µm

2.13 Sample treatment:

Sample should be rinsed, drained on the sieve and subsampled at least 5 times (one subsample is 1/30 of whole sample). All animals from subsamples need to be identified and counted until total number of organisms exceeds 350. In case of mass occurrence of selected taxa (Oligochaeta, Isopoda, Amphipoda, Cirripedia, Chironomidae and Simuliidae) it is possible to estimate its abundance based on smaller subsamples.

2.14 Level of taxonomical identification:

Level: Family

Specification of level of determination: Animals are identified to the family level, except for Oligochaeta, Porifera, Bryozoa, Cnidaria, Hydracarina, that are not identified to the lower taxonomic level.

2.15 Record of abundance:

Determination of abundance: relative abundance

Abundance is related to: sampled area

Unit of the record of abundance: number of individuals per square meter

2.16 Quantification of biomass: n.a.

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: Bigger animals and protected species should be identified and counted in the field and set free prior to fixation of the sample.

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Multimetric MMI PL is a weighted average of six component metrics:

- Average Score Per Taxon PL (**ASPT_PL**);
- selected families from Ephemeroptera, Plecoptera, TRichoptera and Diptera (**Log10 (sel_EPTD + 1)**);
- abundance of Gastropoda, Oligochaeta and Diptera (**1 - GOLD**);
- Total number of families (**S**);
- the number of families of Ephemeroptera, Plecoptera, Trichoptera (**EPT**);
- Shannon-Wiener Diversity Index (**Shannon-Wiener-Index**).

Before the Multimetric MMI PL is calculated, all metrics are normalised to Ecological Quality Ratios (EQRs).

3.02 Does the metric selection differ between types of water bodies: no

3.03 Combination rule for multi-metrics:

Weighted average of Ecological Quality Ratios (normalized metrics) according to the formula:

MMI PL = 0.334 x EQR ASPT_PL + 0.266 x EQR $\log_{10}$(selEPTD + 1) + 0.067 x EQR (1-GOLD) + 0.167 x EQR S + 0.083 x EQR EPT + 0.083 x EQR H'

The MMI PL values range from 0 (most disturbed) to 1 (least disturbed conditions).

3.04 From which biological data are the metrics calculated:

Abundance of animals per square meter

Reference conditions

3.05 Scope of reference conditions:

Reference conditions were determined based on the selected reference sites from the dataset of over 1114 sites. Reference sites constituted 20% of all sites.

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: n.a.

3.07 Reference site characterisation:

Number of sites: 4-24 depending on biocenotic type

Geographical coverage: n.a.

Location of sites: n.a.

Data time period: 2000-2006, 2008-2011

Criteria: Reference sites were selected based on the *Intercalibration Common Metrics index* (ICMi) value (highest values).

3.08 Reference community description: not provided (reference conditions for each biocenotic type and for MMI PL were set as the median of *Intercalibration Common Metrics index* (ICMi) value from reference sites)

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries:

High-good boundary derived from metric variability at near-natural reference sites. Following boundaries set by equidistant division of the EQR gradient.

3.11 Boundary setting procedure:

The class boundaries were defined with the use of median value of the ICMi index from the specific number of reference sites, whereby:

- boundary high/good was defined as the 5th percentile of ICMi values in reference sites for a given river biocoenotic type;
- boundary good/moderate was defined as REF EQR * 0,75, else 0,75 * median value of ICMi index in reference sites for a given river biocoenotic type;
- boundary moderate/poor was defined as REF EQR * 0,50, else 0,50 * median value of ICMi index in reference sites for a given river biocoenotic type;
- boundary poor/bad was defined as REF EQR * 0,25, else 0,25 * median value of ICMi index in reference sites for a given river type.

The class boundaries therefore are type-specific:

River type (1st and 2nd RBMP)*	River type (3rd RBMP)*	Ecological status/potential				
		HIGH	GOOD	MOD	POOR	BAD
1, 2	PGT	≥0.674	≥0.614	≥0.409	≥0.205	<0.205
3, 4, 5, 8, 10	PGS, RW_krz, RsW_krz	≥0.860	≥0.667	≥0.445	≥0.222	<0.222

River type (1st and 2nd RBMP)*	River type (3rd RBMP)*	Ecological status/potential				
		HIGH	GOOD	MOD	POOR	BAD
6, 7, 9, 12, 14, 15	RW_wap, RWf_krz, RWf_wap, RsW_wap	≥0.891	≥0.698	≥0.465	≥0.233	<0.233
17	PNp	≥0.908	≥0.716	≥0.477	≥0.239	<0.239
16, 18, 26	PN	≥0.903	≥0.717	≥0.478	≥0.239	<0.239
19, 20, 21, 22	RzN, RwN, PN_uj, RzN_uj	≥0.913	≥0.710	≥0.473	≥0.237	<0.237
23, 24, 25	P_org, Rz_org, P_poj, Pl_poj, R_poj, Rl_poj	≥0.893	≥0.687	≥0.458	≥0.229	<0.229

*For river types see: Hobot A. (red.), Banaszak K., Ciupak E., Kraśniewski W., Kolada A., Komosa M., Kunert M., Kutyła S., Krzymiński W., Mutryn J., Stachura-Węgierek A., Pasak D., Pasztaleniec A., Soszka H., 2015. Aktualizacja wykazu JCWP i SCWP dla potrzeb kolejnej aktualizacji planów w latach 2015-2021 wraz z weryfikacją typów wód 22 części wód. Etapy I-II. Praca wykonana w ramach konsorcjum Pectore-Eco Sp. z o.o. oraz Instytutu Ochrony Środowiska – Państwowego Instytutu Badawczego na zlecenie KZGW. Pectore-Eco – IOŚ-PIB, Gliwice - Warszawa (manuscript, in Polish).

3.12 "Good status" community:

Good ecological status is characterized by relatively high amount of Ephemeroptera, Trichoptera and Plecoptera taxa. Animal community is characterized by high taxonomic diversity. Tolerant taxa, such as Gastropoda, Oligochaeta and Diptera constitute small share of all fauna.

Uncertainty

3.13 Consideration of uncertainty: no

Specification of uncertainty consideration: n.a.

3.14 Comments: none

5. Macroinvertebrates in dam reservoirs

Method: Macroinvertebrate index for dam reservoirs (MZB)

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: n.a.

1.02 Category: Rivers (dam reservoirs)

1.03 BQE: Benthic Invertebrates

1.04 Country: Poland

1.05 Specification: All types of dam reservoirs, regardless of retention time

1.06 Method name: macrozoobenthic index MZB

1.07 Original name: wskaźnik makrozoobentosu dla zbiorników zaporowych MZB

1.08 Status: Finalized, formally agreed national method; officially in use since 2011

1.09 Detected pressure(s):

saprobization, shore-line modification

Specification of pressure-impact-relationship: n.a.

Pressure-impact-relationship: n.a.

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Picińska-Fałtynowicz J., Błachuta J. 2012. WYTYCZNE METODYCZNE do przeprowadzenia monitoringu i oceny potencjału ekologicznego zbiorników zaporowych w Polsce Wersja 2012, Wrocław, listopad 2012 (in Polish)

1.12 Scientific literature: not available

1.13 Method developed by:

Joanna Picińska-Fałtynowicz, Jan Błachuta, Institute of Meteorology and Water Management National Research Institute

1.14 Method reported by:

Aleksandra Bielczyńska; e-mail: a.bielczynska@ios.edu.pl;

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Picińska-Fałtynowicz J., Błachuta J. 2012. WYTYCZNE METODYCZNE do przeprowadzenia monitoringu i oceny potencjału ekologicznego zbiorników zaporowych w Polsce Wersja 2012, Wrocław, listopad 2012 (in Polish)

2.02 Short description:

Kick-sampling is performed. Samples consists of 8 1-metrer swipes, taken from different depths (max. depth 1-1,2 m). Sample should be preserved with ethanol.

2.03 Method to select the sampling/survey site or area:

Sampling site should be located close to the shore line, in the transition zone of the reservoir (not too close to river inlet ant to the dam).

2.04 Sampling/survey device: hydrobiological net

2.05 Specification: hydrobiological net, 25/25 cm net size, 0,5/0,5 mm mesh-size

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: n.a.

Sampled habitat: n.a.

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): Spring/Autumn

2.09 Number of sampling/survey occasions (in time) to classify site or area: once per year

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

One site per waterbody

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

2 m^2 of sampled area (8 sweeps, 0,25 m^2 each)

Sample processing

2.12 Minimum size of organisms sampled and processed: 500 µm

2.13 Sample treatment:

Sample should be looked over in the field. Bigger animals and protected species should be identified and counted in the field and set free prior to fixation of the sample. Larger pieces of organic matter should be carefully rinsed and remover from sample. Then the sample is preserved with ethanol.

All animals from sample should be identified and counted. In case of mass occurrence of some taxa it is possible to estimate its abundance based on smaller subsamples.

2.14 Level of taxonomical identification:

Level: Family

Specification of level of determination: Animals are identified to the family level, except for Oligochaeta, Porifera, Bryozoa, Cnidaria, Hydracarina, that are not identified to the lower taxonomic level.

2.15 Record of abundance:

Determination of abundance: abundance

Abundance is related to: total sample

Unit of the record of abundance: number of individuals per sample

2.16 Quantification of biomass: n.a.

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Multimetric index MZB is a weighted average of two component metrics:

- Average Score Per Taxon PL (**ASPT_PL**);
- Margalef Diversity Index (**Margalef-Index**)

3.02 Does the metric selection differ between types of water bodies: no

3.03 Combination rule for multi-metrics:

Weighted average of Ecological Quality Ratios (normalized metrics):

MZB = 0.8 x ZASPT + 0.2 x Zd

Where:

ZASPT = ASPT_PL/10

The MZB values range from 0 (most disturbed) to 1 (least disturbed conditions).

3.04 From which biological data are the metrics calculated:

Abundance of animals per sample

Reference conditions

3.05 Scope of reference conditions: n.a.

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: n.a.

3.07 Reference site characterisation:

Number of sites: n.a

Geographical coverage: n.a.

Location of sites: n.a.

Data time period: n.a.

Criteria: n.a.

3.08 Reference community description: n.a.

3.09 Results expressed as EQR: n.a.

Boundary setting

3.10 Setting of ecological status boundaries: n.a.

3.11 Boundary setting procedure: Equdistant

Following boundaries set by equidistant division of the EQR gradient:

Ecological potential	MZB value
MAXIMUM	>0.60
GOOD	≥0.50
MODERATE	≥0.40
POOR	≥0.20
BAD	<0.20

3.12 "Good status" community:

Good ecological status is characterized by relatively high amount of taxa, and similar abundance of these taxa. In good status, there is high amount of taxa with high score used to BMWP_PL and low amount of taxa with low scores.

Uncertainty

3.13 Consideration of uncertainty: no

Specification of uncertainty consideration: n.a.

3.14 Comments: none

6. Fish in rivers

Method: Fish indices for river classification (EFI+PL and EFI+IBI_PL)

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: n.a.

1.02 Category: Rivers

1.03 BQE: Fish

1.05 Specification:

1.06 Method name: Fish indices for rivers (EFI+PL and IBI_PL)

1.07 Original name:

Ocena stanu ekologicznego rzek w oparciu o ichtiofaunę – metoda EFI+IBI_PL

1.08 Status: Finalized, formally agreed national method; applied in the state monitoring

1.09 Detected pressure(s):

Hydromorphological alteration, Substrate changes, Connectivity disruption, General degradation, Toxic pollution.

Pressure-impact-relationship: Pressure-impact relationship has been tested, significant relationships were confirmed for EFI+Pl index, but not for IBI_PL index (due to low data amount).

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Adamczyk. M., Prus P., Buras P., Wiśniewolski W., Ligięza J., Szlakowski J., Borzęcka I. and Parasiewicz P. 2017. Development of a New tool for Fish-Based River Ecological Status Assessment In Poland (EFI+IBI_PL). Acta Ichthyologica et Piscatoria (2017) 47 (2): 173-184 DOI: 10.3750/AIEP/0200.

Adamczyk M., Prus P., Wiśniewolski W. 2013. Możliwości zastosowania Europejskiego Wskaźnika ichtiologicznego (EFI+) do oceny stanu ekologicznego rzek Polski [Possibilities of applying the European Fish Index (EFI+) to assess the ecological status of rivers in Poland]. Rocz. Nauk. PZW 26: 21–51 [in Polish, English Summary].

Commission Decision (EU) 2018/229 of 12 February 2018 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Commission Decision 2013/480/EU

Napiórkowska-Krzebietke A., Chybowski Ł., Prus P., Adamczyk M. 2020. Assessment Criteria and Ecological Classification of Polish Lakes and Rivers: Limitations and Current State. In: Korzeniewska E., Harnisz M. [eds] Polish River Basins and Lakes – Part II. The Handbook of Environmental Chemistry, vol 87. Springer, Cham, pp. 295-325. https://doi.org/10.1007/978-3-030-12139-6_14.

Prus P., Adamczyk M., Buras P., Ligięza J., Szlakowski J., Suska K., Parasiewicz P., Wiśniewolski W. 2019. Krajowa metoda oceny stanu ekologicznego rzek w oparciu o zespoły ryb i jej zastosowanie w monitoringu środowiska w latach 2017-2018. W: Funkcjonowanie i ochrona wód płynących (red. Robert Czerniawski, Paweł Bilski). Wolumina pl. Daniel Krzanowski Szczecin: 183-207. ISBN 978-83-7867-799-4. [in Polish]

Prus P., Wiśniewolski W. Adamczyk M. [red] 2016. Przewodnik metodyczny do Monitoringu ichtiofauny w rzekach [Methodological guidelines for ichthyofauna monitoring in rivers]. Biblioteka Monitoringu Środowiska – GIOŚ, pp. 92. [in Polish]

1.12 Scientific literature:

Bady P., Pont D., Logez M., Veslot J. 2009. Deliverable 4.1. Report on the modelling of reference conditions and on the sensitivity of candidate metrics to anthropogenic pressures http://efi-plus.boku.ac.at/downloads/EFI+DeliverablesD4.1andD4.2.pdf.

Błachuta J., Rosa J., Wiśniewolski W., Zgrabczyński J., Bartel R., Białokoz W., Borzęcka I., Chybowski Ł., Depowski R., Dębowski P., Domagała J., Drożdżyński K., Hausa P., Kukuła K., Kubacka D., Kulesza K., Ligięza J., Ludwiczak M., Pawłowski M., Picińska-Fałtynowicz J., Lisiński K., Witkowski A., Zgrabczyński D., Zgrabczyńska M. 2010. Ocena potrzeb i priorytetów udrożnienia ciągłości morfologicznej rzek w kontekście osiągnięcia dobrego stanu i potencjału części wód w Polsce [Assessment of the needs and priorities of improving the morphological continuity of rivers in the context of achieving the good status and potential of water bodies in Poland]. Krajowy Zarząd Gospodarki Wodnej, Warszawa, pp. 56. [in Polish]

Dussling U., Berg R., Klinger H., Wolter C. 2004. Assessing the Ecological Status of River Systems Using Fish Assemblages. Handbuch Angewartdte Limnologie – 20. Erg. Lfg. 12/04. ss. 84

EFI+ Manual. 2009. Manual for the application of the New European Fish Index (EFI+) with Annexes. http://efi-plus.boku.ac.at/software/documentation.php

FAME Consortium, 2004. Manual for the application of the European Fish Index – EFI. A fish-based method to assess the ecological status of European rivers in support of the Water Framework Directive. Version 1.1. http://fame.boku.ac.at/downloads/manual_Version_Februar2005.pdf.

Karr J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6: 21-27.

Karr J.R., Fausch K.D., Angermeier P.L., Yant P.R., Schlosser I.J. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois National History Survey Special Publication 5, Urbana, Illinois, USA, ss. 28.

Pont D., Hugeney B., Beier U., Goffaux D., Melcher A., Noble R., Rogers C., Roset N., Schmutz S. 2006. Assessing the biotic integrity of rivers at the continental scale: a European approach using fish assemblages. J. Appl. Ecol., 43: 70-80.

Schinegger R., Trautwein C., Melcher A. Schmutz S. 2011. Multiple human pressures and their spatial patterns in European running waters. Water and Environment Journal. Print ISSN 1747-6585, ss. 13.

Schmutz S., Cowx I.G., Haidvogl G., Pont D. 2007. Fish-based methods for assessing European running waters: a synthesis. Fisheries Management and Ecology, Vol. 14(6), 369-380.

Wiśniewolski W., Engel J. [red]. 2006. Restoring migratory fish and connectivity of rivers in Poland. Wydawnictwo IRS, Olsztyn, ss. 81.

1.13 Method developed by:

Paweł Prus, Wiesław Wiśniewolski, Mikołaj Adamczyk [eds] and others – a multi-author publication; e-mail: irs@infish.com.pl; The Stanisław Sakowicz Inland Fisheries Institute, Oczapowskiego 10, 10-719 Olsztyn, Poland

1.14 Method reported by:

Paweł Prus and Mikołaj Adamczyk; e-mail: pruspaw@wp.pl, mikolaj_adamczyk@op.pl

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

CEN-EN 14011, 2003. Water analysis: Fishing with Electricity (EN 14011) for wadable and non-wadable rivers. European Committee for Standarization (CEN), Brussels 19pp.

Prus P., Wiśniewolski W. Adamczyk M. [red] 2016. Przewodnik metodyczny do Monitoringu ichtiofauny w rzekach. Biblioteka Monitoringu Środowiska – GIOŚ, pp.92.

Dz. U. 1980 nr 6 poz. 17. Rozporządzenie Ministra Rolnictwa z dnia 4 lutego 1980 r. w sprawie bezpieczeństwa i higieny pracy w rybactwie śródlądowym.

2.02 Short description:

The method is consistent with CEN-EN 14011, 2003. Water analysis: Fishing with Electricity (EN 14011) for wadable and non-wadable rivers. It is based on single eletrofishing (by wading upstream or from a boat floating downstream) results. For rivers less than 70-cm deep, wading electrofishing is performed. For rivers with shallow and deep part – mixed wading and boat electrofishing technique is applied, while rivers deeper than 70 cm are fished from a boat. At last 30 specimens ad more than one species should be caught to make a relevant ecological status assessment.

2.03 Method to select the sampling/survey site or area:

Sites most representative of waterbody and associated with sampling sites used for other biota, but not at the river mouth section (to avoid the direct influence of the ichthyofauna migrating from a recipient river). Orthophotomap analysis should be done for sampling site selection.

2.04 Sampling/survey device:

A standard, attested electrofishing device with one or two anodes, according to the standard CEN-EN 14011, 2003. Water analysis: Fishing with Electricity (EN 14011) for wadable and non-wadable rivers.

2.05 Specification:

Eletrofishing device (backpack or stationary) – according to CEN-EN 14011, 2003, 1-2 anode, cathode, 1-2 landing nets (5 mm mesh size), buckets and larger containers for fish handling, water-aerating device, waders, boat (with engine and/or oars), rubber gloves.

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: In small and medium-size rivers (<10 m width), the whole riverbed width is fished, while in large rivers partial electrofishing or sampling along one shore is recommended. General rule is sampling at least 20 times the stream width, except for very small streams, where a minimum distance of 100 m is sampled and for very large rivers, where a distance of at least 1000 m or fished surface of 1000 m^2 (chosen habitats) is adopted as sufficient sampling site. It is important to fish habitats used as shelters by fish: overhanging canopy cover, undercut banks, large woody debris, large stones vicinity, aquatic plants, muddy bottom near shores (lampreys larvae habitat).

Sampled habitat: Multi habitat(s) sampling at chosen river stretch.

2.07 Sampled/surveyed zones in areas with tidal influence:

not relevant, rivers with the influence of brackish waters are excluded from fish fauna assessment in Poland

2.08 Sampling/survey month(s):

Late summer and autumn, preferably from mid-August to the end of October

2.09 Number of sampling/survey occasions (in time) to classify site or area:

One occasion per sampling season

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

Minimum 100 m of river length fished per sampling occasion, usually river stretch at least 20 times the stream width (whole area or one bank sampled), 1000 m stretch or 1000 m^2 sampled area for very large rivers.

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

At least 50 m^2 (streams of 0,5 m width, 100 m site length).

Sample processing

2.12 Minimum size of organisms sampled and processed: fish fry of 20 mm length

2.13 Sample treatment:

Sample is sorted directly in the field, fish are identified to the species level alive, measured (to classes of total length of ≤150 mm and >150 mm), weighted (by species) and released (except of invasive alien species).

2.14 Level of taxonomical identification:

Level: Species

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: Relative abundance – specimens per fished area

Abundance is related to: fished area, calculated from site length and effective fishing width estimated in the field

Unit of the record of abundance: Number of individuals per 100 m^2

Other record of abundance: na

2.16 Quantification of biomass: biomass per species (direct measurement)

2.17 Other biological data: presence of hybrids or specimens with visible anomalies

2.18 Special cases, exceptions, additions:

Data that characterise the parameters of the site, collected during the study and field work (such as the ecoregion, the abiotic type of the river, catchment area, distance from the source, depth and width of the river, the presence of a flood plain, average air temperature: annual, in January and July) are required to calculate the EFI+IBI_PL index. The literature data and all available information (gained, for example, from fishery managers) are used to supplement data on the occurrence of diadromous species, both in the past and at present, in order to calculate the additional diadromous index D. It is a supplement for a fish-based assessment of the ecological status or potential for most abiotic types of rivers except for organic and inter-lake rivers.

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Fish indices for rivers: EFI+PL and IBI_PL with Auxiliary index concerning diadromous fish – D metrics (Napiórkowska-Krzebietke et al. 2020):

EFI+PLSalmonid = (Ni.O2.Intol+Ni.Hab.Intol.150)/2 – for types 0-20, 22 and 26 Salmonid dominated;

EFI+PLCyprinid = (Ric.RH.Par+Ni.LITHO)/2 – for types 0-20, 22 and 26 Cyprinid dominated;

IBI_PL21a = ∑score (1-3-5)(TR+RWC+RB+RLR+IS% +Rr%+Pis%+Inv%+Omn-Rr%+DisHyb%+ CPUE+Alien%)/60 – for type 21a, sandy;

IBI_PL21b = ∑score (1-3-5)(TR+RWC+RB+E+Lith% +ES+RPis%+Inv%+Omn-Rr%+DisHyb%+CPUE +Alien%)/60 – for type 21, gravel;

IBI_PL23,24,25a = ∑score (1-3-5)(TR+RLith+RWC+RB +El%+Rr%+Pis%+RPisInv%+Omn-Rr%+ DisHyb%+CPUE+Alien%)/60 – for types 23, 24 and 25a (no salmonids);

IBI_PL25b = ∑score (1-3-5)(TR+RWC+RB+Lith%+ El%+Sal%+Pis%+RPisInv%+Omn%+DisHyb%+ CPUE+Alien%)/60 – for type 25b (with salmonids);

D = PDR/HDR (for types 0-22 and 26)

Where:

Ni.O2.Intol – density of species intolerant to oxygen depletion, (requiring more than 6 mg dm-3 O2);

Ni.Hab.Intol.150 – density of species intolerant to habitat degradation – specimens ≤ 150 mm (total length);

Ric.RH.Par – richness (number of rheopar species) requiring a rheophilic reproduction habitat;

Ni.LITHO – density of species requiring lithophilic reproduction habitat;

TR - total number of fish species;

RLith - richness of lithophilous species;
RWC - richness of water column species;
RB - richness of benthic species;
RLR - richness of fish species typical for large rivers;
E - species evenness index E;
Lith% - percent of lithophilous species;
IS% - percent of indicator species;
El% - percent of Esox lucius;
Rr% - percent of Rutilus rutilus;
ES% - percent of eutrophic species;
Sal% - percent of salmonid species;
Pis% - percent of piscivores;
RPis% - percent of relative piscivores;
Inv% - percent of invertivores;
RPisInv% - percent of relative piscivores and invertivores;
Omn% - percent of omnivores;
Omn-Rr% - percent of omnivores except Rutilus rutilus;
DisHyb% - percent of diseased fish or fish hybrids;
CPUE - abundance of fish expressed as a catch per unit effort;
Alien% - percent of alien species;
PDR – present diadromous species richness;
HDR – historic diadromous species richness.

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: Average metric scores

3.04 From which biological data are the metrics calculated:

Data from single sampling/survey occasion

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: For EFI+PL index: Existing near-natural reference sites, Modelling, Expert knowledge (at European scale within the project "Improvement and Spatial extension of the European Fish Index EFI+), For IBI_PL index river-type specific reference conditions: Existing near-natural reference sites, Expert knowledge, Least Disturbed Conditions.

3.07 Reference site characterisation:

Number of sites: EFI+ method (as a basis for EFI+PL): a total of 533 reference sites and 2526 slightly disturbed sites for different abiotic river types in Europe; IBI_PL method: 16 reference and slightly disturbed sites for different abiotic river types

Geographical coverage: Reference zones distributed in Europe for EFI+ (in Central Highlands, Carpathians, Central Plains, Baltic Province and Eastern Plains for Poland); for IBI_PL - reference zones in natural and landscape parks in Central Plains, Baltic Province and Eastern Plains

Location of sites: For EFI+: protected areas in Poland, Lithuania, Germany, France and Austria), For IBI_PL: Drawieński, Narwiański and Biebrzański National Parks, Welski Landscape Park

Data time period: EFI+: August-October 1982-2007, IBI_PL: August-October 2011-2015.

Criteria: Undisturbed river bed morphology and hydrology, preserved longitudal and lateral river connectivity, absence of point pollution sources, watershed dominated by natural forests, meadows and wetlands.

3.08 Reference community description:

Rivers assessed with EFI+PL: Fish community dominated by lithophilic and rheophilic fish species, abundance of species sensitive to oxygen depletions and presence of species sensitive to habitat changes, presence of diadromous species that occurred historically in an assessed river;

Rivers assessed with IBI_PL: high abundance of species indicative for a stream/river type, e.g. predatory species, insectivorous species, salmonids, species characteristic for large rivers and low abundance of omnivorous and eutrophying fish species or alien species, presence of diadromous species that occurred historically in an assessed river (for very large rivers and rivers in a valley of a very large river).

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries:

EFI+PL – YES, IBI_PL – n.a.

3.11 Boundary setting procedure:

For EFI+PL – finished in 2018, for IBI_PL – in preparation

3.12 "Good status" community:

There are slight changes in species composition and abundance from the type-specific communities attributable to anthropogenic impacts on physicochemical and hydro-morphological quality elements. In Salmonid and Cyprinid type rivers assessed with EFI+PL method, occurrence of species representative for guilds Ni.O2.Intol , Ni.Hab.Intol.150, Ric.RHt.Par, Ni.LITHO shows minor impact of anthropogenic pressure. In rivers assessed with IBI_PL method species composition and trophic guilds structure is only slightly different from that characteristic for a given abiotic river type, with CPUE value only slightly lower from that corresponding to river size. The age structures of the fish communities show signs of disturbance attributable to anthropogenic impacts on physico-chemical or hydro-morphological quality elements and in a few instances are indicative of a failure in the reproduction or development of a particular species to the extent that some age classes may be missing. In Salmonid type rivers species within the guild Ni.Hab.Intol.150 are represented by individuals smaller than 150 mm total length, but their abundance may be reduced due to reduced recruitment. Some diadromous species are dependent on stocking practices due to lack of river connectivity on catchment scale or lack of sufficient spawning grounds. In rivers assessed with EFI+PL method (and in rivers of abiotic type no. 26 assessed with IBI_PL method) at least 50% of historically noted diadromous fish species are present and able to reproduce naturally. In case, when less than 50% diadromous fish species are present the local fish community is stable and not affected by anthropogenic pressure, as at high status. There is moderate effect of fish stocks exploitation by fisheries or angling and of stocking on fish community structure. No stocking with any species that is not type specific occurs.

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none

7. Phytoplankton in lakes

Method: Phytoplankton Metric for Polish Lakes (PMPL)

1. General information

1.01 GIG: Central-Baltic;

Relevant intercalibration types: L-CB1, L-CB2

1.02 Category: Lakes

1.03 BQE: Phytoplankton

1.04Country: Poland

1.05 Specification: Lowlands

1.06 Method name: Phytoplankton Metric for Polish Lakes (PMPL)

1.07 Original name: Multimetriks fitoplanktonowy dla jezior polskich

1.08 Status: Finalized, intercalibrated, officially accepted, used in the state monitoring for the second and third RBMP (since 2016)

1.09 Detected pressure(s):

Eutrophication;

Has the pressure-impact-relationship been tested?

The pressure-impact-relationship between PMPL and eutrophication indicators has been tested with quantitative data, e.g. against the range of sites reflecting continuous gradient of a pressure. Testing of the PMPL`s performance was done using an independent dataset consisted of 235 “lake-years-sites”. The relationship between the three phytoplankton metrics (chlorophyll *a*, total biomass, biomass of cyanobacteria) and TP showed significant correlation (Spearman rank correlation coefficient ranging from 0.49 to 0.64). The correlation between multimetric PMPL and TP was 0.62.

1.10 Internet reference:

https://miiz.waw.pl/pliki/article/ar62_3_11.pdf;
https://op.europa.eu/en/publication-detail/-/publication/1fca496f-24bd-4be7-98c6-5b4d2498c689/language-en

1.11 Pertinent literature of mandatory character:

Hutorowicz A., Pasztaleniec A., 2011. Procedura oceny stanu ekologicznego jezior w oparciu o multimetriks fitoplanktonowy (Phytoplankton Metric For Polish Lakes -PMPL), Olsztyn-Warszawa, Chief Inspector of Environmental Protection (manuscript, in Polish),
https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/ocena_PMPL.pdf

1.12 Scientific literature:

Hutorowicz A., Pasztaleniec A., 2014. Phytoplankton metric of ecological status assessment for Polish lakes and its performance along nutrient gradients, Polish Journal of Ecology, 62: 525-542.

1.13 Method developed by:

Andrzej Hutorowicz, e-mail: ahut@infish.com.pl, The Stanisław Sakowicz Inland Fisheries Institute, Olsztyn.

Agnieszka Pasztaleniec, e-mail: paszta@ios.edu.pl, Institute of Environmental Protection – National Research Institute, Warsaw.

1.14 Method reported by:

Agnieszka Pasztaleniec, e-mail: paszta@ios.edu.pl,

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska: sekretariatdm@gios.gov.pl

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Hutorowicz A., 2004. Metoda poboru prób i analiza ilościowo-jakościowa fitoplanktonu w jeziorach. GIOŚ, Olsztyn.

Hutorowicz A., 2006. Opracowanie standardowych objętości komórek do szacowania biomasy wybranych taksonów glonów planktonowych wraz z określeniem sposobu pomiarów i szacowania. GIOŚ, Olsztyn. http://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/objetosci_PMPL.pdf

Hutorowicz A., 2009. Wytyczne do przeprowadzenia badań terenowych i laboratoryjnych fitoplanktonu jeziornego. GIOŚ, Olsztyn. http://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/wytyczne_PMPL.pdf

2.02 Short description:

Integrated samples taken from zone 0-5 m (spring, autumn) or epilimnion (summer) - stratified lakes; whole water column - polimictic lakes.

2.03 Method to select the sampling/survey site or area:

The deepest part of the lake

2.04 Sampling/survey device: Water sampler, Plankton net

2.05 Specification: e.g. Ruttner-type water sampler, integrated samples

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: pelagial-epilimnion/euphotic zone, all integrated samples in 1m steps of each water layer

Sampled habitat: Single habitat

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): March/May, June/September, October

2.09 Number of sampling/survey occasions (in time) to classify site or area:

Four sampling occasions per vegetation period

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

Usually, one representative sampling point is located at one lake.

Sample processing

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

Sample for phytoplankton quantitative analysis –from 150 ml to 250 ml, sample for chlorophyll *a* analysis - at least 0,5 l (max. taken volume 5 l).

2.12 Minimum size of organisms sampled and processed: 2 µm

2.13 Sample treatment:

Sub-samples are analyzed in inverted microscope by Utermöhl-technique. For the details see:

PN-EN 15204:2006, Jakość wody – Wytyczne do oznaczania ilościowego fitoplanktonu z użyciem odwróconego mikroskopu (metoda Utermöhla);

PB-BL-07/BS wydanie 1 z dnia 15.03.2013 r., Analiza i biomasa fitoplanktonu - Metoda mikroskopowa, jakościowa i ilościowa;

PN-EN 16695: 2016-01, Jakość wody - Wytyczne do określania bioobjętości fitoplanktonu (English version);

2.14 Level of taxonomical identification:

Level: Family, Genus, Species/species groups

Specification of level of determination: Most taxonomical groups of phytoplankton are identified to the species level or genus level. Key importance is distinguishing of cyanobacteria.

2.15 Record of abundance:

Determination of abundance: Individual counts

Abundance is related to: Volume

Unit of the record of abundance: Biomass of individuals (mg) per liter (mg/l)

2.16 Quantification of biomass: Utermöhl technique

2.17 Other biological data: Size of organisms

2.18 Special cases, exceptions, additions: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

The phytoplankton multimetric PMPL is composed of three obligatory metrics: “chlorophyll *a*”, “total biomass” and “biomass of cyanobacteria”.

Chlorophyll *a* concentration: The seasonal mean (March-October) of chlorophyll *a* concentration. The mean value of chlorophyll *a* (X_{Ch}) is transformed to a parameter index (Y_{Ch}) value according to a lake type-specific function, which is determined by the class boundaries for the five status classes. The parameter index value ranges from 0 to 5.

Total biomass of phytoplankton: Total biovolume of all phytoplankton taxa (seasonal mean – March-October). The mean total biomass value (X_{Bm}) is transformed to a parameter index value (Y_{Bm}) according to a lake type-specific function, which is determined by the class boundaries for the five status classes. The parameter index value ranges from 0 to 5.

Biomass of cyanobacteria: The summer measure of cyanobacterial biomass (in stratified lakes – at least once between 15 July - 15 September; in polymictic lakes – at least twice between 4 June – 30 September). The cyanobacterial biomass value (B_{CY}) is transformed to a parameter index value (Y_{CY}) according to function, which is determined by the class boundaries for the five status classes. The parameter index value ranges from 0 to 5.

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics:

For stratified lakes, the PMPL is an average metric scores:

$PMPL = (Y_{CH} + Y_{BM} + Y_{CY})/3$

For polymictic lakes, the PMPL is weighted average metric scores:

$PMPL = [(Y_{CH} + Y_{BM} + (0.5 \times Y_{CY})]/2.5$

The PMPL ranges from 0 to 5 were 0 reflects most disturbed, while 5 near-pristine conditions.

3.04 From which biological data are the metrics calculated:

Aggregated data from multiple sampling/survey occasions in time and reference conditions

Reference conditions

3.05 Scope of reference conditions: Specific for lake abiotic type

3.06 Key source(s) to derive reference conditions

Scope of reference conditions: Reference values of parameters for all abiotic types of lakes were established by "best of existing" method. The reference sites were chosen as the 10th percentile of the value of each parameter distribution regarding type of lake. The boundary value of reference status was set as the median of those. In the case of chlorophyll *a* concentration and total phytoplankton biomass, means from growing season were taken into calculations, for biomass of cyanobacteria – only summer data were used.

3.07 Reference site characterization: n. a.

3.08 Reference community description:

At reference conditions the phytoplankton community was dominated by chrysophytes, cryptophyces and/or diatoms. Chlorophyta and Cyanoprokaryota constituted less important groups except of small species from Chroococaceae, Synechococcaceae and Merismopediaceae, which reached a great percentage share in total phytoplankton biomass in several lakes. Abundance of species close to equal.

3.09 "Good status" community:

At good status, besides chrysophytes, cryptophytes and diatoms also Dinophyceae and chlorococcales Chlorophyta occured. The filamentous Cyanoprokaryota and Microcystis genera are noted but do not reach a great abundance. Abundance of different species close equal or 3-5 species are dominants.

Boundary setting

3.10 Setting of ecological status boundaries:

Boundaries of total biovolume were established based on the correlation between TP, chlorophyll a, SD and biomass following Carlson`s procedure (Carlson 1977), the earlier adopted chlorophyll *a* classification system and information from Polish scientific literature (Hillbricht-Ilkowska and Wiśniewski, 1994). Metric "biomass of cyanobacteria" was based on distribution curve of cyanoprokaryota in Polish lakes along trophy gradient, and the assumption that the upper border of cyanoprokaryota biomass in particular ecological status classes should be half lower than the border for total biomass regarding the abiotic type of lake.

Carlson, R.E., 1977. A trophic state index for lakes. Limnol. Oceanogr. 22, 361-369.

Hillbricht-Ilkowska, A., Wiśniewski, R.J., 1994. Zróżnicowanie troficzne jezior Suwalskiego Parku Krajobrazowego i jego otuliny. Stan obecny, zmienność wieloletnia, miejsce w klasyfikacji troficznej jezior. In: Hillbricht-Ilkowska, A., Wiśniewski, R.J. (Eds.), Jeziora Suwalskiego Parku Krajobrazowego. Wydawnictwo PAN, Zeszyty Naukowe 7, Wrocław-Warszawa-Kraków, pp. 181-200.

The PMPL class boundaries for all types of Polish lakes:

Ecological status/potential	PMPL value
HIGH/MAXIMUM	≤1.00
GOOD	<2.00
MODERATE	<3.00
POOR	<4.00
BAD	≥4.00

Uncertainty

3.13 Consideration of uncertainty: No

8. Phytobenthos in lakes

Method: Diatom Index for Lakes (IOJ)

1. General information

1.01 GIG: Central-Baltic

1.02 Category: Lakes

1.03 BQE: Benthic Diatoms

1.04 Country: Poland

1.05 Specification: none

1.06 Method name: Assessment system for lakes using diatoms

1.07 Original name:

Ocena stanu ekologicznego jezior w oparciu o Multimetryczny Indeks Okrzemkowy (Indeks Okrzemkowy IOJ)

1.08 Status: Officially accepted, intercalibrated, used in the state monitoring for the second and third RBMP (since 2016)

1.09 Detected pressure(s): Catchment land use, Eutrophication

Pressure-impact-relationship: No, pressure-impact relationship has not been tested.

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Zgrundo A., Peszek Ł., Poradowska A., 2018. Podręcznik do monitoringu i oceny jeziornych jednolitych części wód powierzchniowych na podstawie fitobentosu. GIOŚ, Gdańsk (in Polish).

1.12 Scientific literature:

Bielczyńska A., 2015. Bioindication on the basis of benthic diatoms: Advantages and disadvantages of the Polish phytobenthos lake assessment method (IOJ – the Diatom Index for Lakes). Environmental Protection and Natural Resources 26/4: 48-55. DOI 10.1515 /oszn-2015-0027.

1.13 Method developed by:

Joanna Picińska-Fałtynowicz, e-mail: joanna.faltynowicz@imgw.wroc.pl, Institute of Meteorology and Water Management, Wroclaw Branch, Department of Ecology

Aleksandra Zgrundo, e-mail: aleksandra.zgrundo@ug.edu.pl; University of Gdansk, Faculty of Oceanography and Geography (verified version, 2018)

1.14 Method reported by:

Aleksandra Zgrundo, e-mail: aleksandra.zgrundo@ug.edu.pl

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

EN-PN 13946:2014-05 „Jakość wody – Wytyczne do rutynowego pobierania próbek oraz wstępnego przygotowania do analiz okrzemek bentosowych z rzek i jezior”

EN-PN 14407:2014-05 „Jakość wody – Wytyczne dotyczące identyfikacji i oznaczania ilościowego próbek okrzemek bentosowych z rzek i jezior”.

Zgrundo i in. 2018. Podręcznik do monitoringu i oceny jeziornych jednolitych części wód powierzchniowych na podstawie fitobentosu

2.02 Short description:

The method is consistent with the EN 13946 Water quality - Guidance for the routine sampling and preparation of benthic diatoms from rivers and lakes and EN 14407:2014 Water quality - Guidance for the identification and enumeration of benthic diatom samples from rivers and lakes

2.03 Method to select the sampling/survey site or area:

Sites most representative of waterbody and associated with sampling sites used for other biota

2.04 Sampling/survey device:

Toothbrush, knife, scraper, strong scissors, plastic tray, plastic sample bottles with watertight lids, waterproof permanent marker pen or another means of labelling samples, artificial substrate

2.05 Specification: none

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: Generally, hard substrates of natural (as cobbles, boulders) and anthropogenic origin but also other as macrophytes and macroalgae when former are not present. Sample habitat is chosen based on whether it is appropriate for optimising the presence of diatoms at a site.

Sampled habitat: Single habitat(s)

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): Late summer – autumn

2.09 Number of sampling/survey occasions (in time) to classify site or area:

One occasion per sampling season

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

One replicate per sampling

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area: n.a.

Sample processing

2.12 Minimum size of organisms sampled and processed: n.a.

2.13 Sample treatment:

Sample is divided (sub-sampling) and organisms of a sub-sample are identified.

2.14 Level of taxonomical identification:

Level: Species/species groups

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: Relative abundance

Abundance is related to: n.a.

Unit of the record of abundance: Number of valves

Other record of abundance: a total of at least 300 diatom valves counted per sample (in a permanent slide)

2.16 Quantification of biomass: n.a.

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Diatom Index for Lakes IOJ is composed of two component metrics:

- TJ calculated using a weighted formula of Zelinka & Marvan (1961), recalculated to ZTJ = 1-(TJ x 0.1);
- GRJ = sum of relative abundance of reference taxa;

The multimetric IOJ is a weighted average of two component metrics calculated as:

IOJ = 0.6 x ZTJ + 0.4 x xGRJ

The IOJ ranges from 0 to 1 were 0 reflects most disturbed, while 1 near-pristine conditions.

3.02 Does the metric selection differ between types of water bodies: no

3.03 Combination rule for multi-metrics: Average metric scores

3.04 From which biological data are the metrics calculated:

Data from single sampling/survey occasion in time

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: Existing near-natural reference sites, Expert knowledge, Least Disturbed Conditions

3.07 Reference site characterisation:

Geographical coverage: Reference zones in natural and landscape parks of Central Plains, Baltic Province and Eastern Plains

Location of sites: Drawienski Natural Park, Chojnicki, Drawski and Suwalski Landscape Parks

Data time period: August-October 2006-2009

Criteria: Absence of point pollution sources, watershed overgrown by natural forests, meadows and wetlands

3.08 Reference community description:

Epiphytic diatom communities dominated by reference species, i.e. oligo-, meso- or eutrophilous depending on lake type

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries: n.a.

The IOJ class boundaries for all types of Polish lakes:

Ecological status/potential	Wartość IOJ
HIGH/MAXIMUM	>0.705
GOOD	≥0.590
MODERATE	≥0.400
POOR	≥0.150
BAD	<0.150

3.11 "Good status" community: In preparation

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none

9. Macrophytes in lakes

Method: Ecological Status Macrophyte Index (ESMI)

1. General information

1.01 GIG: Central-Baltic

1.02 Category: Lakes

1.03 BQE: Macrophytes

1.04 Country: Poland

1.05 Specification: none

1.06 Method name:

Macrophyte-based indication method for lakes - Ecological Status Macrophyte Index (ESMI)

1.07 Original name: Makrofitowa metoda oceny stanu ekologicznego jezior

1.08 Status: Officially accepted, intercalibrated, used in the state monitoring for the first, second and third RBMP (since 2007)

1.09 Detected pressure(s):

Eutrophication, General degradation, Pollution by organic matter, Riparian habitat alteration

Has the pressure-impact-relationship been tested?

The pressure-impact-relationship between ESMI and main eutrophication indicators has been tested using quantitative data (e.g. against range of sites reflecting continuous gradient of pressure). At initial stage of the metric development (2005), biological and environmental data from 47 stratified lakes and 40 non-stratified lakes (all highly alkaline; >1meq/l,>25 mgCa/l) were used. The relationship between macrophyte index ESMI and TP, TN, SD, chlorophyll "a" concentration (spring, summer and mean values) showed significant correlation (Monte Carlo permutation test, $p<0,005$). During the intercalibration process (2008-2012), the correlations derived from the data from 427 lakes were: $R=0.67$ with SD, −0.56 with TN and −0.43 with TP (in: Ciecierska and Kolada, 2014).

1.10. Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Ciecierska, H., A. Kolada, H. Soszka & M. Golub, 2005- 06. Methodological Aspects of Macrophyte-Based Biological Monitoring of Lakes – a Pilot Study. In Kolada, A., H. Soszka, M. Golub, H. Ciecierska, K. Szoszkiewicz, J. Zbierska, S.Z. Jusik & T. Zgola (eds), Methodological Aspects of Macrophyte-Based Biological Monitoring of Surface Waters – a Pilot Study, stage I – November 2005, stage II – 24 November 2006. Ministry of the Environment, Warsaw (manuscript, in Polish).

1.12 Scientific literature:

Ciecierska H., Kolada A., 2014. ESMI: a Macrophyte Index for assessing the Ecological Status of lakes. Environmental Monitoring and Assessment, 186, 5501-5517.

1.13 Method developed by:

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Agnieszka Kolada, e-mail: akolada@ios.edu.pl; Department of Freshwater Assessment Methods and Monitoring, Institute of Environmental Protection in Warsaw, Poland

1.14 Method reported by

Agnieszka Kolada, e-mail: akolada@ios.edu.pl; Department of Freshwater Protection, Institute of Environmental Protection – National Research Institute, Warsaw, Poland

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska, e-mail: sekretariatdm@gios.gov.pl

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines

Kolada, A. & H. Ciecierska, 2009. Wytyczne do prowadzenia badań terenowych makrofitów w jeziorach oraz do sposobu zestawiania i przetwarzania danych [Guidelines for a study of macrophyte communities in lakes and for data compilation and processing], Department of Freshwater Assessment Methods and Monitoring. Institute of Environmental Protection, Warsaw (manuscript, in Polish)

2.02 Short description

Macrophytes are surveyed within the belt transects located uniformly around the lake and set perpendicularly to the shoreline. At each transect the following data are collected: total vegetation cover (%), maximum vegetation depth (m), the list of all plant communities identified. In the survey method the phytosociological approach is applied where the plant communities not species are considered. The term 'community' is used for homogenous and uniform vegetation areas over a surface of at least 1 m^2 with at least 25% coverage named after the dominant species; the vegetation abundance within the community is measured using the quantitative 7-point Braun-Blanquet scale (1951).

2.03 Method to select the sampling/survey site or area:

Number of transects per lake is calculated based on the lake area and the shoreline length; transects are uniformly located around a lake, the location of each transect is fixed based on the expert knowledge.

2.04 Sampling/survey device: Grapnel, rake, bathyscope/aquascope

2.05 Specification:

A grapnel on a scaled rope. The grapnel should be sufficiently dense and the rope sufficiently long to enable reaching submerged vegetation.

2.06 Sampled/surveyed habitat: All available habitats per site (multi-habitat)

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): mid-June - mid-September (optimally July-August)

2.09 Number of sampling/survey occasions (in time) to classify site or area

One occasion per year during the vegetation season; a lake is surveyed for macrophytes once every 6 years

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area

One lake is one survey area. The number of transects per lake is calculated based on the lake area and the shoreline length; Transect dimensions are: the width of app. 30 m and the length from shoreline to maximum colonisation depth are set. Data from all transects within a lake are then recalculated for a lake-level to provide a basis for the classification of the ecological status of a lake.

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area

The total lake area is a survey area.

Sample processing

2.12 Minimum size of organisms sampled and processed: no limit

2.13 Sample treatment: All plant species within a sample are identified.

2.14 Level of taxonomical identification:

Other (community level); the term 'community' is used for homogenous and uniform vegetation areas (phytocoenoses *sensu* Westhoff and van der Maarel, 1973, after Jensen, 1977), named after the dominant species. Communities of the following ecological groups: charophytes, mosses, elodeids, nymphaeids and helophytes are identified.

2.15 Record of abundance:

Percentage cover of the phytolittoral area by the vegetation, relative abundance of plant communities within each transect

2.16 Quantification of biomass: n.a.

2.17 Other biological data:

Within each transect the following data are recorded: number of plant communities (syntax), syntaxonomic composition, relative abundance of plant communities in Braun-Blanquet scale, maximum colonisation depth, overall vegetation cover.

The relative abundance of each plant community is assessed in B-B 7-point scale; afterwards recalculated to absolute area occupied by each plant community in m2/ha

2.18 Special cases, exceptions, additions: the survey method does not include macroalgae

2.19 Comments none

3. Data evaluation

Evaluation

3.01 List of biological metrics

The ESMI index is composed of two main metrics:

- Measure of taxonomic composition: the index of evenness J by Pielou, which is a ratio of the phytocenotic diversity index H' (Shannon-Weaver index based on a syntaxa) and maximum phytocenotic diversity index Hmax (=lnS, where S - number of syntaxa);

- Measure of abundance: colonization index Z, which expresses the proportion of a total area occupied by macrophytes and area of phytolittoral where water is shallower than 2,5 m

Additionally, the typological factor P/N (total lake area to total vegetated area) is included.

The multimetric Ecological State Macrophyte Index is an exponential function of combination of J, Z and typological factor calculated as:

ESMI = 1-exp[-J x Z x exp(N/P)]

The ESMI ranges from 0 to 1 were 0 reflects most disturbed, while 1 near-pristine conditions.

3.02 Does the metric selection differ between types of water bodies? No

3.03 Combination rule for multi-metrics: Not relevant; all metrics are combined into one multimetric formula

3.04 From which biological data are the metrics calculated?

Biological data from all transects (number of plant communities (syntax), relative abundance of plant communities in Braun-Blanquet scale, maximum colonisation depth, overall vegetation cover) are recalculated to the entire lake level; metrics are calculated for a lake (not transects)

Reference conditions

3.05 Scope of reference conditions:

Reference conditions were determined based on the set of data from 26 near-natural lakes (lakes under near-pristine conditions).

3.06 Key source(s) to derive reference conditions:

Existing near-natural reference sites, Expert knowledge, Least Disturbed Conditions

3.07 Reference site characterisation

To select potential reference lakes, a set of pressure-screening criteria was used (absence of urban areas, low human population density, a high proportion of forests and wetlands in catchments, an absence of human settlements in the direct vicinity of the shoreline, an absence or very low recreational use). In hard water lakes, the abundant submerged vegetation and the presence of Chara-meadows are typical of reference conditions. In soft water lakes, the presence and good condition of isoetid communities are expected in reference conditions.

Number of sites: to derive reference conditions and set H/G boundary data from 26 reference lakes have been used

Geographical coverage: All lakelands in Poland (lowland, CB-GIG); reference lakes are relatively evenly distributed, although some areas are less affected and more abundant in the reference lakes (NE Poland, National Parks)

Location of sites: All lakelands in Poland but most lakes situated in NE lakelands

Data time period: Contemporary data (lakes surveyed in 2000-2006)

3.08 Reference community description

Highly alkaline, lowland lakes: vegetation well developed, dense and extensive Chara-meadows dominating, in deep lakes high maximum colonisation depth (>3-4 m, even 5m and more), in shallow lakes high %cover of bottom area (~100%); rush vegetation developed only to a small or at least moderate extent (not dominating).

Criteria: Mainly pressure criteria - no evidence of pressure (on sources of pollution, no urban and agricultural areas, forests dominating, no tourist pressure); the vegetation composition and spatial structure correspond to the description of non-disturbed community.

3.09 Results expressed as EQR? Yes (ESMI >0.680)

Boundary setting

3.10 Setting of ecological status boundaries:

High-good boundary was set as 25perc (Q1) of the ESMI values in the near-natural reference sites. Other boundaries were set by division of ESMI gradient between H/G and the lowest ESMI value recorded in the dataset in logarithmic scale. Class boundaries were initially set for highly alkaline shallow and deep lakes separately type-specific class boundaries). During the intercalibration process (2008-2012) the boundaries were adjusted (modified) and two lake types (stratified and polymictic) were merged into one type (highly alkaline lowland lakes).

The ESMI class boundaries for highly-alkaline lowland Polish lakes:

Ecological status/potential	ESMI value
HIGH/MAXIMUM	≥0.680
GOOD	≥0.410
MODERATE	≥0.205
POOR	≥0.070
BAD	<0.070

In 2016, the separate classification systems for saline (coastal) lakes ($ESMI_Z$) and lagoons ($ESMI_{JP}$) have been elaborated. Class boundaries were set analogously as for the other lakes but the modelled reference value of 0.457 for coastal and 0.306 for lagoons were used.

The ESMI class boundaries for coastal lakes ($ESMI_Z$) and lagoons ($ESMI_{JP}$):

Ecological status/potential	$ESMI_{JP}$ value	$ESMI_Z$ value
HIGH/MAXIMUM	≥0.340	≥0.204
GOOD	≥0.205	≥0.123
MODERATE	≥0.103	≥0.060
POOR	≥0.035	≥0.002
BAD	<0.035	<0.002

3.11 "Good status" community:

Highly alkaline, lowland lakes: submerged vegetation is still well developed, Chara-meadows are not dominating but still exist (or welcome). Dense and extensive submerged vegetation is dominating (vascular plants communities). In deep lakes maximum colonisation depth is not lower than 2.5 m. Rush vegetation developed only to a moderate extent (not dominating in relative abundance over the submerged vegetation).

Uncertainty

3.12 Consideration of uncertainty:

The ESMI variability due to different sampling techniques and surveyor teams was tested in 2008 within the scientific project. The index appeared weakly sensitive to both sources of uncertainty (sampling technique and inter-surveyor variability).

3.13 Comments: none

10. Macroinvertebrates in lakes

Method: Lake Macroinvertebrate Index (LMI)

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: LCB1 and LCB2

1.02 Category: Lakes

1.03 BQE: Benthic Invertebrates

1.04 Country: Poland

1.05 Specification: Lowland lakes, except lakes under the influence of the sea

1.06 Method name: Lake Macroinvertebrate Index (LMI)

1.07 Original name:

Zweryfikowana Metoda Oceny Stanu I Potencjału Ekologicznego Jezior Na Podstawie Zoobentosu Litoralowego

1.08 Status: Officially accepted, intercalibrated, used in the state monitoring since 2019.

1.09 Detected pressure(s):

Eutrophication, General degradation, Hydromorphological modifications

Specification of pressure-impact-relationship: LMI is significantly, negatively correlated with Total Phosphorus, Chlorophyll a and share of agriculture in the lake catchment. All correlations are negative, correlation with Chlorophyll a is the strongest, with agriculture in catchment is the weakest.

Pressure-impact-relationship: All correlations are negative, correlation with Chlorophyll a is the strongest, with agriculture in catchment is the weakest.

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Bielczyńska A., Soszka H., Kolada A., Pasztaleniec A., Kornijów R., Woźniczka A. 2017. Zweryfikowana metoda oceny stanu i potencjału ekologicznego jezior na podstawie zoobentosu litoralowego. Biblioteka Monitoringu Środowiska, Warszawa (manuscript, in Polish)

1.12 Scientific literature: n.a.

1.13 Method developed by:A

Aleksandra Bielczyńska*(1, e-mail: bielczynska@ios.edu.pl), Hanna Soszka, Agnieszka Kolada(1), Agnieszka Pasztaleniec(1), Ryszard Kornijów(2), Adam Woźniczka(2)

1: Department of Freshwater Protection, Institute of Environmental Protection - National Research Institute

2: Department of Fisheries Oceanography and Marine Ecology, National Marine Fisheries Research Institute

1.14 Method reported by:

Aleksandra Bielczyńska, e-mail: a.bielczynska@ios.edu.pl

Email of institute reporting the method: Institute of Environmental Protection – National Research Institute: sekretariat@ios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Bielczyńska A., Soszka H., Kolada A., Pasztaleniec A., Kornijów R., Woźniczka A. 2017. Zweryfikowana metoda oceny stanu I potencjału ekologicznego jezior na podstawie zoobentosu litoralowego. Biblioteka Monitoringu Środowiska, Warszawa (manuscript, in Polish)

2.02 Short description:

Animals are sampled by kick-sampling. Kick-sampling is performed for 2 minutes per site. The entire time of sampling is shared between different habitats at the sampling site, proportionally to their percentage of occurrence. When kick-sampling is not possible due to the inaccessibility of the lake from the land side (e.g. due to the thick reed belt), sampling can be performed from a boat within a reed belt, using a bottom sampler. If there is no possibility of performing laboratory processing of the sample within three days form sampling, sample should be preserved with 96% ethanol.

2.03 Method to select the sampling/survey site or area:

Sites should be distributed evenly along the shoreline, representing diverse conditions in lake littoral. The morphometry of a lake basin should be taken into account when designing sampling site location

2.04 Sampling/survey device:

hydrobiological net for kick sampling, bottom sampler for sampling from boat

2.05 Specification:

hydrobiological net of 500 µm mesh-size, for sampling form boat Günther sampler is preferred

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: littoral

Sampled habitat: multi-habitat sampling

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): May or September-October

2.09 Number of sampling/survey occasions (in time) to classify site or area:

once per year

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

Number of sites depends on the size and morphometry. In lakes of area up to 200 ha, three sampling sites, while in larger lakes four sampling sites should be located.

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

Three or four sites per lake (depending on its area), each sample represents 2-minutes kick-sampling.

Sample processing

2.12 Minimum size of organisms sampled and processed: 500 µm

2.13 Sample treatment:

All animals should be sorted, identified, counted and preserved in 70% ethanol. If there is mass occurrence of certain taxa (ex. Chironomidae or Oligochatea) subsampling is recommended.

2.14 Level of taxonomical identification:

Level: Family

Specification of level of determination: Animals are identified to the family level, except for Oligochaeta, Porifera, Bryozoa, Cnidaria, Hydracarina, that are not identified to the lower taxonomic level.

2.15 Record of abundance:

Determination of abundance: relative abundance

Abundance is related to: 2-minutes kick-sample

Unit of the record of abundance: number of individuals

2.16 Quantification of biomass: n.a.

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Multimetric index LMI is composed of four metrics:

- Average Score Per Taxon PL (**ASPT_PL**);
- Shannon-Wiener Diversity Index (**Shannon-Wiener-Index**);
- percentage share of Diptera in all fauna (**Diptera [%]**);
- the number of families of Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Bivalvia and Odonata (**EPTCBO**).

3.02 Does the metric selection differ between types of water bodies: no

3.03 Combination rule for multi-metrics:

Each metric is transformed to the Ecological Quality Ration (EQR) ranging from 0 (most disturbed) to 1 (least disturbed conditions).

Multimetric index LMI per sampling site is a weighted average of four EQRs of composition metrics:

LMI = (2xEQR ASPT_PL + EQR H + 2xEQR Diptera[%] + EQR EPTCBO)/6

The LMI values range from 0 (most disturbed) to 1 (least disturbed conditions).

For a lake, LMI is an arithmetic average of multi-metrics for all sampling sites within a lake.

3.04 From which biological data are the metrics calculated:

Abundance of animals per site.

Reference conditions

3.05 Scope of reference conditions:

Reference conditions were determined based on the set of data from near-natural lakes (lakes under near-pristine conditions).

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: Existing near-natural reference sites. Lakes with mostly natural catchments, without direct inflow of pollution, without hydromorphological modifications and without intensive tourist pressure were selected as reference.

3.07 Reference site characterisation

Number of sites: 8

Geographical coverage: Northern Poland

Location of sites: mainly Mazurian Lakeland, South-Pomeranian Lakeland (Poland)

Data time period: 2013-2016

Criteria: over 90% natural area in lake catchment, less than 5% of antropogenic area in lakes 100 m buffer zone and lakeshore, no point sources of pollution in the catchment, no intensive tourist pressure, at least good ecological status on the basis of other biological quality elements

3.08 Reference community description:

Macrozoobenthos from reference lakes contains many taxa of Ephemeroptera, Odonata Trichoptera and Bivalvia. Share of Diptera is relatively low. Fauna is characterized by high diversity, i.e. many taxa of similar abundance. Many of highly sensitive taxa are present, such as Trichoptera: Leptoceridae, Molannidae, Odontoceridae, Lepidostomatidae.

3.09 Results expressed as EQR:

Yes, reference value of LMI was derived as an upper quartile of LMI values from the reference lakes and it was 0,901.

Boundary setting

3.10 Setting of ecological status boundaries:

High-good boundary derived from metric variability at near-natural reference sites. Following boundaries set by equidistant division of the EQR gradient

3.11 Boundary setting procedure:

The high/good boundary value was set as a lower quartile from the LMI values from the reference lakes. Subsequent boundaries, i.e. good/moderate, moderate/poor and poor/bad were set as 75%, 50% and 25% of high/good boundary value, respectively.

The LMI class boundaries for all Polish lakes:

Ecological status/potential	LMI values
HIGH/MAXIMUM	≥0.920
GOOD	≥0.588
MODERATE	≥0.392
POOR	≥0.196
BAD	<0.196

3.12 "Good status" community:

Good ecological status is characterized by relatively high amount of Odonata, Trichoptera and Coleoptera taxa. Minor disturbance in diversity results in slight domination of one taxon or few taxa over other taxa. Fauna contains species moderately sensitive like Ephemeroptera: Caenidae, Baetidae, Odonata: Coenagrionidae, Trichoptera: Limnephilidae.

Uncertainty

3.13 Consideration of uncertainty: Yes

Specification of uncertainty consideration: Uncertainty can be assessed in three degrees scale (high, moderate, low), depending on correct number of sites (3 or 4) and representative number of animals in samples (at least 200).

3.14 Comments: none

11. Fish in lakes

Method: Fish indices for lake classification (LFI+ and LFI-EN)

1. General information

1.01 GIG: Central-Baltic

1.02 Category: Lakes

1.03 BQE: Fish

1.04 Country: Poland

1.05 Specification:

1.06 Method name:

Ichtiofauna indices – Lake Fish Index (LFI+ and LFI-EN)

1.07 Original name:

Ocena stanu ekologicznego jezior w oparciu o ichtiofaunę z wykorzystaniem metod LFI-EN I LFI+)

1.08 Status: Finalized, formally agreed national method; applied in the state monitoring

1.09 Detected pressure(s):

Water transparency (Secchi disc), total phosphorus content, chlorophyll content, Trophic State Index TSI (Carlson, 1977).

Pressure-impact-relationship: Pressure-impact relationship has been tested, significant relationships were confirmed.

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Chybowski Ł, Białokoz W, Wołos A, Draszkiewicz-Mioduszewska H, Szlakowski J. 2016. Przewodnik metodyczny do monitoring ryb w jeziorach [Methodological guidelines for ichthyofauna monitoring in lakes]. Biblioteka Monitoringu Środowiska, Warszawa [in Polish].

1.12 Scientific literature:

Carlson R. E 1977 - A trophic state index for lakes. Limnology and oceanography. 22: 361-369.

Commission Decision (EU) 2018/229 of 12 February 2018 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Commission Decision 2013/480/EU

1.13 Method developed by:

Chybowski Łucjan, Białokoz Witold, Wołos Arkadiusz, Draszkiewicz-Mioduszewska Hanna, Szlakowski Jacek. e-mail: irs@infish.com.pl; The Stanisław Sakowicz Inland Fisheries Institute, Oczapowskiego 10, 10-719 Olsztyn, Poland

1.14 Method reported by:

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Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

LFI+ method – yearly commercial fishery catches – at last 10 years series, with regular monthly catches and no species-selective catches.

LFI-EN - Norm (European Committee for Standardization (EN 14757): 2005 (E) - Water quality - Sampling of fish with multi-mesh gillnets).

Chybowski Ł, Białokoz W, Wołos A, Draszkiewicz-Mioduszewska H, Szlakowski J. 2016. Przewodnik metodyczny do monitoring ryb w jeziorach [Methodological guidelines for ichthyofauna monitoring in lakes]. Biblioteka Monitoringu Środowiska, Warszawa [in Polish].

2.02 Short description:

The method is composed of two indices used alternatively: LFI+ - based on the outcome of multi-year commercial fishing and LFI-EN – based on the results of one-off fishing with nordic gillnets, consistent with EN 14757.

2.03 Method to select the sampling/survey site or area:

Sites for gillnet placement (LFI-EN) most representative of waterbody – localization planned with the use of lake bathymetry data.

2.04 Sampling/survey device:

For LFI+ method – traditional fishery nets and other equipment used by fishery manager of a lake;

For FLI-EN method: standard Nordic panel gillnets (benthic and pelagic), according to EN 14757.

2.05 Specification:

LFI+ - standard fishery equipment: gillnets of different mesh size, dredges, fish-traps etc.;

LFI-EN – standardized Nordic gillnets: benthic multi-mesh gillnets – height of 1,5 m, length of 30 m, mesh size 5-55 mm; pelagic multi-mesh gillnets – height of 6,0 m, length of 27,5 m, mesh size 6,25-55 mm

2.06 Sampled/surveyed habitat:

Specification of sampled habitat:

LFI+ - commercial fishery performed across all lake habitats;

LFI-EN: benthic multi-mesh gillnets should be placed in various lake sections and pelagic multi-mesh gillnets – in a deepest part of the lake, from the bottom to the water surface. Number of gillnets per lake (depending of lake area and depth) is described in the standard EN 14757.

Sampled habitat: Multiple habitat sampling at various depth and in various parts of a lake.

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s):

LFI+ – whole year; LFI-EN: summer stagnation period (usually July – September)

2.09 Number of sampling/survey occasions (in time) to classify site or area:

LFI+ - 10 years data; LFI-EN – one occasion per sampling season

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

10 years data for LFI+ and one sampling for LFI-EN

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area: n.a.

Sample processing

2.12 Minimum size of organisms sampled and processed: n.a.

2.13 Sample treatment:

LFI+ - fish are weighted by: size group within the species or by species; LFI-EN: Sample is sorted separately from each gillnet and fish are identified to species and weighted by species and gillnet. Fish from gillnets shall be utilized in cooperation with the fishery user of a lake.

2.14 Level of taxonomical identification:

Level: Species

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: n.a.

Abundance is related to: net fish catches are not related to the fished area

Unit of the record of abundance: n.a.

Other record of abundance: n.a.

2.16 Quantification of biomass:

Direct measurement by species or size group within a species

2.17 Other biological data: optional individual fish length measurements

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

Ichtiofauna indices LFI+ and LFI-EN:

LFI = b0 + b1 X1 + b2 X2 + ... bn Xn

Where:

X1...Xn - the weight shares (%) in the catch of fish considered as metric X1, X2, Xn,

b0...bn - the regression coefficients for each weight shares

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: Average metric scores

3.04 From which biological data are the metrics calculated:

Data from 10 years commercial fishery catches (LFI+) or single sampling/survey occasion in time with gillnets (LFI-EN)

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: Historic fishery data on near-natural reference sites, Expert knowledge, Least Disturbed Conditions

3.07 Reference site characterisation:

Geographical coverage: Reference zones in natural and landscape parks of Central Plains, Baltic Province and Eastern Plains

Location of sites: National and Landscape Parks, North and Central Poland

Data time period: July-October 1952-2013

Criteria: Absence of point pollution sources, watershed overgrown by natural forests, meadows and wetlands, low nutrient content, high water transparency

3.08 Reference community description:

Fish community composed of species characteristic for fishery lake type, larger size classes of fish present and abundant in catches, low abundance of eurytopic and eurtrophying fish species.

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries: YES.

3.11 Boundary setting procedure: for LFI+ and LFI-EN finished in 2018

The LFI+ and LFI-EN class boundaries for all types of Polish lakes:

Ecological status/potential	LFI+ value	LFI-EN value
HIGH/MAXIMUM	≥0.866	≥0.804
GOOD	≥0.595	≥0.557
MODERATE	≥0.250	≥0.250
POOR	≥0.100	≥0.100
BAD	<0.100	<0.100

3.12 "Good status" community:

In the LFI+ method, in stratified lakes, reference fish community is characterized by the low percentage shares of zander and bream P (S – Small, M- Medium, N - undersized) (whose shares increased considerably with increasing pressure), and the high shares of pike, tench, perch and bream D (large) in the total catch of bream (whose shares decreases with increasing pressure indices). In non-stratified lakes, the reference conditions included the low percentage shares of zander and crucian carp (whose shares increased with increasing pressure indices), and the high shares of pike, tench, perch and roach S (whose shares decreased with increasing pressure indices).

In the LFI-EN formula, in stratified lakes, the reference conditions included the low percentage shares of: bream, white bream, roach, bleak, ruffe (whose shares increased with increasing pressure indices), and the high shares of tench, rudd and perch (whose shares decreased with increasing pressure indices). In non-stratified lakes, reference conditions included low percentage shares of: bream, white bream, roach, bleak, ruffe and zander (whose shares increased with increasing pressure indices), and the high shares of rudd and perch (whose shares decreased with increasing pressure indices).

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none

12. Macrophytes in transitional and coastal waters

Method: Verified macrophyte method for classification of transitional and coastal water (SM_1)

1. General information

1.01 GIG: Southern Baltic

Relevant intercalibration types: n.a.

1.02 Category: Coastal and transitional waters

1.03 BQE: Macrophytes

1.04 Country: Poland

1.05 Specification: n. a.

1.06 Method name: Macrophyte quality assessment index SM_1

1.07 Original name: Wskaźnik stanu makrofitów SM_1

1.08 Status: Finalized, formally agreed national method; applied in the state monitoring

1.09 Detected pressure(s):

Eutrophication, General degradation

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Kruk-Dowgiałło L., Brzeska P., Opioła R., Kuliński M. 2010. Makroglony i okrytozalążkowe, W: Przewodniki metodyczne do badań terenowych i analiz laboratoryjnych elementów biologicznych wód przejściowych i przybrzeżnych. Biblioteka Monitoringu Środowiska, Warszawa, ISBN 978-83-61227-36-6: 33–63.

Kraśniewski W., Zalewska T., Danowska B., 2018. Aktualizacja wstępnej oceny stanu środowiska wód morskich. IMGW-PIB w Gdyni, 865 p.

1.12 Scientific literature:

Osowiecki A., Łysiak-Pastuszak E., Kruk-Dowgiałło L., Błeńska M., Brzeska P., Kraśniewski W., Lewandowski Ł., Krzymiński W., 2012a. Development of tools for ecological quality assessment in the Polish marine areas according to the Water Framework Directive. Part IV – preliminary assessment. Oceanological and Hydrobiological Studies 41(3): 1–10.

1.13 Method developed by:

Lidia Kruk-Dowgiałło, Paulina Brzeska-Roszczyk

1.14 Method reported by:

Paulina Brzeska-Roszczyk

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska: e-mail: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Kruk-Dowgiałło L., Brzeska P., Opioła R., Kuliński M. 2010. Makroglony i okrytozalążkowe, W: Przewodniki metodyczne do badań terenowych i analiz laboratoryjnych elementów biologicznych wód przejściowych i przybrzeżnych. Biblioteka Monitoringu Środowiska, Warszawa, ISBN 978-83-61227-36-6: 33–63.

2.02 Short description:

Biomass samples are collected and vegetation coverage is assessed at the sampling station.

2.03 Method to select the sampling/survey site or area: Expert knowledge.

2.04 Sampling/survey device: Diver observations, video observations, frame sampling

2.05 Specification: Frame size 20 x 20 cm^2

2.06 Sampled/surveyed habitat:

Specification of sampled habitat Soft bottom habitat, Hard bottom habitat

Sampled habitat: Single habitat

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): June, September

2.09 Number of sampling/survey occasions (in time) to classify site or area:

One occasion per sampling month

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

3 replicates per sampling station

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

400 cm^2 (DAK frame) x3 = 1200 cm^2

Sample processing

2.12 Minimum size of organisms sampled and processed: n.a.

2.13 Sample treatment:

Sample is analysed under a microscope and organisms are identified.

2.14 Level of taxonomical identification:

Level: Species

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: percentage coverage

Abundance is related to: frame area

Unit of the record of abundance: g DW per 1 m^2

Other record of abundance: n.a.

2.16 Quantification of biomass: accuracy 0,001 g

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

SM_1 index is calculated as a ratio of the abundance (biomass x coverage) of positive taxa to abundance of all taxa identified within a site, according to the formula:

$SM1 = \sum(B_p \times pd_p)_{June} + \sum(B_p \times pd_p)_{Sept} / \sum(B_t \times pd_t)_{June} + \sum(B_t \times pd_t)_{Sept}$

Where:

Bp – biomass of positive taxa (g dw);

pdp – coverage of the positive taxa;

Bt – biomas of all taxa (g dw)

Pdt - coverage of all taxa;

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: No

3.04 From which biological data are the metrics calculated:

List of biological metrics: biomass, vegetation coverage

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions: Expert knowledge, Historical data

3.07 Reference site characterisation:

Number of sites: n.a.

Geographical coverage: Southern Baltic

3.08 Reference community description:

Positive macrophyte taxa dominate at the site.

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries: National legislation.

3.11 Boundary setting procedure: Available

The SM1 class boundaries for Polish coastal and transitional waters (except of BT1 type):

Ecological status/potential	SM_1 value
HIGH/MAXIMUM	≥0.95
GOOD	≥0.80
MODERATE	≥0.57
POOR	≥0.20
BAD	<0.20

3.12 "Good status" community: Established

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none

13. Macroinvertebrates in transitional and coastal waters

Method: Verified macroinvertebrate method for classification of the transitional and coastal water (B)

1. General information

1.01 GIG: Central-Baltic

Relevant intercalibration types: n.a.

1.02 Category: Coastal and transitional waters

1.03 BQE: Benthic Macroinvertebrates

1.04 Country: Poland

1.05 Specification:

1.06 Method name:

Assessment method for the ecological status transitional and coastal waters on the basis of benthic macroinvertebrates

1.07 Original name:

Zweryfikowana metoda oceny stanu w wodach przejściowych i przybrzeżnych na podstawie makrobezkręgowców bentosowych

1.08 Status: Method used in the State Monitoring Programme

1.09 Detected pressure(s): Eutrophication, General degradation,

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character: n.a.

1.12 Scientific literature: n.a.

1.13 Method developed by: n.a.

1.14 Method reported by: Główny Inspektorat Ochrony Środowiska

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Osowiecki A., Błeńska M., 2010. Makrobezkręgowce bentosowe [w:] Przewodniki metodyczne do badań terenowych i analiz laboratoryjnych fitoplanktonu, innej flory wodnej i makrobezkręgowców bentosowych w wodach przejściowych i przybrzeżnych, Biblioteka Monitoringu Środowiska, Warszawa, s. 65-84.

2.02 Short description:

The method is based on HELCOM Guidelines for the routine sampling and analyses of marine benthic macroinvertebrates

2.03 Method to select the sampling/survey site or area:

Sites most representative of waterbody and associated with sampling sites used for other biota

2.04 Sampling/survey device: van Veen and Günther grabs

2.05 Specification:

Sediment grabs, 0,1 mm sieves, plastic sample bottles with watertight lids

2.06 Sampled/surveyed habitat:

Specification of sampled habitat: Marine soft bottom substrates (sand, silt, etc.)

Sampled habitat: Single habitat(s).

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s): Spring and (optionally) autumn.

2.09 Number of sampling/survey occasions (in time) to classify site or area:

One occasion per sampling season.

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

3-5 replicates per sampling station.

2.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area: 0.3-0.5 m^2 (van Veen grab), 0.08-0.13 m^2 (Günther grab)

Sample processing

2.12 Minimum size of organisms sampled and processed: n.a.

2.13 Sample treatment:

Sample is analysed under a stereo-microscope and organisms are identified.

2.14 Level of taxonomical identification:

Level: Species

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: Yes

Abundance is related to: 1 m^2.

Unit of the record of abundance: 1 m^2

Other record of abundance: n.a.

2.16 Quantification of biomass: accuracy 0,001 g

2.17 Other biological data: none

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

The index B is calculated based on the species sensitivity to anthropopressure and dominance class according to the formula:

B = [∑(w x Q x sn)/∑D] - log(1+∑D)

where: W - dominance class weight; D - number of taxa in dominance class; sn - pressure sensitivity/tolerance index.Q = 0 when D=0, Q=1 when D>0.

3.02 Does the metric selection differ between types of water bodies: No

3.03 Combination rule for multi-metrics: No

3.04 From which biological data are the metrics calculated:

Data from single sampling, No of taxa, abundance sensitivity of species

Reference conditions

3.05 Scope of reference conditions: Surface water type-specific

3.06 Key source(s) to derive reference conditions:

Scope of reference conditions:

Existing near-natural reference sites, Expert knowledge, Least Disturbed Conditions

3.07 Reference site characterisation:

Number of sites: A total of 900 samples representing sites of different marine habitats

Geographical coverage: Southern Baltic

3.08 Reference community description:

Benthic communities dominated by numerous sensitive taxa

3.09 Results expressed as EQR: Yes

Boundary setting

3.10 Setting of ecological status boundaries: National legislation.

3.11 Boundary setting procedure: Available

The B index class boundaries for Polish coastal and transitional waters:

Ecological status/potential	B index value
HIGH/MAXIMUM	≥3.72
GOOD	≥3.18
MODERATE	≥2.70
POOR	≥1.91
BAD	<1.91

3.12 "Good status" community: Established

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none

14. Fish in coastal and transitional waters

Method: Polish Multimetric Fish Index (PMFI)

1. General information

1.01 GIG: Central-Baltic

1.02 Category: Coastal and transitional waters

1.03 BQE: Fish

1.04 Country: Poland

1.05 Specification: n.a.

1.06 Method name:

Polish Mulitimetric Fish Index (PMFI)

1.07 Original name:

Wskaźnik multimetryczny PMFI

1.08 Status: Finalized; in October 2020 accepted by the ECOSTAT Working Group, formally agreed national method; will be applied in the state monitoring

1.09 Detected pressure(s):

Eutrophication

Pressure-impact-relationship: The effect of depth, surface water temperature, bottom water temperature, salinity and water transparency on fish assemblage structure has been tested; significant relationships were confirmed.

1.10 Internet reference: n.a.

1.11 Pertinent literature of mandatory character:

Psuty I., Wandzel T., Lejk A.M., Podolska M., Zaporowski R., Smoliński S., Grochowski A., Wodzinowski T., 2014. Przewodnik metodyczny do badań terenowych i analiz laboratoryjnych ichtiofauny w wodach przejściowych i przybrzeżnych w ramach monitoringu diagnostycznego ichtiofauny. Inspekcja Ochrony Środowiska, Biblioteka Monitoringu Środowiska, Warszawa (in Polish).

Smoliński S., Całkiewicz J., 2019. Ewaluacja polskiego indeksu multimetrycznego ryb (PMFI) dla wód przejściowych. Morski instytut Rybacki – Państwowy Instytut Badawczy, Gdynia (manuscript, in Polish).

Całkiewicz J., Margoński P., Smoliński S., Dziemian Ł., Spich K., 2020. Evaluation on the Polish Multimetric Fish Index (PMFI) for transitional waters. Version II. MIR-PIB, Gdynia.

1.12 Scientific literature:

Smoliński S., Całkiewicz J., 2015, A fish-based index for assessing the ecological status of Polish transitional and coastal waters. Marine Pollution Bulletin. 101: 497-506.

1.13 Method developed by:

Całkiewicz Joanna, Margoński P., Smoliński Szymon, Dziemian Łukasz, Spich Katarzyna; Morski instytut Rybacki – Państwowy Instytut Badawczy, Gdynia

1.14 Method reported by:

Dziemian Łukasz, Spich Katarzyna; Morski instytut Rybacki – Państwowy Instytut Badawczy, Gdynia

Email of institute reporting the method: Główny Inspektorat Ochrony Środowiska: sekretariatdm@gios.gov.pl

1.15 Comments: none

2. Data acquisition

Field sampling/surveying

2.01 Sampling/Survey guidelines:

Psuty I., Wandzel T., Lejk A.M., Podolska M., Zaporowski R., Smoliński S., Grochowski A., Wodzinowski T., 2014. Przewodnik metodyczny do badań terenowych i analiz laboratoryjnych ichtiofauny w wodach przejściowych i przybrzeżnych w ramach monitoringu diagnostycznego ichtiofauny. Inspekcja Ochrony Środowiska, Biblioteka Monitoringu Środowiska, Warszawa (in Polish).

Całkiewicz J., Margoński P., Smoliński S., Dziemian Ł., Spich K., 2020. Evaluation on the Polish Multimetric Fish Index (PMFI) for transitional waters. Version II. MIR-PIB, Gdynia.

2.02 Short description:

Surveys are conducted by qualified biologists and followed the protocol of national ichthyofaunal monitoring. Three net types are used: the Polish coastal survey net, the Polish coastal multimesh net and the Nordic coastal multimesh gillnets (see HELCOM (2015) for a detailed description).

2.03 Method to select the sampling/survey site or area:

Sampling stations are fixed in the state monitoring programme. Their number and location in transitional and coastal areas is determined by the division into waterbodies.

2.04 Sampling/survey device:

Three types of fishing gear: the Nordic coastal multimesh gillnet or Polish coastal survey net, and bottom trawl.

2.05 Specification:

HELCOM, 2015. Guidelines for Coastal Fish Monitoring Sampling Methods of HELCOM; HELCOM, 2019. Guidelines for coastal fish monitoring; HELCOM COMBINE (Cooperative Monitoring in the Baltic Marine Environment

2.06 Sampled/surveyed habitat: n.a.

2.07 Sampled/surveyed zones in areas with tidal influence: not relevant

2.08 Sampling/survey month(s):

Summer period (usually July – August)

Fishing with Nordic nets should be carried out from July 1 to August 31, and bottom trawling from July 25 to August 31.

2.09 Number of sampling/survey occasions (in time) to classify site or area:

One occasion per sampling season

2.10 Number of spatial replicates per sampling/survey occasion to classify site or area:

HELCOM, 2015. Guidelines for Coastal Fish Monitoring Sampling Methods of HELCOM; HELCOM, 2019. Guidelines for coastal fish monitoring;

.11 Total sampled/surveyed area or volume or total sampling duration to classify site or area:

Sample processing

2.12 Minimum size of organisms sampled and processed: n.a.

2.13 Sample treatment:

Fishes from each catch are sorted out for the species for each catch separately. Individuals are then analysed for the gender, weighted for the biomass and measured for the body length, using *longitudo totalis (l.t.), longitudo caudalis (l.caud.)* or *longitudo corporis (l.c.)* depending on the species. Fish asre assessed also for the gonadal maturity. Scales and otoliths are analysed to determine the fish assemblage age structure.

2.14 Level of taxonomical identification:

Level: Species

Specification of level of determination: n.a.

2.15 Record of abundance:

Determination of abundance: number of individuals/species

Abundance is related to: per catch

Unit of the record of abundance: number of individuals/species

Other record of abundance: n.a.

2.16 Quantification of biomass: n.a.

2.17 Other biological data: n.a.

2.18 Special cases, exceptions, additions: none

2.19 Comments: none

3. Data evaluation

Evaluation

3.01 List of biological metrics:

The PMFI is composed of four metrics:

- Number of species (NS);
- Shannon index (SI);
- Number of freshwater species (NFS)
- Abundance of alien species (AAS).

All four metrics describe the taxonomic composition and diversity, as well as the abundance of fish and fish groups. The number of species (NS) is the total number of unique species in the catch. Shannon index (SI) is calculated based on the abundance of particular species in the catch. The number of freshwater species (NFS) is the total of unique freshwater species in the catch. The abundance of alien species (AAS) is the total abundance of fish belonging to alien species. The abundance is expressed as the catch per unit effort (number of specimens/unit effort).

3.02 Does the metric selection differ between types of water bodies:

No, but the metric classification depends on the water salinity.

3.03 Combination rule for multi-metrics:

In order to get the final assessment for a water body, in the first step one should set values for the following metrics: NS, SI, NFS, AAS for particular sampling sites. Next, the scoring class should be assigned for a given value of metrics (from 1 to 5 - which corresponds to the ecological status assessment classes). As the values of all metrics depend on the salinity, the appropriate salinity class should be used. Then, scores for metrics should be averaged between sites belonging to the same water body. The resulting mean should be rounded down to make the status assessment more conservative. Then the mean of 4 metrics is calculated for each water body, which should be also rounded down.

3.04 From which biological data are the metrics calculated:

Fish species composition and diversity per catch.

Reference conditions

3.05 Scope of reference conditions:

Not provided; the lack of historical data and relevant reference points, representing a good or high ecological status, does not currently allow setting reference conditions.

3.06 Key source(s) to derive reference conditions: not provided

3.07 Reference site characterisation: not provided

3.08 Reference community description: not provided

3.09 Results expressed as EQR: no

Boundary setting

3.10 Setting of ecological status boundaries:

Class boundaries were derived based on modelling. Metric values were modelled for the corresponding pressures values at the site-basis. The predetermined best models were used to predict the metric value.

3.11 Boundary setting procedure:

Boundaries of particular classes for each candidate metric were determined for 11 levels of salinity. The values of all selected metrics depend on the salinity. Therefore, when determining the ecological status class, the appropriate row of the table corresponding to the observed salinity level (from 0 to 10) should be selected. The state boundaries were taken as 0.2 x maximum metric value for a specific salinity/gear, and x 0.4, 0.6 and 0.8, respectively.

3.12 "Good status" community: not provided

Uncertainty

3.13 Consideration of uncertainty: No (to be done)

3.14 Comments: none