Justeret fiskeindeks til vurdering af økologisk tilstand i søer

Betydning for EU-interkalibreringen

Notat fra DCE - Nationalt Center for Miljø og Energi

Dato: 19. juni 2017

Torben L. Lauridsen
Liselotte Sander Johansson

Institut for Bioscience

Rekvirent:
Miljøstyrelsen
Antal sider: 20

Faglig kommentering:
Martin Søndergaard
Kvalitetssikring, centret:
Poul Nordemann Jensen

AARHUS
UNIVERSITET
DCE – NATIONALT CENTER FOR MILJØ OG ENERGI

Tel.: +45 8715 0000
E-mail: dce@au.dk
http://dce.au.dk

Indhold

1 Introduktion

I forbindelse med en kvalitetssikring af data har Aarhus Universitet, DCE og Miljøstyrelsen (tidligere SVANA) i 2016 haft fokus på data fra undersøgelser og målinger foretaget i søer, som indgår i det Nationale Program for Overvågning af Vandmiljø og Natur (NOVANA), herunder resultater fra fiskeundersøgelser i perioden 2004-2015. Proceduren for kvalitetssikring er optimeret i forbindelse med DCEs muligheder for at kvalitetsmærke data i overfladevandsdatabasen (ODA). Desuden er der i Miljøstyrelsen foretaget en såkaldt ″datavask″ som en del af forberedelserne til overgang til den fremtidige VANDA-database (afløseren for ODA). I forbindelse med disse tiltag er der foretaget korrektioner/forbedringer, som i visse tilfælde har betydning for de resulterende CPUE-værdier (fangst per indsatsenhed) for de undersøgte søer. Datagrundlaget for det nuværende interkalibrerede fiskeindeks for danske søer er hermed ændret. Som konsekvens heraf skal der foretages revurdering af EU-interkalibreringen for at sikre det danske indeks fortsat er sammenligneligt med øvrige fiskeindeks i Den Central Baltiske sø-GIG.

Nærværende notat beskriver kort de udførte korrektioner, justeringer og forbedringer, der er udført i såvel DCE regi som Miljøstyrelsesregi. Endvidere er den obligatoriske interkalibrering til et allerede interkalibreret resultat beskrevet, samt konsekvenserne heraf for miljøkvalitetsgrænserne for den biologiske kvalitetsparameter fisk.

2 Korrektioner, justeringer og forbedringer

2.1 Korrektioner og justeringer

- I forbindelse med databehandlingen af fiskedata fra søer med flere dybdezoner er følgende korrigeret: Hvis tykkelsen af vandsøjlen i den nederste dybdezone er mindre end 1,5 m, lægges volumen af de to nederste dybdezoner sammen. Dette er ikke gjort hidtil og har i nogle tilfælde betydning for de endeligt beregnede CPUE-værdier.

- I databasen Fiskbase er der korrigeret for fejl og indhentet manglende oplysninger vedrørende enkelt-nets placering i dybdezoner. Korrekte oplysninger om netplacering er væsentlig for korrekt beregning af CPUE værdier i dybere søer med flere dybdezoner.

- Endvidere er der foretaget en forbedring i beregningen af CPUE værdier, idet der nu konsekvent anvendes sødybdeoplysninger eller hypsograf til estimering/beregning af voluminer for de enkelte dybdezoner. Jf. den internationale standard for beregning af CPUE (EN-14757, 2005) kan der anvendes en antagelse om identisk volumen i en søs dybdezoner, hvilket hidtil har været praksis. Med den nye praksis bliver resultaterne for CPUE i hver dybdezone vægtet i henhold til volumen i denne dybdezone og det vurderes at give et mere retvisende resultat for CPUE for søen som helhed.

Disse korrektioner og forbedringer har ført til ændringer i nogle af de tidligere afrapporterede resultater. Afvigelser fra tidligere beregnede resultater kan således skyldes flere af de ovennævnte korrektioner og forbedringer.

2.2 Logaritmetransformation vs ikke-logaritmetransformation

Jf. Teknisk Anvisning nr. S05 – Fiskeundersøgelse i søer version 2 (http://bios.au.dk/fileadmin/bioscience/Fagdatacentre/Ferskvand/S05_fiskeundersoegelser_i_soer_ver2.pdf) er CPUE-data fra de enkelte dybdezoner hidtil logaritmetransformeret, hvorefter der er beregnet en samlet log-CPUE for hele søen. For at beregne en "rå" CPUE pr. sø er denne værdi tilbagetransformeret. Pga. statistiske antagelser og matematiske regler giver denne tilbagetransformering ikke samme endelige resultat, som hvis der anvendes ikke-logaritmetransformerede data. Forskellen mellem disse værdier (logaritme- vs ikke-logaritmetransformerede data) er større, jo større forskellen mellem CPUE-værdierne i de enkelte dybdezoner er. Undladelse af logaritmetransformeringen giver således et mere gennemskueligt og logisk resultat for CPUE for søen som helhed. På den baggrund er det besluttet fremover at undlade logaritmetransformeringen.

Samlet set er det Aarhus Universitet, DCE's opfattelse, at undladelsen af logaritmetransformation giver anledning til at ændre proceduren for CPUE beregningen, til anvendelse af ikke-logaritmetransformerede data.

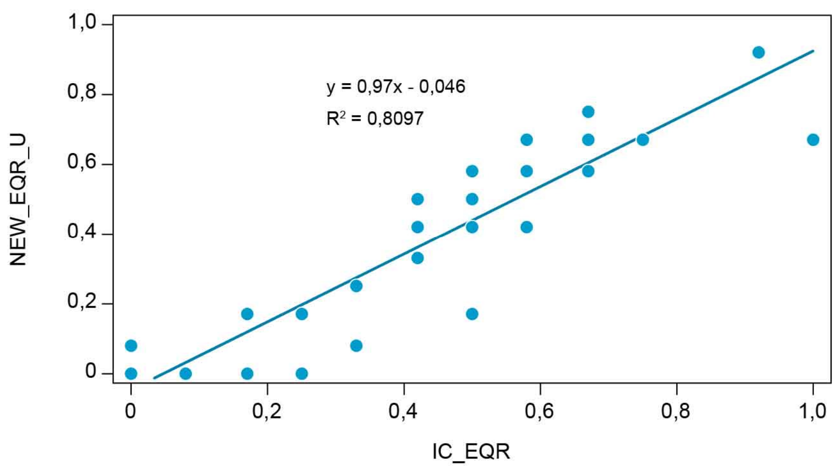
3 Betydning for EU-interkalibreringen

Med henblik på at få vurderet hvilken betydning kvalitetstjekket og de justerede beregningsmetoder har for EU-interkalibreringen af det danske fiskeindeks i den Centralbaltiske GIG, blev resultaterne fra de logaritmetransformerede (NEW_EQR_M) og de ikke logaritmetransformerede data (NEW_EQR_U) sendt til Dr. David Ritterbusch, IGB, Berlin, tidligere leder af den centralbaltiske interkalibreringsgruppe vedrørende fisk i søer.

David Ritterbusch har efterfølgende behandlet data og konklusionerne er:

- Vi kan anvende det justerede indeks baseret på ikke-logaritmetransformerede data (NEW_EQR_U). Baggrunden er, at korrelationen mellem det justerede indeks NEW_EQR_U og det allerede interkalibrerede IC_EQR viser en korrelationsværdi (r^2) på 0,8097 (kravet er >0,8) (Figur 1).
- Med udgangspunkt i korrelationen: y=0,97x – 0,046 bliver de nye interkalibrerede Høj/God og God/Moderat grænser hhv. 0,75 og 0,54 (tidligere hhv. 0,824 og 0,6).
- Grænseværdierne for den justerede metode er i overensstemmelse med de tidligere interkalibrerede grænseværdier for både Danmark og de øvrige medlemsstater i den Centralbaltiske GIG.

Figur 1. Korrelation mellem det justerede EQR (NEW_EQR_U) og det interkalibrerede EQR (IC_EQR).



Med udgangspunkt i korrelationen: y=0,97x – 0,046 (figur 1) kan der også beregnes en Moderat/Ringe og en Ringe/Dårlig grænse, således de nye EQR grænseværdier bliver [se også dokumentation fra David Ritterbusch (Bilag 1) samt den udfyldte Gap2 template (Bilag 2) for godkendelse fra IC review panelet samt WG ECOSTAT, begge følger herunder]:

	NEW_U grænse
H/G	0,75
G/M	0,54
M/R	0,34
R/D	0,15

De reviderede EQR grænseværdier betyder, at det danske pointtildelingssystem (0-12 point, Søndergaard m.fl. , 2013) revideres således (se evt. Bilag 3 for pointtildeling):

	Gl. Point_interval	Ny point_interval
H	11-12	10-12
G	8-10	7-9
M	6-7	5-6
R	4-5	2-4
D	0-3	0-1

Denne ændring kan ses som en svækkelse af kravene til de indikatorer, der anvendes til at beskrive den økologiske kvalitet på baggrund fisk i søer, idet der eksempelvis kun skal 7 point til at opnå god økologiske tilstand mod tidligere 8. Men set i lyset af, at de reviderede og kvalitetstjekkede fiskedata generelt resulterer i et lille fald i EQR og dermed også i point, betyder det ikke, at ændringen resulterer i flere søer i god eller høj tilstand, sammenlignet med tidligere. EQR-grænseværdierne og pointene for H/G og G/M ligger fast på baggrund af interkalibreringen.

Fra EU-side er der ikke krav til grænseværdier og point for de ikke-gode kvalitetsklasser (moderat, ringe, dårlig). Det vil sige, at man på nationalt niveau principielt selv kan fastlægge disse.

4 Konklusion

DCE anbefaler:

- At anvende de kvalitetstjekkede fiskedata
- At anvende beregnede voluminer for de enkelte dybdezoner i dybe søer
- At anvende ikke-logaritmetransformerede fiskedata
- At anvende de interkalibreringsbaserede korrigerede EQR grænseværdier
- At anvende de justerede interkalibreringsbaserede pointintervaller for det danske fiskeindeks.

5 Litteratur

Søndergaard, M., T. L. Lauridsen, E. A. Kristensen, A. Baattrup-Pedersen, P. Wiberg-Larsen, R. Bjerring, N. Friberg. 2013. Biologiske indikatorer i danske søer og vandløb. Videnskabelig rapport fra DCE- Nationalt Center for Miljø og Energi, nr. 59.

EN-14757, 2005. Vandundersøgelse – Prøvetagning af fisk i søer ved hjælp af biologiske oversigtsgarn. Water quality – Sampling of fish with multi-mesh gillnets. Dansk Standard.

Bilag 1 Dokumentation på anvendelse af det justerede system

Dokumentation fra David Ritterbusch, IGB, Berlin vedr. revideret system til beregning af fiskeindeks. I bilag 2 er vist den udfyldte Gap2 Template , som efterfølgende er godkendt af EU's IC review panel og WG ECOSTAT.

Comparison of a revised Danish lake fish assessment system with a former intercalibrated version - some comments on the class boundaries

Situation

At the beginning of 2016, Danish scientists have modified the fish based system to assess the ecology of lakes. It should be assured that the improved system can be regarded as intercalibrated; i.e. the class boundaries of the new system should be in line with the intercalibrated class boundaries of the former Danish system or within the range of the harmonized class boundaries of the Central-Baltic member states. As former leader of the intercalibration group, I was asked to comment the situation.

Data

DK sent a table for 34 polymictic Danish lakes > 50 ha including:

- The EQR values of the intercalibrated Danish system (IC)
- The EQR values of two versions of the improved system NEW_U and NEW_M, it is to be decided which system will be adopted,
- some pressure information.

David Ritterbusch added the values of the combined pressure index used in the intercalibration process (TAPI12i).

Analyses

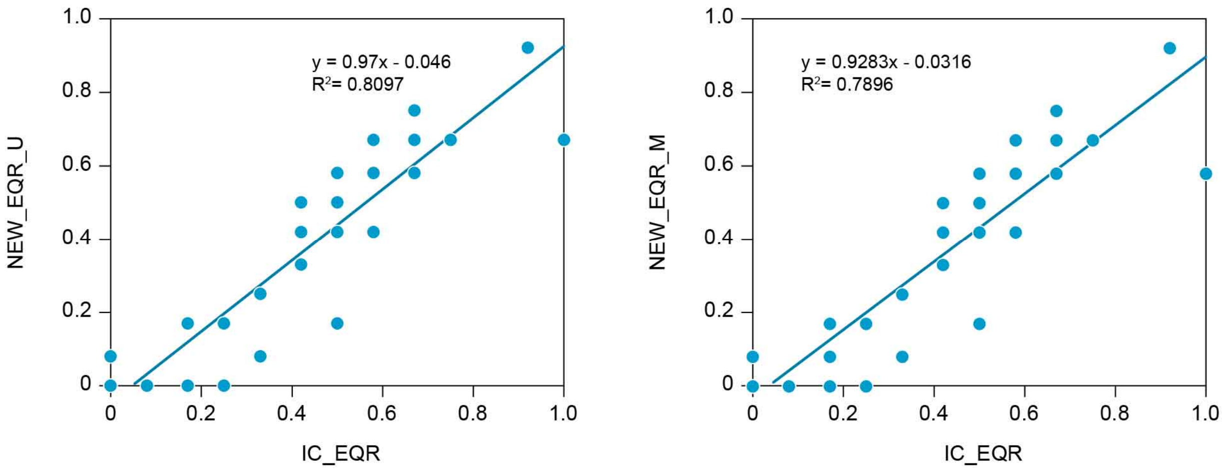


Figure 1. Correlations of the revised Danish fish assessment methods with the previous intercalibrated version.

Both new methods correlate very well with the intercalibrated version of the Danish LFI (**Figure 1**). To assess the harmony of the new systems with the intercalibrated system, the next steps follow precisely the guidance for fitting new or updated methods (CIS 2015). The new Danish LFI systems are revised versions of the intercalibrated LFI method. Therefore it is referred to chapter 4 in the guidance.

A direct comparison of class boundaries can be done if Pearsons $R^2 > 0.8$. This situation is given for the NEW_U approach. Therefore, the old class boundaries for high-good and for good-moderate can be translated directly into the new ones using the equation given in **Figure 1**. The thresholds of the NEW_U class boundaries need to be as strict as the already intercalibrated class boundaries (or stricter). **Table 1** provides the lowest possible values for the H/G and the G/M boundaries. The H/G class boundary is the outcome of the intercalibration process (was 0.8 before class boundary harmonisation).

Table 1. EQR values of the NEW_U system corresponding to the class boundaries of the intercalibrated system (NEW_U = 0.97*IC-0.046).

	old IC boundaries	NEW_U boundaries minimum
H/G	0,824	0,75
G/M	0,6	0,54
M/P	0,4	0,34
P/B	0,2	0,15

The current class boundaries of the new method are 0.8 (H/G) and 0.6 (G/M). Both boundaries are higher than the corresponding EQR values of the intercalibrated Danish method. Therefore, both new boundaries are more precautionary and acceptable according to CIS (2015). The class boundaries can be lowered to 0.75 (H/G) or 0.54 (G/M) and would still be in line with the intercalibration results.

The translation of the M/P and the P/B boundaries is added for information. These class boundaries are not harmonized in the intercalibration process.

The NEW_M approach slightly misses the requirement of a Pearson $r >= 0.8$. The class boundaries of this approach can be compared to the intercalibrated class boundaries using the TAPI index. I have not done this because the U-approach is favoured by the Danish colleagues.

Conclusion

According to the comparisons, I conclude that the class boundaries of the new Danish methods are in line with the previously intercalibrated class boundaries of both Denmark and the other member states of the Central Baltic GIG.

I suggest submitting the present analysis to Sandra Poikane (Joint Research Center) for confirmation. Please note that according to the official guidance document for new or update methods (CIS 2015) additional information has to be provided (See the filled template (Gap 2) below; TLL). This includes an updated method description, the confirmation of compliance to the WFD, and the description of the compliance with the established IC results. These documents are required to obtain approval of the IC review panel and the WG ECOSTAT.

Literature

CIS (2011): Guidance document on the Intercalibration Process 2008-2011. ECOSTAT 14, Implementation Strategy for the Water Framework Directive (2000/60/EC) - Guidance Document.

CIS (2015): Procedure to fit new or updated classification methods to the results of a completed intercalibration exercise. ECOSTAT 30, Implementation Strategy for the Water Framework Directive (2000/60/EC) - Guidance Document.

Søndergaard, M., T. L. Lauridsen, E. A. Kristensen, A. Baattrup-Pedersen, P. Wiberg-Larsen, R. Bjerring, N. Friberg. 2013. Biologiske indikatorer i danske søer og vandløb. Videnskabelig rapport fra DCE- Nationalt Center for Miljø og Energi, nr. 59.

Bilag 2 Gap 2 template delivered to EU

(Delivered by Torben L. Lauridsen to the IC review panel and WG ECOSTAT, July 2016)

Template for reporting on Intercalibration of new or revised ecological assessment methods according to finalised Intercalibration results (Gap 2)

1. Introduction

- MS: Denmark
- BQE: fish
- Water body category is L-CB1 (deep) and L-CB2 (shallow) lakes.

2. Description of national assessment methods

Denmark has modified the existing, already intercalibrated and accepted, assessment method for fish in lakes (Ritterbusch et al., 2015).

The modification consist of a quality check of data, use of calculated volumes for depth strata (instead of assuming similar volumes in the different depth strata in a given lake) and using non-transformed fish data (instead of log-transformed data) in the calculation of fish CPUE.

A more detailed description of the national method, including origin of data, data treatment and analyses (except for volume of depth strata and log-transformation of data) are provided in Søndergaard et al., 2013.

2.1. Methods and required BQE parameters

Table 1. Overview of the metrics included in the national method - example given for phytpoplankton. For other BQEs there will be other indicative parameters (see Table 1. Page 17, IC Guidance)

MS	Taxonomic composition	Abundance	Diversity	Age
DK	% PISC, % ROACH-BREAM	NPUE	% ROACH-BREAM	INDIV BIOM

Normalized EQR of the four metric scores are summed and divided by 12.

The selected metrics all comply with requirements concerning parameters for fish in lakes.

2.2. Sampling and data processing

Description of sampling and data processing:

- Sampling time and frequency: Between August 15 and September 15th, once every 5th year;
- Sampling method: 12-mesh sized gill nets using a modified version of the EN 14757 (Johansson and Lauridsen, 2014)
- Data processing: The catch is treated per net on location immediately following landing. Fish are measured and weighed. Data are typed into a data base and data are handled using SAS software
- Identification level: Fish are identified to species level but in the data processing also treated as groups.

2.3. National reference conditions

Danish landscapes are heavily impacted by human activities, about 60% of the total area being used for agriculture, and in addition urban areas (including roads) make up about 10%. Thus, true antropogenically un-impacted or minimally impacted lake ecosystems do not exist. There are several definitions of the term "reference condition" (Stoddard et al. 2006) representing a pragmatic and systematised procedure for cases where no truly un-impacted or minimally impacted ecosystems exist. The specific physical and chemical characteristics defining the best achievable condition for Danish lakes based on representative paleolimnological records dated back to approx. 1850 and defined as *"least disturbed condition "*have been identified by Søndergaard (2003) and are summarised in Table 2. These values were (according to Böhmer et al. 2014) supplemented with a criteria of <10% agriculture and <10% artificial land (urban settlements, roads, paved surfaces etc.), and only minor anthropogenic modifications of the riparian and littoral zones defined as a Pressure Index value according to Miler et al. (2012). Thus the Danish concept for reference status equals an under current conditions "least disturbed condition" combined with an expert judgement of what is acceptable and what not (Søndergaard et al., 2013).

Table 2. Values defining the best achievable condition for Danish lakes belonging to lake types 9 or 10 (Danish EPA 2004). Data originates from Søndergaard et al. (2003).

Lake type	Total-P (µg L-1)	Total-N (mg L-1)	Chl a (µg L-1)	Secchi-depth (m)
9 (L-CB 2)	14.6	0.4	3.7	3.8
10 (L-CB 1)	7.6	0.38	3.9	5.4

2.4. National boundary setting

For the description of the fish abundance and fish composition of Danish lakes, seven environmental explaining variables were used: mean depth, area, Secchi depth, total phosphorus (TP), chlorophyll, total nitrogen (TN) and alkalinity.

To identify the best explainable variables for the fish community, a partial Canonical Correspondence Analysis (pCCA) with the environmental variables was performed. To make this analysis more robust we only included fish species occurring in minimum 5 lakes. Based on an initial cross correlation between the included environmental variables, and due to high co-variance with several variables, Secchi depth was included as a co-variable. After subtracting the effect of Secchi depth, the remaining environmental variables, explained 11 % of the variation in the fish community, with mean depth and TP as significant explaining variables (**Table** 3). The inter-correlation between variables was relatively large (largest for chlorophyll a), though weakening the robustness of the analysis.

In the weighted correlation matrix for the analysis, highest correlations were seen between TP and Chlorophyll a, and between mean depth and Chlorophyll a, saying that part of the variation of the fish distribution pattern can be explained by Chlorophyll a. Consequently TP and Chlorophyll a was chosen as the structuring factors for the fish communities. Besides, Chlorophyll a is an integrating variable dependent not only on nutrients such as TP and TN, but also on more general biological and physical conditions such as the fish community, light conditions and macrophyte appearance.

Table 3. Results of a multivariate analysis (pCCA) of the biomass based fish composition, including 6 environmental variables and Secchi depth as a co-variable. The 6 variables explained 11 % of the fish distribution pattern.

Variable	**P**	**F**
Mean depth	0.005	3.36
Total P	0.005	3.05
Area	0.008	2.68
Chlorophyll a	0.060	1.82
Total N	0.345	1.11
Total alkalinity	0.528	0.88

To identify boundaries between quality classes, the 4 metrics (see below) were plotted against TP and Chlorophyll a ranges (TP ranged as: 0-25 µg/liter, >25-50; >50-100; >100-200; >200 µg/liter, and Chlorophyll a ranged as: 0-11 µg/liter, >11-23, >23-56, >56-90, >90 µg/liter). **Figure 1** shows an example for NPUE in shallow lakes L-CB2 lakes.

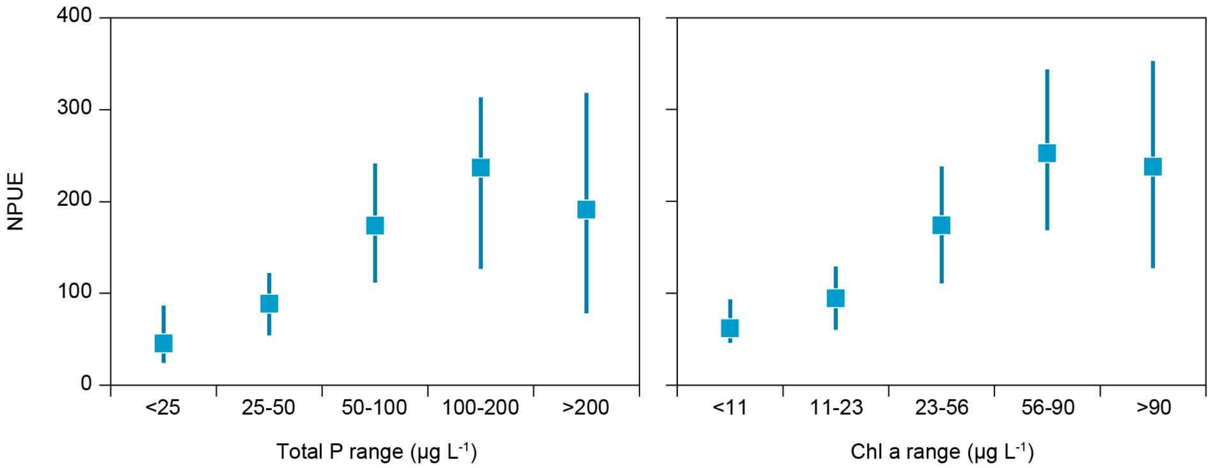


Figure 1: Correlations between NPUE and the explainable variables TP and Chlorophyll a. The black horizontal lines show the median NPUE values for the given category of lakes

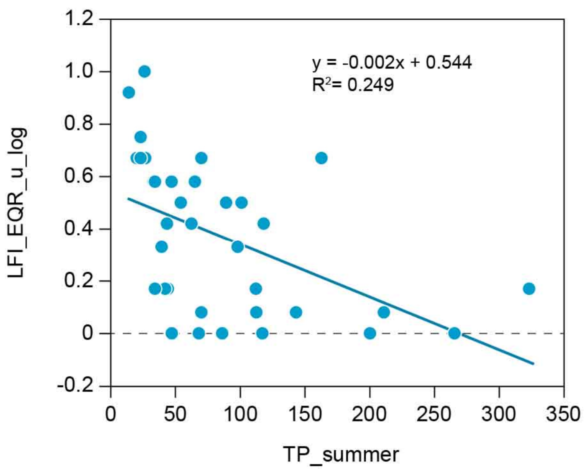
The calculation of the boundaries was performed by taking the average values of the two medians for a given TP and Chlorophyll a range. E.g. the boundary between high and good status for shallow lakes is the average of the median for the lowest TP class (0-25 µg/liter) and the median for the lowest chlorophyll class (0-11 µg/liter). The important boundary between good and moderate status is the average of the median for the second TP class (>25-50 µg/liter) and the median for the second chlorophyll class (>11-23 µg/liter). This exercise is performed for all the four metrics and ends up with the table containing all the boundaries used for calculating the EQR values.

2.5. Pressures addressed

The Danish system focuses on eutrophication using the following four metrics:

- NPUE: high numbers shows high productivity as a consequence of eutrophication
- Piscivores: biomass decreases with increasing eutrophication (well known for perch and pike that they diminishes if littoral structures decrease. Pike-perch percentages are decreasing too at high levels of eutrophication)
- Roach, Bream and roach/bream hybrids: biomass of the two/three species are increasing with eutrophication
- Individual biomass: size/biomass decreases because of an increase of small fish species and stunted growth.

For the intercalibration process on the LCB2 lakes, only lakes >50 ha were used, restricting the number to 34 lakes. For those 34 lakes there was a significant correlation between the overall EQR and TP: EQR = -0.002 * TP_summer + 0.544 (R^2 = 0.249). Loss of habitats was used too in the intercalibration process. Here we also found a significant correlation between the overall EQR and habitat numbers, which can be converted to loss of habitats: EQR = 0.0702 * habitat number (R^2=0.421), thus demonstrating the adequate sensitivity of the fish EQR. Both correlations are shown in **Figure** 2.



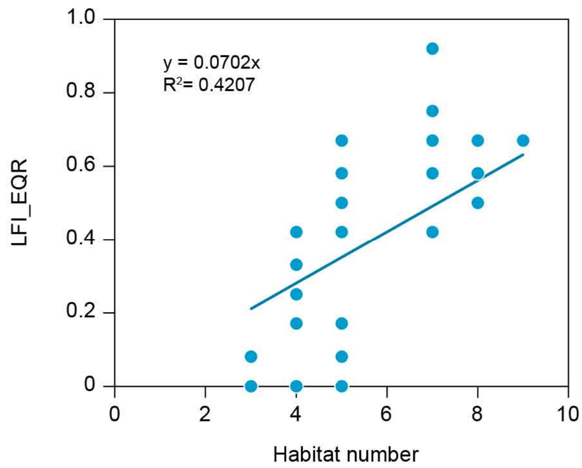


Figure 2. Regression and coefficients of correlation for the Danish LFI and two anthropogenic pressures; TP_summer and habitat number.

3. WFD compliance checking

The first step in the Intercalibration process requires the checking of national methods considering the following WFD compliance criteria.

Table 4. List of the WFD compliance criteria and the WFD compliance checking process and results

Compliance criteria	Compliance checking
Ecological status is classified by one of five classes (high, good, moderate, poor and bad).	YES
High, good and moderate ecological status are set in line with the WFD's normative definitions (Boundary setting procedure)	YES
All relevant parameters indicative of the biological quality element are covered (see Table 1 in the IC Guidance). A combination rule to combine parameter assessment into BQE assessment has to be defined. If parameters are missing, Member States need to demonstrate that the method is sufficiently indicative of the status of the QE as a whole	YES. Taxonomic composition, abundance, sensitive taxa and age are all included in the multimetric index: Roach, bream and piscivores representing composition; piscivores representing the sensitive taxa and size/indiv. biomass representing age.
Assessment is adapted to intercalibration common types that are defined in line with the typological requirements of the Annex II WFD and approved by WG ECOSTAT	YES. Lakes belonging to Danish types 9 and 10 are included in the intercalibration, being equivalent to those included in the CB-GIG intercalibration process (L-CB1 and L-CB2).
The water body is assessed against type-specific near-natural reference conditions	YES. Two out of 34 lakes included in the intercalibration were considered reference or near reference lakes (according to criteria that were comparable to those used by CB-GIG). Ideally the number of reference lakes should have been at least five, but those selected was assessed as sufficient to carry out the intercalibration successfully.
Assessment results are expressed as EQRs	YES. Using standard procedures: Total sum of metric scores, divided by total possible maximum score of metrics (EQR varying from 0-1).
Sampling procedure allows for representative information about water body quality/ecological status in space and time	YES. Standardized gill net sampling according to the CEN 14757 standard representing different depth strata. Water chemistry and Chlorophyll a was described by at least 7 samplings during a year (same year as the fish sampling).
All data relevant for assessing the biological parameters specified in the WFD's normative definitions are covered by the sampling procedure	YES
Selected taxonomic level achieves adequate confidence and precision in classification	YES

4. IC Feasibility checking

4.1. Typology

The national method addresses the same common lake types as were included by the other countries in the CB-GIG (L-CB1 = national type 9 and L-CB2 = national type 10), see 3.

4.2. Pressures addressed

The overall pressure in the Danish lakes is eutrophication; therefore the assessment system is addressed to this pressure. All MS have developed systems that take the effect of eutrophication into account, which is the major human pressure in the CB GIG.

4.3. Assessment concept

The national method follows the same assessment concept as the majority of the countries in the CB-GIG. CZ, DE, DK, EE, FR and PL follow European standard for multimesh-gillnet fishing (EN 14757 2005) more or less exactly.

Although differences might occur due to the deviating application of the EN procedure, the data is generally comparable.

4.4. conclusion on the Intercalibration feasibility

The national method is consistent and IC feasible.

5. Demonstrating the compliance with the completed intercalibration exercise

5.1. Background

At the 2nd CB LakeFish meeting the GIG discussed the options for the intercalibration process (step 3). All three options proposed by the Phase II guidance have special challenges (see Ritterbusch et al., 2015).

It was decided to use IC option 2 with the use of a non-biological common metric, i.e. a total anthropogenic pressure index (TAPI). We compiled a comprehensive table with pressure information. A total of 26 parameters in the pressure groups eutrophication, hydro-morphological pressures, biological pressures and pollution are included. All the pressure intensities were classified and got either 1/2/3/4/5 or 1/3/5 points (5 being reference-like conditions). We made several tests to combine these parameters to a total pressure index. The aim was achieving the highest possible number of significant correlations to the EQR values of the national systems. The TAPI provides the possibility to intercalibrate a satisfying number of MS, but not all. Details about the TAPI are described in Ritterbusch et al., 2015 Part B.

5.2. Description of IC dataset

The National data set were obtained primarily from the National Monitoring Program for Nature and Aquatic Environment (NOVANA). Data were collected during 2007-2013 for fish, physics and water chemistry. For the intercalibration process only lakes larger than 50 ha were included, making a total of 37 lakes. Data were provided by the regional environmental authorities (being present at this time). Despite this temporal difference of the data set, it is assessed that data from all lakes are directly comparable in a comprehensive analysis. Thus, it has been possible to provide matching fish and pressure data for each of the included lakes, and to ensure that the sampling and sample processing for fish, assessment of anthropogenic pressures (PI), and environmental data were compatible (same methods for sampling and analysing water samples).

5.3. Description of Intercalibration procedure

The entire intercalibration procedure is described in details in Ritterbusch et al. (2015).

The intercalibration of the original DK system within the CB GIG was done using an anthropogenic pressure index as intercalibration common metric. The results were reported to the JRC (Ritterbusch et al. 2015) and accepted.

The modification/update of the Danish system (not a new system) was carefully tested to be consistent with the intercalibration results according to the corresponding CIS Guidance (CIS 2015).

A report is attached below.

Comparison of a revised Danish lake fish assement systen with a former intercalibrated version - some comments on the class boundaries by David Ritterbusch, IGB, Berlin

Situation

At the beginning of 2016, Danish scientists have modified the already intercalibrated fish based system to assess the ecology of lakes. It should be assured that the improved system can be regarded as intercalibrated; i.e. the class boundaries of the new system should be in line with the intercalibrated class boundaries of the former Danish system or within the range of the harmonized class boundaries of the Central-Baltic member states. As former leader of the intercalibration group, I was asked to comment the situation.

Data

DK sent a table for 34 polymictic Danish lakes > 50 ha including:

- The EQR values of the intercalibrated Danish system (IC)
- The EQR values of two versions of the improved system NEW_U and NEW_M, it is to be decided which system will be adopted (afterwards it has been decided to use the system NEW_U; Torben Lauridsen)
- some pressure information.

David Ritterbusch added the values of the combined pressure index used in the intercalibration process (TAPI12i).

Analyses

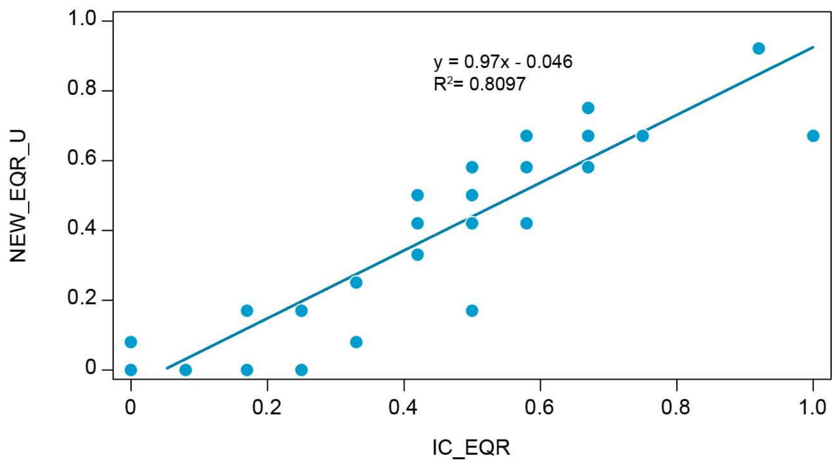


Figure 4: Correlations of the revised Danish fish assessment methods (NEW_EQR_U) with the previous intercalibrated version.

The new method correlates very well with the intercalibrated version of the Danish LFI (**Figure 1**4). To assess the harmony of the new systems with the intercalibrated system, the next steps follow precisely the guidance for fitting new or updated methods (CIS 2015). The new Danish LFI systems are revised versions of the intercalibrated LFI method. Therefore it is referred to chapter 4 in the CIS 2015 guidance.

A direct comparison of class boundaries can be done if Pearsons $R^2 > 0.8$ (Figure 4). This situation is given for the NEW_U approach. Therefore, the old class boundaries for high-good and for good-moderate can be translated directly into the new ones using the equation given in **Figure 1**4. The thresholds of the NEW_U class boundaries need to be as strict as the already intercalibrated class boundaries (or stricter). **Table 1**5 provides the lowest possible values for the H/G and the G/M boundaries. The H/G class boundary is the outcome of the intercalibration process (was 0.8 before class boundary harmonisation).

Table 5. EQR values of the NEW_U system corresponding to the class boundaries of the intercalibrated system (NEW_U = 0.97*IC-0.046).

b	old IC boundaries	NEW_U boundaries
H/G	0.824	0.75
G/M	0.6	0.54
M/P	0.4	0.34
P/B	0.2	0.15

The current class boundaries of the new method are 0.8 (H/G) and 0.6 (G/M). Both boundaries are higher than the corresponding EQR values of the intercalibrated Danish method. Therefore, both new boundaries are more precautionary and acceptable according to CIS (2015). The class boundaries can be lowered to 0.75 (H/G) or 0.54 (G/M) and would still be in line with the intercalibration results.

The translation of the M/P and the P/B boundaries is added for information. These class boundaries are not harmonized in the intercalibration process.

Conclusion

According to the comparisons, I conclude that the class boundaries of the new Danish methods are in line with the previously intercalibrated class boundaries of both Denmark and the other member states of the Central Baltic GIG.

5.4. Final boundaries

	NEW_U boundaries
H/G	0.75
G/M	0.54
M/P	0.34
P/B	0.15

6. Description of the biological communities

Fish communities can be dependent on several stressors. Based on Søndergaard et al. (2003), the common stressor in Danish systems is eutrophication. However, due to the small systems and e.g. limited dispersal possibilities, absence of certain species can be caused by other reasons but eutrophication.

Based on the given conditions the Danish index is based on 4 metrics: 1) NPUE (number per unit effort) as total catch per net; 2) percentage piscivores >10 cm, measured as biomass of perch, pike and pikeperch of the total catch; 3) percentage roach and bream, measured as biomass of roach, bream and roach/bream hybrids of the total catch; 4) Mean individual biomass of the total catch (BPUE/NPUE).

NPUE values are positively correlated with eutrophication due to increasing productivity. The increase is particularly due to increasing numbers of smaller sized roach and perch and to some extent number of breams. Number of pikes is normally negatively correlated to increasing eutrophication.

The percentage of large piscivores is negatively correlated to eutrophication, primarily because of increased dominance of the planktivores; this despite the above mentioned increasing number of small sized perch with increasing eutrophication. In contrast the percentage biomass of roach, bream and the hybrids of roach and bream is positively correlated to eutrophication. Not necessarily because fish are becoming larger, but because of increasing numbers of small sized roach and breams. However, large sized breams do occur in eutrophicated systems, thus contributing to the positive correlation with eutrophication.

Description of the biological communities at HIGH status
At high status the Danish lakes have a fish NPUE <54 fish per gill net (EN 14757), an individual biomass >60 g. The piscivore biomass constitute >54 % of the total fish biomass, and roach/bream < 28% of the total fish biomass.

Description of the biological communities at GOOD status
The fish community at good status has a NPUE value between 92 and 54 individuals per net, the individual biomass vary between 41 and 60 g and the percentage of piscivores constitute 32-54 % of the total fish biomass.

Description of the biological communities at MODERATE status
The fish community at moderate status has a NPUE value between 174 and 92 individuals per net, the individual biomass vary between 26 and 41 g and the percentage of piscivores lies within 25 and 32 % of the total fish biomass. Correspondingly the roach/bream biomass contributes with 55 to 43 % of the total fish biomass.

7. References

Böhmer, J. Arbaciauskas, K., Benstead, R., Gabriels, W., Porst, G., Reeze, B. & Timm, H. (2014) Central Baltic Lake benthic invertebrate ecological assessment methods. Water Framework Directive Intercalibration Technical Report. JRC Technical Reports (JRC88273), 72 pp.

CIS (2015): Procedure to fit new or updated classification methods to the results of a completed intercalibration exercise. ECOSTAT 30, Implementation Strategy for the Water Framework Directive (2000/60/EC) - Guidance Document.

Johansson, L. S, T. L. Lauridsen (2014): Fiskeundersøgelser i søer. Teknisk anvisning fra DCE, Nationalt Center for Energi og Miljø, Aarhus Universitet. 32 p. http://bios.au.dk/fileadmin/bioscience/Fagdatacentre/Ferskvand/S05_fiskeundersoegelser_i_soer_ver2.pdf

Miler, O., Pusch, M., Pilotto, F., Solimini, A., McGoff, E., Sandin, L. &Clarke R. (2012) Assessment of ecological effects of hydromorphological lake shore alterations and water level fluctuations using benthic invertebrates. WISER Deliverable D 3.3-4. 44 pp. http://www.wiser.eu/results/deliverables/.

Ritterbusch, D., C. Argillier, J. Arle, W. Białokoz, J. Birzaks, P. Blabolil, J. Breine, H. Draszkiewicz-Mioduszewska, N. Jaarsma, I. Karottki, S. Krasucka, T. Krause, J. Kubečka, T. Lauridsen, M. Logez, A. Maire, A. Palm, G. Peirson, S. Poikane, M. Říha, J. Szlakowski, T. Virbickas, 2015. Central Baltic Lake Fish Intercalibration Group, Results of the intercalibration process, 2013-2015, Part A: System descriptions, compliance check and feasibility check; Part B: Development of the intercalibration common metric; Part C: Intercalibration.

Stoddard, J.I., Larsen, D.P., Hawkins, C.P., Johnson, R.K. & Norris, R.H. (2006) Setting expectations for the ecological condition of streams: The concept of reference condition. Ecological Indicators 16: 1267-1276.Søndergaard, M., Jeppesen, E. & Jensen, J.P. (eds.), Bradshaw, Skovgaard, H. & Grünfeld, S. (2003) Vandrammedirektivet og danske søer. Del 1: Søtyper, referencetilstand og økologiske kvalitetsklasser. Danmarks Miljøundersøgelser. 142 pp. – Faglig rapport fra DMU nr. 475. http://faglige-rapporter.dmu.dk

Søndergaard, M., T. Lauridsen, E. Kristensen, A. Battrup-Pedersen, P. Wiberg-Larsen, R. Bjerring & N. Friberg (2013): Biologiske indikatorer til vurdering af økologisk kvalitet i danske søer og vandløb. 59, Aarhus Universitet, Aarhus.

Søndergaard, M., E. Jeppesen, J. P. Jensen & S. L. Amsinck (2005): Water Framework Directive: ecological classification of Danish lakes. Journal of Applied Ecology 42: 616-629.

Bilag 3. Pointtildeling for beregning af fiskeindeks

Scoringssystem og indeks for fisk baseret på forekomst af total fisketæthed og fiskearter i henholdsvis dybe og lavvandede søer. Beregningerne af grænseværdierne er baseret på gennemsnitsværdier af medianer for indikatoren i relation til hhv. TP og klorofyl koncentration.

	Lavvandede søer			Dybe søer		
Indikator	3 point	2 point	1 point	3 point	2 point	1 point
NPUE, antal	<54	<92	<174	<30	<54	<84
%rovfisk	>54	>32	>25	>62	>50	>35
%skalle-brasen	<28	<43	<55	<15	<34	<48
Individbiom.	>60	>41	>26	>53	>38	>31

- NPUE (number per unit effort); total fangst (antal) pr. garn
- % rovfisk >10 cm; biomasse af aborre, gedde og sandart over 10 cm i % af den totale fiskebiomasse
- % skalle-brasen; biomasse af skalle, brasen og skalle/brasen hybrider i % af den totale fiskebiomasse.
- Individbiom.; middel-individbiomasse i den totale fangst (BPUE/NPUE), g.

Totalscoren for en sø beregnes ved at summere scoren for de enkelte indikatorer, som efterfølgende kan omsættes til en økologisk klasse hvor:

høj = 12-10,
god = 9-7,
moderat = 6-5,
ringe = 4-2
dårlig = 1-0.

En sammensat EQR-værdi beregnes ud fra ovennævnte indikatorer ved division af den opnåede totalscore med maks. scoren (12).

Den beregnede sammensatte EQR værdi omsættes til tilstandsklasser således:

Høj: >0,75
God: >0,54-0,75
Moderat: >0,34-0,54
Ringe: >0,15-0,34
Dårlig: 0-0,15