

User's Manual of the Intercalibration Spreadsheets

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Table of Contents

1	Introduction	3
2	Spreadsheet selection	4
3	IC Option 2 spreadsheets	5
3.1	Input requirements	5
3.1.1	Sheet "Bm"	5
3.1.2	Sheet "data"	5
3.2	Steps of calculation	5
3.2.1	Linear regression	5
3.2.2	Benchmark standardisation.....	5
3.2.3	Boundary translation	6
3.2.4	Boundary bias	6
3.2.5	Boundary harmonisation	7
4	IC Option 3 spreadsheets	9
4.1	Input requirements	9
4.1.1	Sheet "Bm"	9
4.1.2	Sheet "data"	9
4.2	Steps of calculation	9
4.2.1	Linear regression against pseudo-common metric.....	9
4.2.2	Benchmark standardisation.....	10
4.2.3	Boundary translation	12
4.2.4	Boundary bias	12
4.2.5	Boundary harmonisation	13
4.2.6	Class agreement.....	14
5	References.....	16

1 Introduction

This document explains the use and functions of the four intercalibration spreadsheet files that can be downloaded from <http://www.uni-due.de/hydrobiology/publications/birk.shtml>, section "Intercalibration tools"¹:

- *IC_Opt2_div.xlsx*
- *IC_Opt2_sub.xlsx*
- *IC_Opt3_div.xlsx*
- *IC_Opt3_sub.xlsx*

The files are designed to support the analytical process of comparing and harmonising the good status boundaries of national assessment methods according to Annex V of CIS (2010).

The spreadsheets are programmed in MS Excel 2007 (.xlsx) and are capable to process up to 16 national assessment methods and 4,000 sample data entries. Cells for data entry are marked in yellow; all other cells are protected from modification².

In the following section we describe how to select the spreadsheet version required for your exercise. Specifications on IC Option 2 and 3 spreadsheets form the main part of the document. We suggest to directly refer to the relevant section of this manual after you have identified the appropriate spreadsheet version. Note that the Annex V criterion of "class agreement" can only be calculated by the Option 3 spreadsheets.

We welcome the use of the spreadsheets for facilitating your intercalibration exercise. However, we strongly advise you to perform independent calculations of boundary comparison and harmonisation. The spreadsheets are primarily designed to quickly check the implications of boundary adjustment, and as a means to review your outcomes.

¹ This manual and cited references can also be downloaded here.

² The spreadsheets are not blank but contain artificial datasets used to test the files. To run your own analysis you need to overwrite these data.

2 Spreadsheet selection

Four different spreadsheet versions were designed to allow for various alternatives of boundary comparison in intercalibration. Select the appropriate version by (1) choosing the IC Option followed in your intercalibration exercise (see CIS, 2010), and (2) identifying the relationships of anthropogenic pressure against national assessment results (i.e. EQRs) (Figure 1).

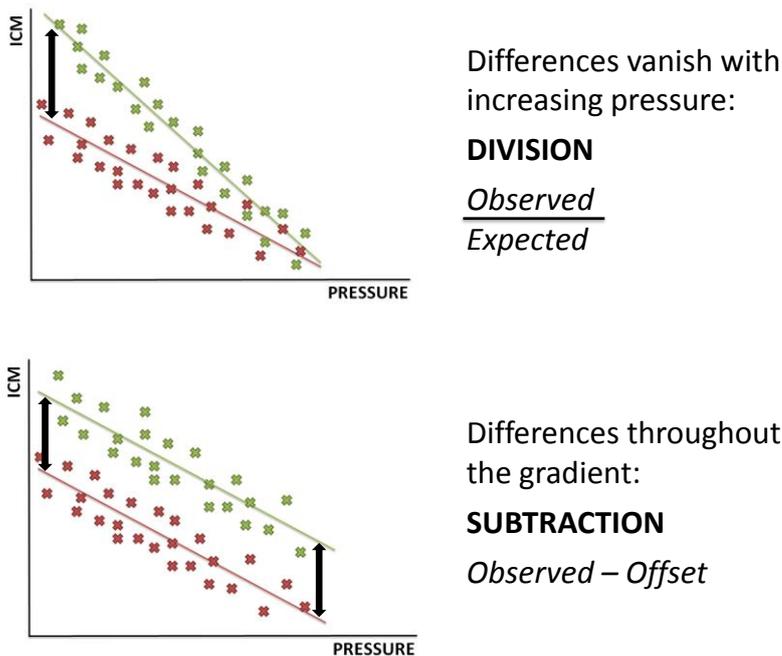


Figure 1: Types of pressure-impact-relationships and options of calculating the benchmark standardisation
 Upper diagram: Standardisation is done by **division** if differences in the biological assessment results (ICM) between national methods (green and red crosses) vanish with increasing pressure.
 Lower diagram: Standardisation is done by **subtraction** if differences remain throughout the entire pressure gradient.

The decision tree in Figure 2 guides the selection process of the required spreadsheet version.

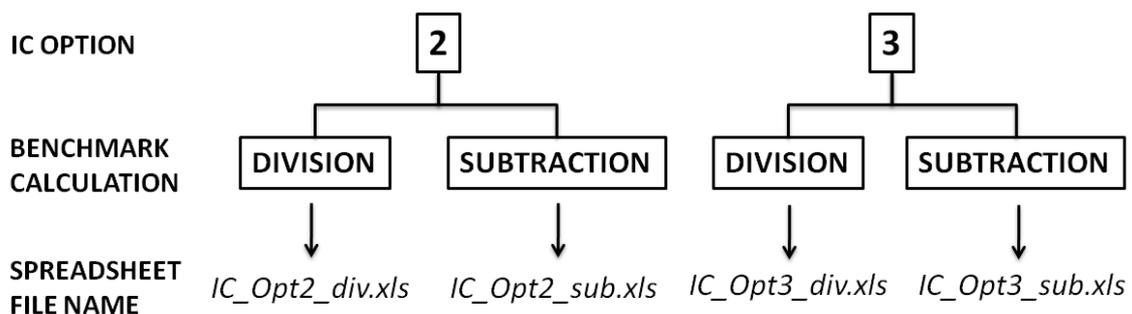


Figure 2: Decision tree for selecting the appropriate spreadsheet version

3 IC Option 2 spreadsheets

3.1 Input requirements

3.1.1 Sheet "Bm"

The reference values (usually "1.00") and all national class boundaries (as EQR values) need to be specified for each method participating in the intercalibration exercise. Select an appropriate identifier for the national methods as table headers, and use the same identifier also in the Sheet *data*.

3.1.2 Sheet "data"

In IC Option 2 the intercalibration analyses are carried out on the basis of separate datasets related to each national method. The spreadsheet on IC Option 2 requires information about:

- Sample code
- National method (same as in Sheet *Bm*)
- National EQR
- Common metric

Furthermore, benchmark sites have to be selected for each method (see Birk & Willby 2010). All data are entered one below the other in Sheet *data* for the individual methods.

Note: Never delete entire rows or columns in the data input sheets.
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3.2 Steps of calculation

3.2.1 Linear regression

The Option 2 spreadsheet establishes ordinary least-square regressions for each national dataset. Sheets *tdata* and *gdata* are used to arrange the data for the subsequent analyses. On this basis the regression the graphs in **Sheet reg** are plotted. These graphs include sample plots, regression formulae and R^2 values. Note that no benchmark standardisation has been applied to the data presented in this sheet.

Sheet calc specifies details of the regressions (rows 2-6). Here, it is possible to *manually enter regression slopes* for testing the effects of different slope values on the intercalibration outcomes³.

3.2.2 Benchmark standardisation

Row(s) 8(-10) of **Sheet calc** include the details for the benchmark standardisation. The "Median ICM" is defined as the median of the common metric values at benchmark sites

³ This may be useful in cases of weak regressions (e.g. low number of samples, low R^2 values).

(specified by the user in Sheet *data*)⁴. This median is calculated separately for each national method/dataset.

*Benchmark calculation: Division*⁵

Standardisation by division is done by dividing the EQR values belonging to a national method by the median value of benchmark sites of this country.

*Benchmark calculation: Subtraction*⁶

The “Offset” of method *x* [*Off_x*] is the deviation of the national median [*nMed_x*] to the average of all benchmark medians [*ØMed*] in common metric units, i.e.

$$Off_x = \emptyset Med - nMed_x$$

For benchmark standardisation this number is added to the national reference and boundary values before boundary comparison (see rows 18-22). The spreadsheet also allows for a *manual input of offsets*. This may be useful to test the effects of differing benchmarks on the intercalibration outcomes.

3.2.3 *Boundary translation*

Rows 16-20 (version: division) or 18-22 (version: subtraction) of **Sheet *calc*** present the position of the national reference⁷ and boundary values (1) after translation into common metric scale by linear regressions, and (2) after benchmark standardisation. For your convenience the original values you entered into Sheet *Bm* are listed in rows 10-14 (div) or 12-16 (sub).

3.2.4 *Boundary bias*

Boundary bias is one of the two components to check the comparability of national quality classifications (CIS, 2010). Boundary bias is defined as the deviation of the relevant national class boundary (high-good or good-moderate) from the average boundary position derived from all methods participating in the exercise (“harmonisation guideline”). Boundary bias is expressed in national class equivalents and must not exceed 0.25 units. All elements required to calculate boundary bias are shown in Figure 3.

⁴ Note that the total number of benchmark sites is specified in Sheet *adj* (row 26).

⁵ Relevant for spreadsheet file *IC_opt2_div.xls*

⁶ Relevant for spreadsheet file *IC_opt2_sub.xls*

⁷ For the translation of the national reference value the spreadsheet uses either the reference given in Sheet *Bm* or the highest national EQR given in Sheet *data*, whichever is higher. This value is used for defining the width of the high status class (see following section).

Rows 22-24 (div) or 24-26 (sub) of **Sheet calc** specify the widths of national classes in common metric units. They are derived from subtracting the lower from the upper boundary value of the corresponding class. Rows 25-26 (div) or 27-28 (sub) include the raw bias for the high-good and good-moderate boundary of a national method. The bias is calculated by subtracting the boundary position on the common metric scale [$Bound_x$] from the average boundary position [$HarmGuid$]. Rows 28-29 (div) or 30-31 (sub) [$bias_CW_x$] relate this raw bias to the width of the respective national class [CW_x] intersected by the harmonisation guideline (see Figure 3), i.e.

$$bias_CW_x = |(HarmGuid - Bound_x)| / CW_x$$

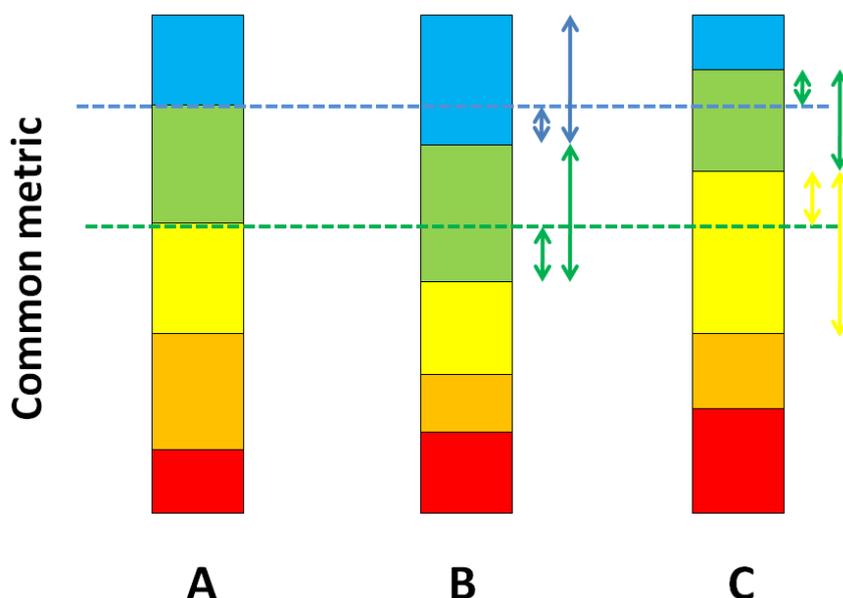


Figure 3: National classification schemes (A, B, C) intersected by the average boundary positions derived in intercalibration (“harmonisation guideline” – broken blue and green horizontal lines). Small arrows depict the distance of relevant national boundary to the harmonisation guideline. Large arrows define relevant national class width. The relation of small to large arrow-lengths specifies the *boundary bias in class equivalents*.

3.2.5 Boundary harmonisation

Sheet adj is designed to simulate the effects of boundary adjustments to the bias. Rows 7-8 contain the original national EQR values of the high-good and good-moderate class boundaries. Rows 24-25 calculate the boundary biases as class equivalents. If a national boundary position is too relaxed (below -0.25 class equivalents) the respective field is coloured in red. If the national boundary position is too stringent (above +0.25 class equivalents) the field appears in yellow colour. Any position within the ± 0.25 boundary bias leaves the field in white background colour.

You can now *manually change the original boundary positions* of any method and see the effects on the boundary bias directly. The scheme uses the regression formulae and benchmark definitions specified in the previous sheets. Note that the harmonisation guideline (average boundary position of all methods) is not affected by the changes you make to this sheet. For your convenience the original boundaries are displayed in rows 2-3.

Results are also presented in the diagrams on boundary bias (Figure 4).

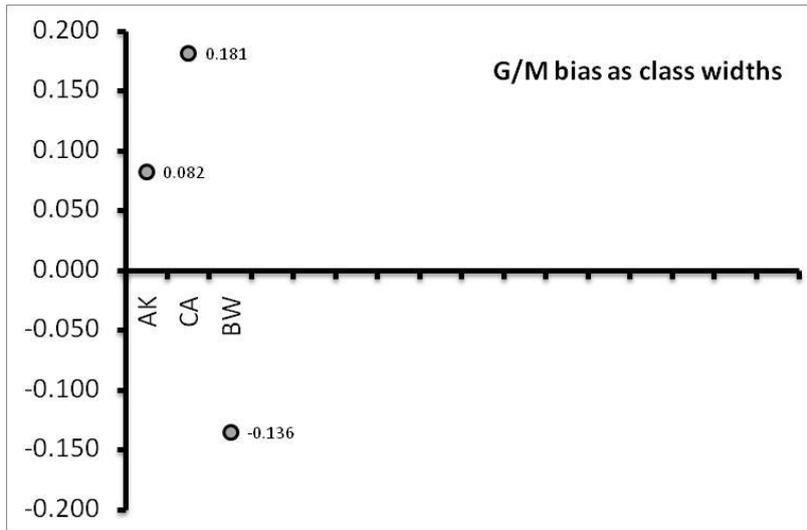


Figure 4: Boundary bias expressed as class width equivalents per national method (diagram taken from Sheet *adj*)

4 IC Option 3 spreadsheets

The basic features of calculating boundary bias are similar to the IC Option 2 spreadsheets described above. The IC Option 3 spreadsheets additionally allow for the calculation of class agreement. Note that the spreadsheets are only designed to follow IC Option 3a (see CIS, 2010).

4.1 Input requirements

4.1.1 Sheet "Bm"

The reference values (usually "1.00") and all national class boundaries (as EQR values) need to be specified for each method participating in the intercalibration exercise (rows 3-7). Select an appropriate identifier for the national methods as table headers.

Option 3 allows to identify up to 5 different subtypes per national method/country (see Birk & Willby 2010). Specify the number of subtypes in row 8 and give different names to all these subtypes in rows 9-13.

4.1.2 Sheet "data"

In IC Option 3 the intercalibration analyses are carried out on the basis of a common dataset that includes samples commonly assessed by all methods participating in the exercise. The spreadsheet on IC Option 3 requires information about:

- Sample code
- Country (origin of sample data)
- Benchmark site (yes/no)⁸
- Subtype (allocation of subtype to benchmark sites⁹; use the name(s) given in Sheet *Bm*)
- National EQRs headed by method identifier (starting from column E)

4.2 Steps of calculation

4.2.1 Linear regression against pseudo-common metric

The spreadsheet performs various calculation steps before establishing the linear regressions (Figure 5). The raw values of the national EQRs are first benchmark standardised (see section 4.2.2 for details). Then, the resulting values are normalised to a range of 0-1¹⁰. Out of these values the Pseudo-Common Metrics (PCM) are derived (average

⁸ Note that you must define benchmark sites for ALL subtypes.

⁹ only necessary for samples that belong to benchmark sites

¹⁰ Min-max normalisation

of all national EQRs per sample excluding the method to be compared against; see Willby & Birk 2010). Finally, the regressions are established and displayed in **Sheet reg**. The graphs include sample plots, regression formulae and R^2 values. Note that at this stage benchmark standardisation and normalisation have been applied to the data.

Sheet calc specifies details of the regressions (rows 8-12). Here, it is possible to *manually enter regression slopes* for testing the effects of different slope values on the intercalibration outcomes¹¹.

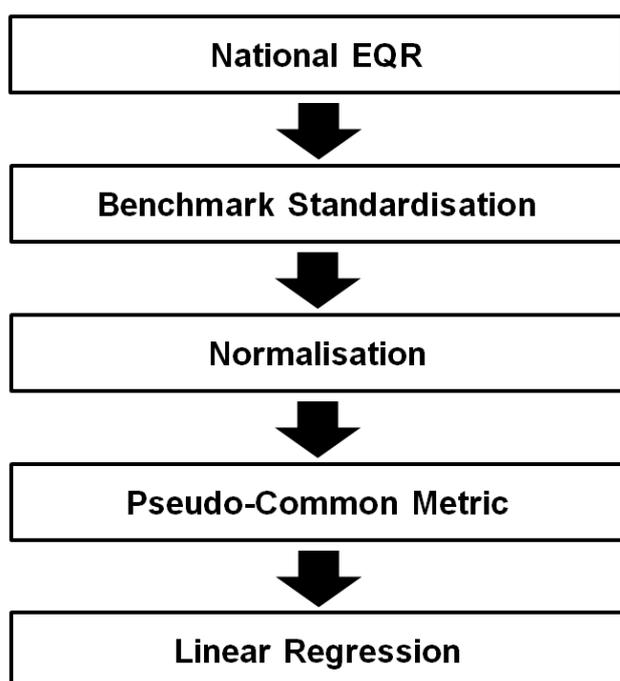


Figure 5: Steps of the calculation before establishing linear regressions

4.2.2 Benchmark standardisation

Compared to IC Option 2 the process of benchmark standardisation is more complex. This is because in Option 3 the assessment methods are applied to both foreign and national data¹². Therefore, each method is standardised individually for the different subtypes¹³ occurring in the GIG (see Birk & Willby 2010).

¹¹ This may be useful in cases of weak regressions (e.g. low number of samples, low R^2 values).

¹² An assessment method is adapted to regional conditions. It presumably performs best in the country of origin, while applied outside its original range it is expected to yield less accurate results because it encounters conditions or associations of species that differ from those of the sites on which it was trained.

¹³ Intercalibration subtypes are characterised by distinct biological communities that differ in taxonomic composition and/or dominance structure. Subtypes occur within a common intercalibration type due to diverse patterns of species dispersal, climatological gradients or regional specificities of the common type (e.g., caused by lithology, topography).

For each subtype (specified in the Sheets *Bm* and *data*) the spreadsheet calculates a separate average (median) EQR of the national methods. These medians are then used for a piece-wise standardisation for each set of subtype-data within a national method¹⁴. The principle is exemplified in Figure 6. The median values per subtype used for the benchmark standardisation are specified in **Sheet *calc*** (rows 14 and following).

Sample	Sub-type	Benchmark	National EQR of Country A	National EQR of Country B	Calculation: EQR of Country A	Calculation: EQR of Country B	Standardised National EQR Country A	Standardised National EQR Country B
S01	I	Yes	0.97	0.80	National EQR of A Median EQR of A at Benchmark Sites of I	National EQR of B Median EQR of B at Benchmark Sites of I	1.11	1.00
S02	I	Yes	0.82	0.78			0.94	0.98
S03	I	Yes	0.87	0.99			1.00	1.24
S04	I	No	0.54	0.65			0.62	0.81
S05	I	No	0.73	0.34			0.84	0.43
S06	I	No	0.34	0.21			0.39	0.26
S07	II	Yes	0.89	0.99	National EQR of A Median EQR of A at Benchmark Sites of II	National EQR of B Median EQR of B at Benchmark Sites of II	1.00	1.27
S08	II	Yes	0.76	0.76			0.85	0.97
S09	II	Yes	0.99	0.78			1.11	1.00
S10	II	No	0.43	0.54			0.48	0.69
S11	II	No	0.32	0.43			0.36	0.55
S12	II	No	0.12	0.22			0.13	0.28

Standardise the national EQR for each subtype's dataset in the common database individually by dividing the actual EQR value of the sample by the median EQR value at benchmark sites of the subtype from which the data originate.

* Example: $0.54 / 0.78 = 0.69$

Figure 6: Principle of benchmark standardisation as used by the spreadsheet (benchmark calculation: division)

Benchmark calculation: Division¹⁵

As depicted in Figure 6 each national EQR value is divided by the median of the subtype the sample belongs to. The standardised EQRs are listed in Sheets *tdata* and *gdata* (columns headed by “sEQR”).

Benchmark calculation: Subtraction¹⁶

For each subtype's benchmark sites the median EQRs of national methods are averaged (Figure 7). To calculate the offset of each subtype the median values are then subtracted from this average. The offset value differs between subtypes, so each subtype-dataset is standardised by an individual offset value. The offsets per subtype and national method are given in **Sheet *calc*** (rows 33 and following).

Each national EQR is added by the offset value of the subtype the sample belongs to. The standardised EQRs are listed in Sheets *tdata* and *gdata* (columns headed by “sEQR”).

¹⁴ If several subtypes are occurring in one country the spreadsheet calculates the arithmetic mean of all subtype-medians and uses this mean to standardise the national method applied to this country's data.

¹⁵ Relevant for spreadsheet file *IC_opt3_div.xls*

¹⁶ Relevant for spreadsheet file *IC_opt3_sub.xls*

Subtype	Benchmark sites assessed by Method A	Average of medians at benchmark sites	Offset
I	Median _{AI}	\emptyset	$\emptyset - \text{Median}_{AI}$
II	Median _{AII}		$\emptyset - \text{Median}_{AII}$
III	Median _{AIII}		$\emptyset - \text{Median}_{AIII}$

Subtype	Benchmark sites assessed by Method B	Average of medians at benchmark sites	Offset
I	Median _{BI}	\emptyset	$\emptyset - \text{Median}_{BI}$
II	Median _{BII}		$\emptyset - \text{Median}_{BII}$
III	Median _{BIII}		$\emptyset - \text{Median}_{BIII}$

Figure 7: Scheme of the *benchmark calculation: Subtraction* for two national methods (A, B) assessing a common dataset that includes three subtypes (I, II, III) (\emptyset : arithmetic mean of subtype medians; see text for explanation)

4.2.3 Boundary translation

Reference values¹⁷ and boundaries are benchmark standardised and normalised before being translated into PCM values. Modified references and boundaries are depicted in **Sheet calc** [standardised values: rows 40-45 (div) or 58-63 (sub); standardised and normalised values: rows 47-52 (div) or 65-70(sub)]. In the rows below these values are translated into PCM units using the regressions specified in rows 8-12 (and displayed in **Sheet reg**).

4.2.4 Boundary bias

Boundary bias is one of the two components to check the comparability of national quality classifications (CIS, 2010). Boundary bias is defined as the deviation of the relevant national class boundary (high-good or good-moderate) from the average boundary position derived from all methods participating in the exercise (“harmonisation guideline”). Boundary bias is expressed in national class equivalents and must not exceed 0.25 units. All elements required to calculate boundary bias are shown in Figure 8.

Rows 61-63 (div) or 79-81 (sub) of **Sheet calc** specify the widths of national classes *high*, *good* and *moderate* in PCM units. They are derived from subtracting the lower from the upper boundary value of the corresponding class. Rows 64-65 (div) or 82-83 (sub) include the raw bias for the high-good and good-moderate boundary of each national method. The bias is calculated by subtracting the boundary position on the PCM scale [$Bound_x$] from the average boundary position [$HarmGuid$]. Rows headed by [$bias_CW_x$] relate this raw bias to

¹⁷ For the translation of the national reference value the spreadsheet uses either the reference given in Sheet *Bm* or the highest EQR of the subtype for which the national method is designed (specified in Sheet *data*), whichever is higher. This value is used for defining the width of the high status class (see following section).

the width of the respective national class [CW_x] intersected by the harmonisation guideline (see Figure 8), i.e.

$$bias_CW_x = (Bound_x - HarmGuid) / CW_x$$

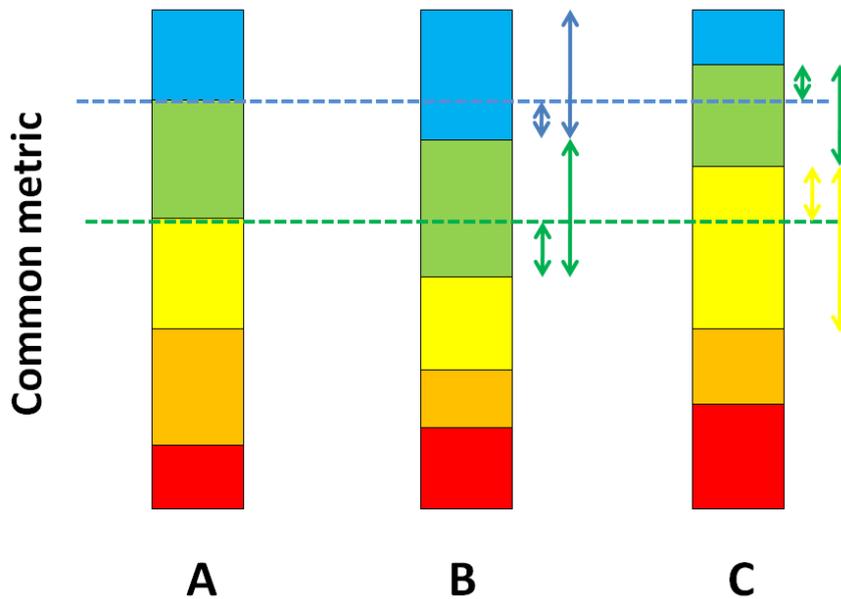


Figure 8: National classification schemes (A, B, C) intersected by the average boundary positions derived in intercalibration (“harmonisation guideline” – broken blue and green horizontal lines). Small arrows depict the distance of relevant national boundary to the harmonisation guideline. Large arrows define relevant national class width. The relation of small to large arrow-lengths specifies the *boundary bias in class equivalents*.

4.2.5 Boundary harmonisation

Sheet *adj* is designed to simulate the effects of boundary adjustments to the bias. Rows 7-8 contain the original national EQR values of the high-good and good-moderate class boundaries. Rows 24-25 calculate the boundary biases as class equivalents. If a national boundary position is too relaxed (below -0.25 class equivalents) the respective field is coloured in red. If the national boundary position is too stringent (above +0.25 class equivalents) the field appears in yellow colour. Any position within the ± 0.25 boundary bias leaves the field in white background colour.

You can now *manually change the original boundary positions* of any method and see the effects on the boundary bias directly. The scheme uses the regression formulae and benchmark definitions specified in the previous sheets. Note that the harmonisation guideline (average boundary position of all methods) is not affected by the changes you make to this sheet. For your convenience the original boundaries are displayed in rows 2-3.

Note: Always harmonise the good-moderate boundaries before adjusting the high-good boundaries!¹⁸

Results are also presented in the diagrams on boundary bias (Figure 9).



Figure 9: Boundary bias expressed as class width equivalents per national method (diagram taken from Sheet *adj*)

4.2.6 Class agreement

Class agreement is the second component to check the comparability of national quality classifications (CIS, 2010). The spreadsheet calculates the **average absolute class difference** for each national method. This measure quantifies how far on average a national classification deviates from all other classifications when assessing a sample. The average absolute class difference must be smaller than 1.0.

To calculate class agreement the spreadsheet uses ordinal-scaled data¹⁹. The national classifications are computed in Sheets *class1* and *class2*. Class agreement is derived from pair-wise comparisons (classification of method A versus B, classification of method A versus C, ...) for each sample. Row 53 in **Sheet *adj*** specifies the average absolute class difference [ACD] according to the formula

$$ACD = (2 \cdot N_2 + 1 \cdot N_1) / N_{tot}$$

where N_x is the number of pair-wise comparisons differing by x classes, and N_{tot} is the total number of pair-wise comparisons.

¹⁸ This will avoid “pseudo”-harmonisation of the GM boundary by decreasing the width of the good class.

¹⁹ 1=high, 2=good, 3=moderate or worse - classes *moderate*, *poor* and *bad* lumped together

We advice to follow a “One out - all out” principle when judging acceptability of comparisons, i.e. for any method not meeting the criterion intercalibration has failed. Note that class agreement is tested after adjusting the boundary bias (i.e. boundary harmonisation).

5 References

Birk S, Willby NJ (2010) The definition of alternative benchmarks in intercalibration – outline of general procedure and case study on river macrophytes. Final report commissioned by JRC Ispra. Essen and Stirling.

CIS (Common Implementation Strategy) (2010) Guidance document on the intercalibration process 2008-2011. Guidance Document No. 14. Implementation Strategy for the Water Framework Directive (2000/60/EC). Brussels.

Willby NJ, Birk S (2010) Definition of comparability criteria for setting class boundaries - Outline of the procedure to compare and harmonise the national classifications of ecological status according to the WFD intercalibration exercise. Final report commissioned by JRC Ispra. Stirling and Essen.