Task 4.2.3 Cross-comparison of environmental assessments and pressures

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CONTENTS

1. Introduction

The aims of this task were to:

- Compare how different marine environmental assessment results relate to different environmental pressures;
- Assess the agreement between different marine environmental status assessments.

EU Water Framework Directive (WFD) and HELCOM HOLAS II assessments were used. HELCOM Baltic Sea Pressure Index (BSPI), Baltic Sea Impact Index (BSII), potential cumulative impacts on benthic habitats, physical disturbance or damage to seabed, and physical loss data layers were used as pressure inputs. Pearson rank correlation and ANOVA were used to statistically test the relationships between assessments and pressures.

2. Material & Methods

2.1. Status assessments

EU Water Framework Directive (WFD) and HELCOM HOLAS II assessment results were included in the analyses. The WFD assessment results data originated from national contact persons and the HOLAS II assessment results were downloaded from HELCOM Maps and Data Services portal (http://maps.helcom.fi/website/mapservice/). The WFD included the following assessment components:

- ecological status;
- physical-chemical status;
- chemical status;
- hydromorphological status;
- biological status;
- phytoplankton status;
- phytobenthos status;
- zoobenthos status.

The WFD assessment results were available for each country in a table format where each row represented one national assessment unit, i.e. coastal water body. The most recent available assessment data was used for each country and water body.

HOLAS II included the following assessment components:

- integrated eutrophication status assessment;
- integrated contamination status assessment;
- integrated biodiversity status assessment – benthic habitats;
- integrated biodiversity status assessment – pelagic habitats;

- integrated biodiversity status assessment – fish;
- integrated biodiversity status assessment – seals.

EU Habitats Directive assessments were not usable in this exercise because a single conservation status class is assigned to the whole national marine area, *i.e.* the whole national sea area serves as the assessment unit. This means that there were no spatial assessment units that could be used in the analyses.

2.2. Pressures

The following pressure and impact datasets were used:

- Baltic Sea Pressure Index (BSPI);
- Baltic Sea Impact Index (BSII);
- Potential cumulative impacts on benthic habitats;
- Physical disturbance or damage to seabed (temporary or reversible effects);
- Physical loss (permanent effects on the seabed).

All datasets originated from HELCOM Maps and Data Services portal.

2.3. Data analysis

2.3.1. Data preparation

The HELCOM HOLAS II assessment results and pressure datasets were available as georeferenced layers in geographical information system (GIS). The WFD assessment results were available in a table format with identification column that enabled to join the assessment results with national GIS layers of coastal water bodies. All GIS data were in ETRS 1989 LAEA coordinate system that is the official coordinate system of EU. The spatial extent of the input data for the analyses included only the marine waters of Sweden, Finland, and Estonia. All input data of assessment results and pressures were compiled using the 1 km European Environmental Agency grid (hereafter "EEA grid"). The values of all assessment results and pressures were extracted for each EEA grid cell (n = 282604) and this data set served as the main input for further analyses. For cross-comparison of WFD assessment results, an additional WFD water body based data set was used where one row represented a single water body (n = 883).

The WFD assessment results had either five or two status classes. The results that were in five classes were converted to two classes for assessing the agreement between different assessments. The conversion from five classes to two classes was done by assigning "1" to all classes below "good-moderate" boundary and "2" to all classes above "good-moderate" boundary. All statuses and the respective classes are shown in table 2.3.1.1.

Table 2.3.1.1. WFD and HOLAS II assessment components and status classes. Ordinal numeric value of original status class is shown in brackets.

Assessment	Original status classes	Binary numeric status classes
WFD ecological status, physical-chemical status, hydromorphological, biological status, phytoplankton status, phytobenthos status, zoobenthos status	high (5)	2
	good (4)	2
	moderate (3)	1
	poor (2)	1
	bad (1)	1
WFD chemical status	good (2)	2
	fail (1)	1
HOLAS II eutrophication status biodiversity status – benthic habitats biodiversity status – pelagic habitats biodiversity status – fish biodiversity status – seals	good (2)	2
	not good (1)	1
HOLAS II contamination status	low (1-2)	2 (not present in data)
	high (3-5)	1

2.3.2. Statistical methods

ANOVA followed by Tukey post-hoc pairwise tests were used to test for differences in the pressures between the levels of status classes. The results were illustrated with boxplots and letter codes after the status level labels; levels are significantly different if they do not have any letters in common. The EEA grid based data was used as an input. The analyses included four subsets of data:

- Pooled data ("se, fi, ee") included data points from all countries (n = 282604);
- Only Sweden ("se") (n = 158436);
- Only Finland ("fi") (n = 86140);
- Only Estonia ("ee") (n = 38028).

The agreement between different assessments was tested using Spearman's rank correlation. Ordinal numeric integer values of assessment results in the EEA grid were used an input (see table 2.3.1.1). Additional cross-comparison of only WFD assessment results were done on the WFD coastal water body level (n = 883). Analyses on the full data set and for each country separately were carried out as described in the previous paragraph.

The percentage agreement between different assessment was also calculated based on EEA grid. All assessment results were binarized, *i.e.* converted to two classes (see Table 2.3.1.1.) and then the agreement (%) of statuses were calculated. The results were visualized on a map.

The workflow of all analyses is shown on Figure 2.3.2.1.

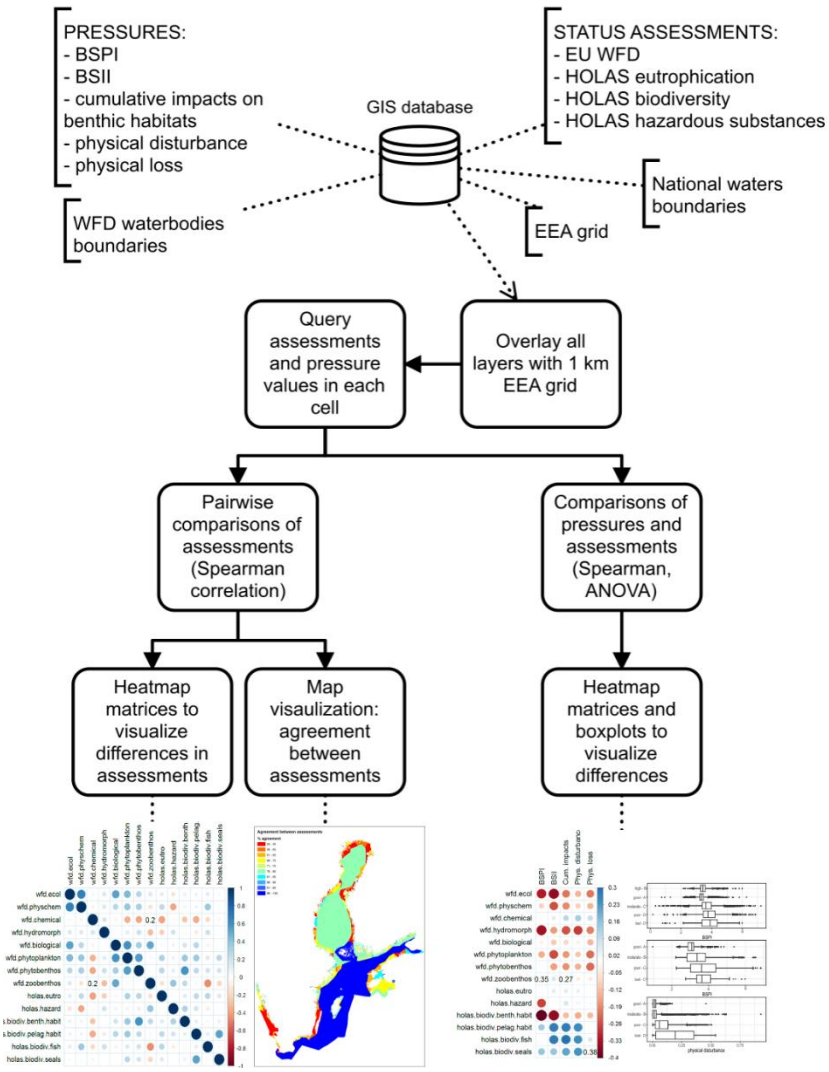


Figure 2.3.2.1. General workflow of the data analyses.

3. Results

3.1. Differences in the pressures between the levels of status classes

With only a few exceptions, all status assessments were statistically significantly correlated to pressures (Figure 3.1.1). In the pooled data (**se, fi, ee**), the WFD assessment results were negatively correlated with pressures except the chemical status that was positively correlated with pressures. The correlations were low or non-significant in WFD zoobenthos. Among HOLAS assessments, the benthic habitat status negatively correlated with pressures while the other HOLAS statuses had mostly no or positive correlations with pressures. The Swedish data (**se**) mainly differed from pooled data by lower or negative correlations between WFD biological, phytoplankton and phytobenthos statuses and pressures. The positive correlation between WFD zoobenthos status and pressures was the most notable difference in Finnish (**fi**) data and positive correlation between WFD phytobenthos and pressures in Estonian (**ee**) data (Figure 3.1.1).

More detailed information on the relationships between status classes and pressures is presented using boxplots and ANOVA tests in Appendix 1 (WFD vs pressures) and Appendix 2 (HOLAS vs pressures).

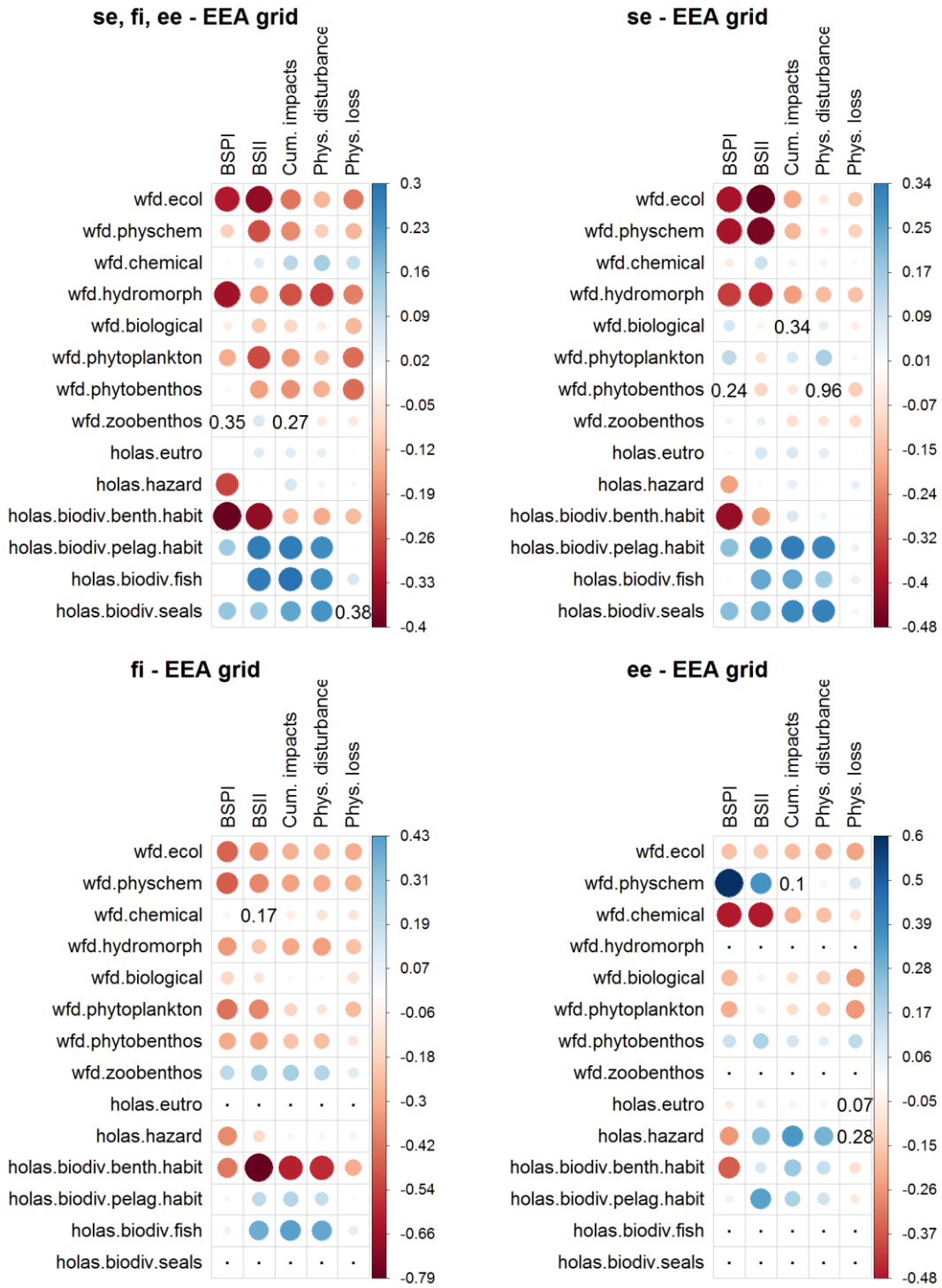


Figure 3.1.1. Correlations between assessments (vertical axis) and pressures (horizontal axis). Colors and circle diameters signify the Spearman rank correlation coefficients. Numbers show the p-values in cases where p > 0.05. Dots represent cases where data was not available or there was no variation in the data. Negative correlations show that higher (better) status is related to lower pressures. Positive correlations show that higher (better) status is related to higher pressures.

3.2. Agreement between different assessments

Status assessment results were statistically significantly correlated with each other with only a single exception of WFD chemical status and WFD zoobenthos status that were not correlated in the EEA grid based pooled data (**se, fi, ee**) (Figure 3.2.1). The correlations were mainly positive, i.e. higher

(better) status of one assessment corresponded to higher (better) status of the other assessment. However, there were some negative correlations that were mainly related to the WFD chemical status (Figure 3.2.1). In Swedish data (**se**), the WFD hydromorphological status exhibited many negative correlations with the other assessments. WFD phytobenthos and WFD zoobenthos assessment showed contrary results in Finnish (**fi**) data.

WFD waterbody based data revealed that only chemical status assessment had negative correlations with some of the other WFD assessments in the pooled (**se, fi, ee**) and Swedish data (**se**) (Figure 3.2.2). Similarly to the EEA grid based data, the WFD zoobenthos and phytobenthos assessments correlated negatively in the WFD waterbody based Finnish (**fi**) data. Furthermore, Finnish WFD phytobenthos assessment did not have any other statistically significant correlations with the other WFD assessments (Figure 3.2.2).

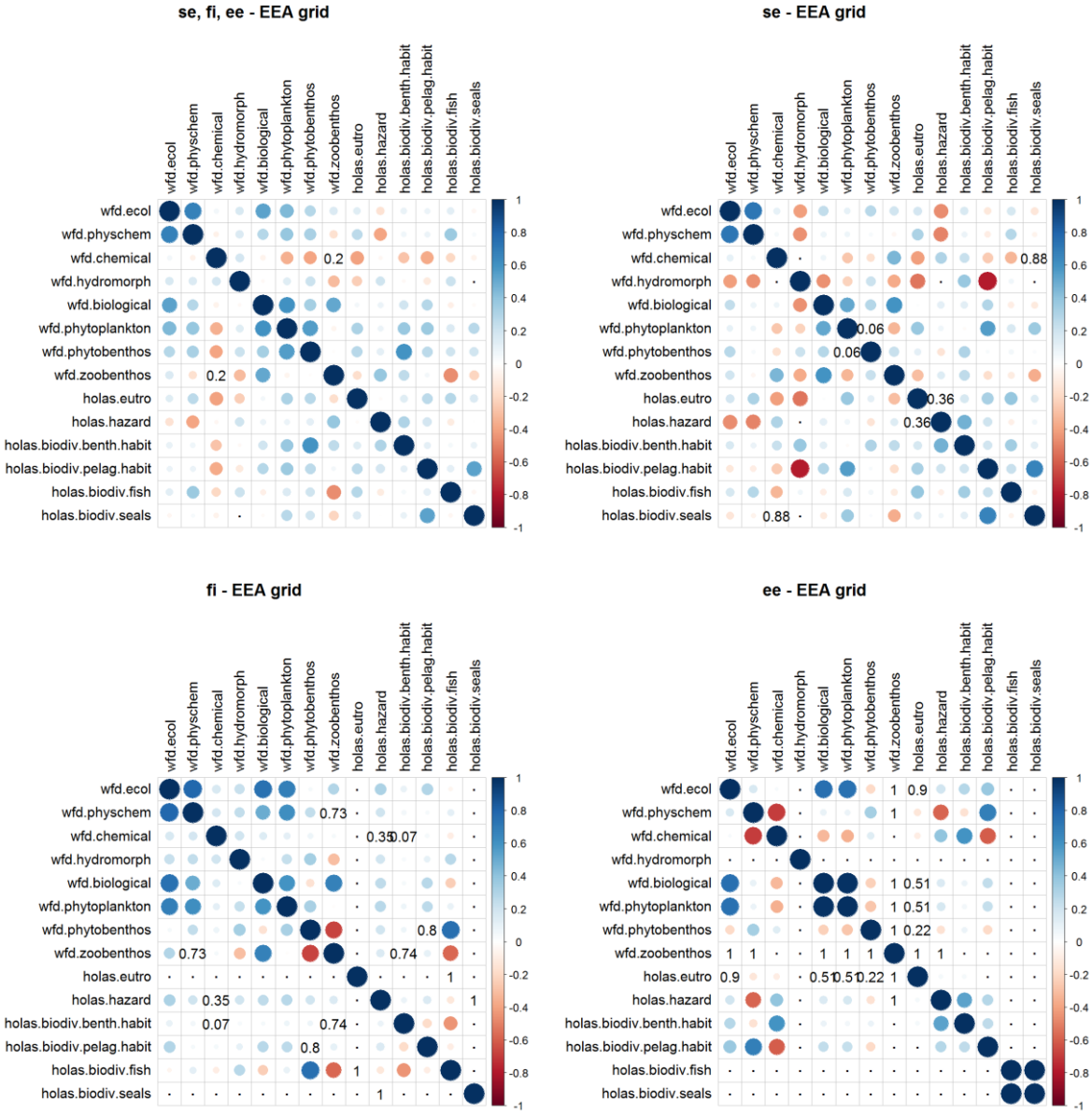


Figure 3.2.1. Correlations between assessments based on EEA grid. Colors and circle diameters signify the Spearman rank correlation coefficients. Numbers show the p-values in cases where p > 0.05. Dots represent cases where data was not available or there was no variation in the data. Positive correlations show that higher (better) status of one assessment corresponds to higher (better) status in the other assessment. Negative correlations show that higher (better) status in one assessment corresponds to lower (worse) status in the other assessment.

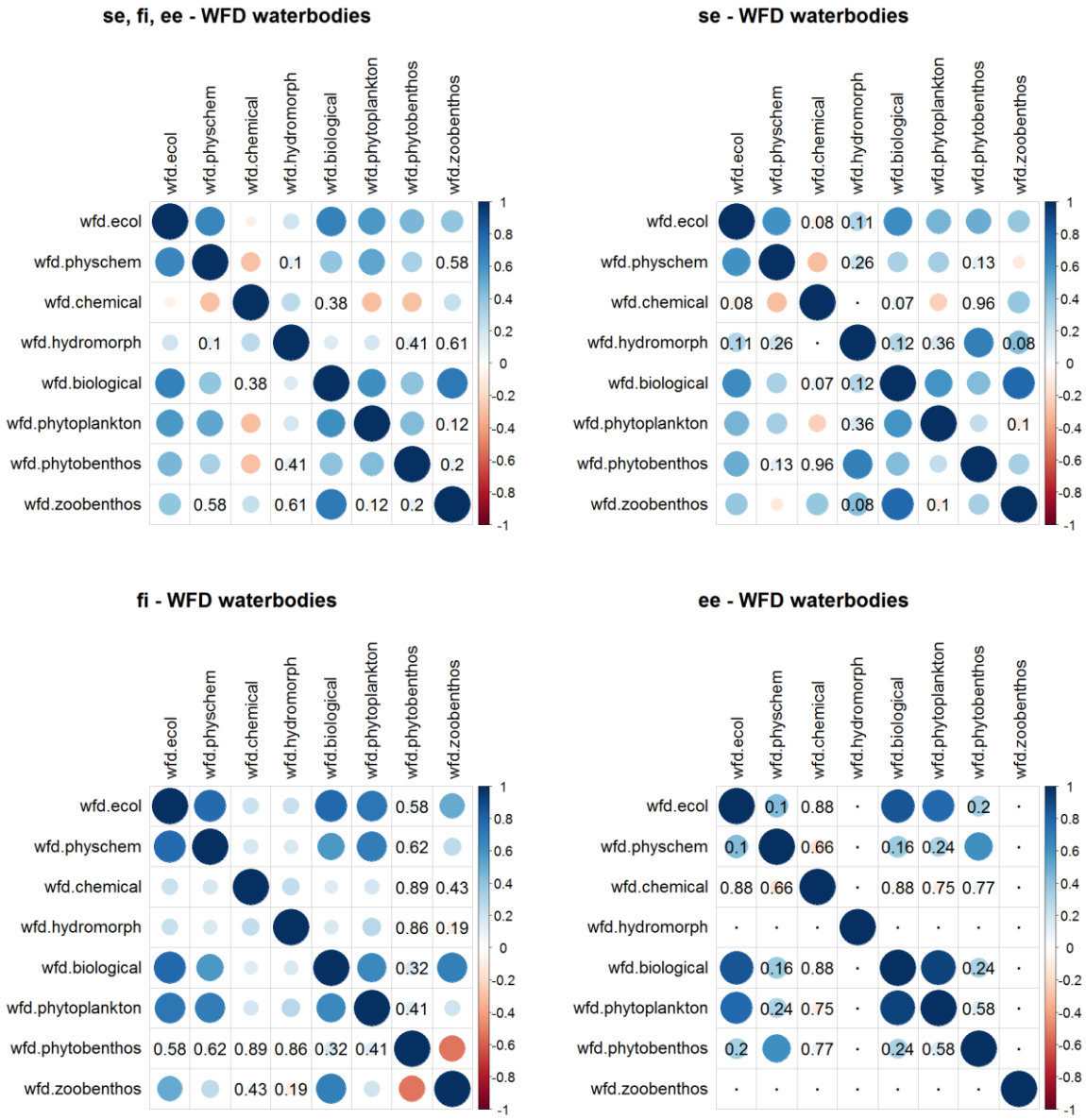


Figure 3.2.2. Correlations between WFD assessments based on WFD waterbodies. Colors and circle diameters signify the Spearman rank correlation coefficients. Numbers show the p-values in cases where p > 0.05. Dots represent cases where data was not available or there was no variation in the data. Positive correlations show that higher (better) status of one assessment corresponds to higher (better) status in the other assessment. Negative correlations show that higher (better) status in one assessment corresponds to lower (worse) status in the other assessment.

The mean agreement of different status assessments was generally over 80% when all EEA grid cells were considered (Figure 3.2.3). The mean agreement values were lower, especially in Estonia, when EEA grid cells from inside the WFD waterbodies were included (Figure 3.2.3).

The spatial representation of the agreement between different assessments is shown in Figure 3.2.4.

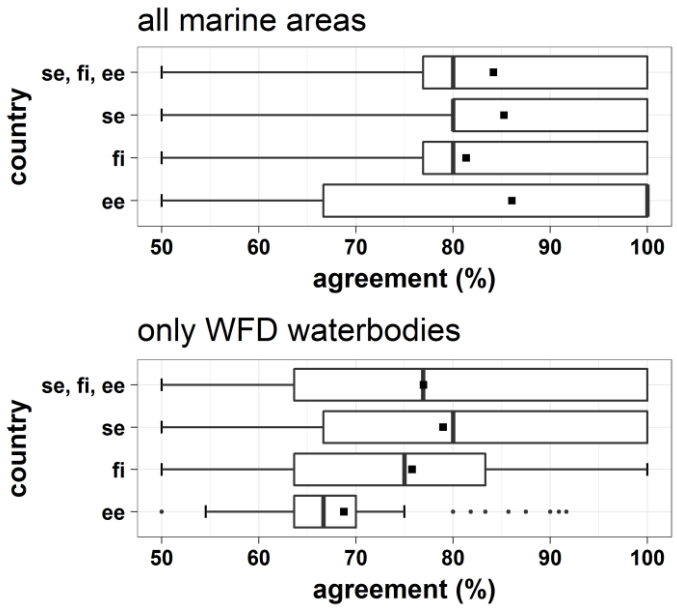


Figure 3.2.3. Boxplots showing the distribution of agreement values between different assessment results in pooled data (se, fi, ee) and in each country. The upper graph represents data from all EEA grid cells and the lower one includes EEA grid cells only from inside the WFD waterbodies. Small rectangles represent means.

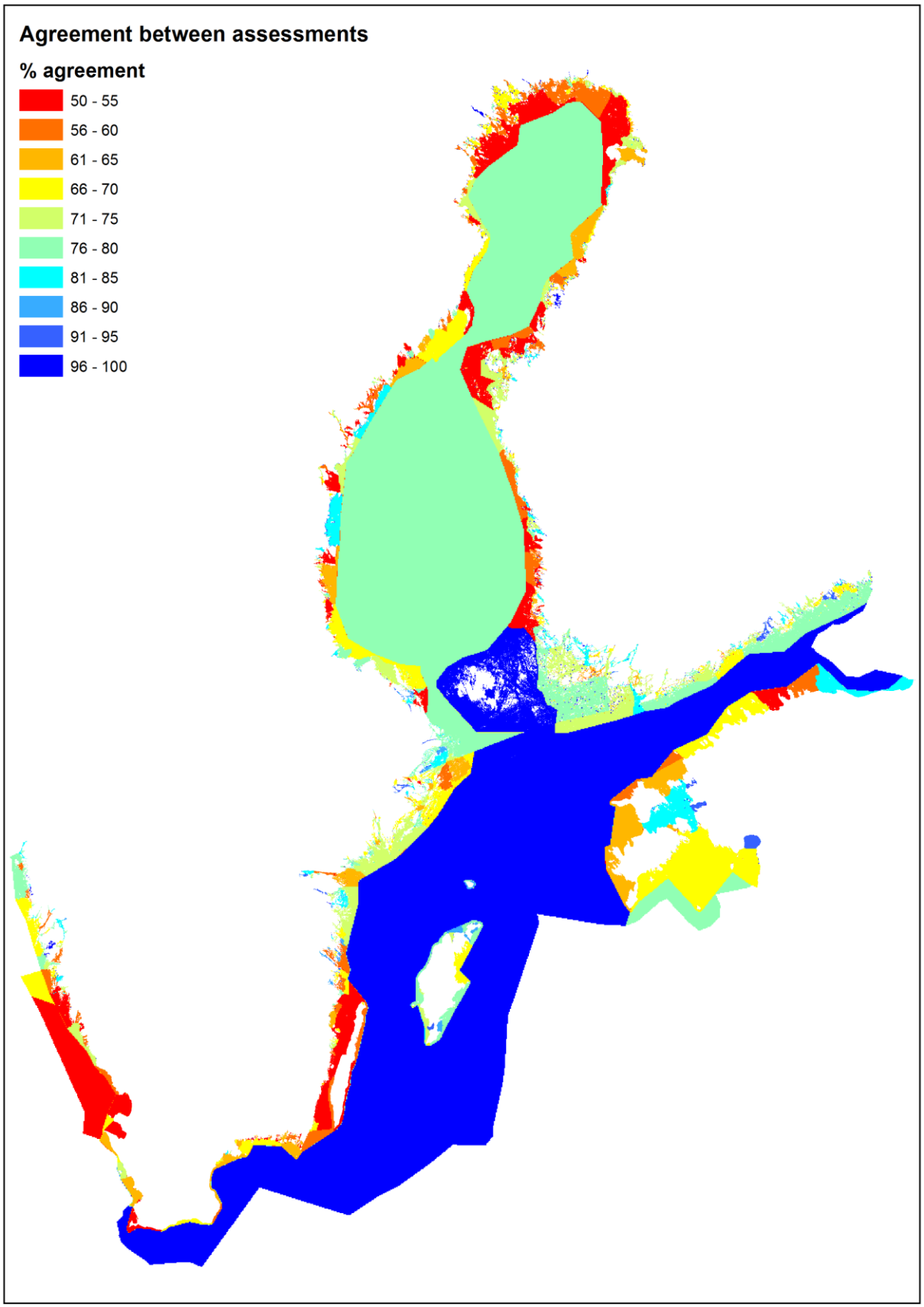
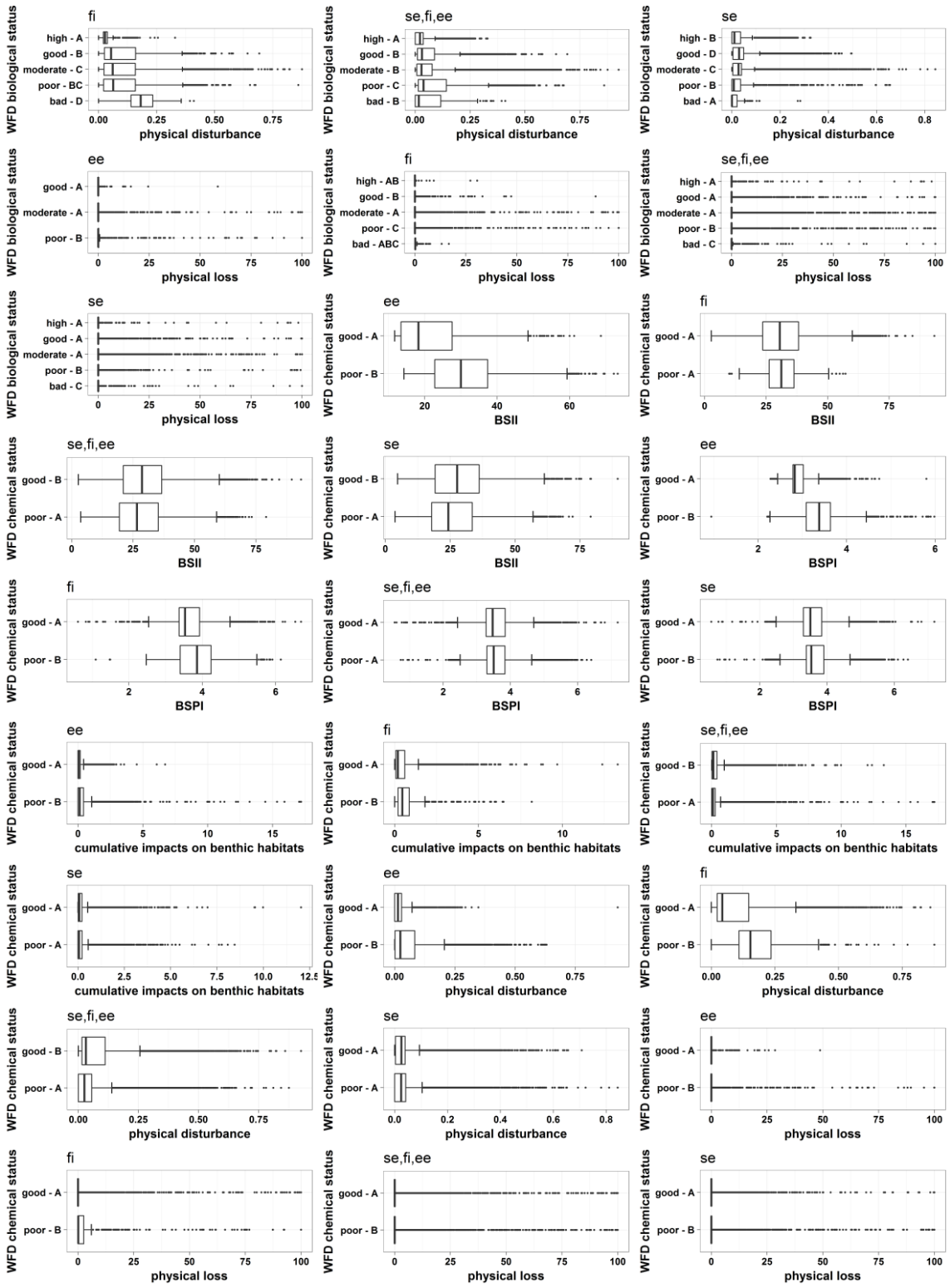
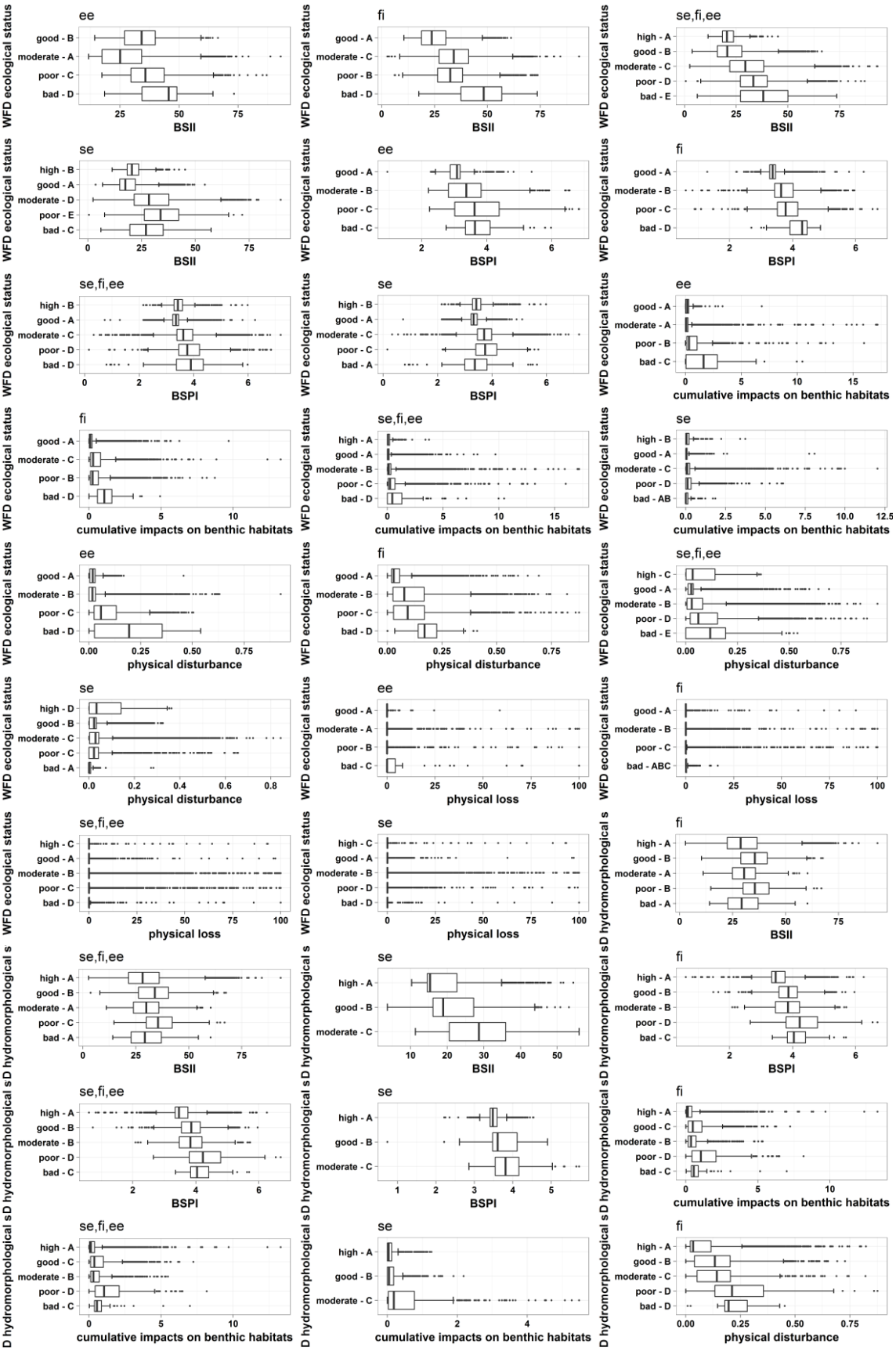


Figure 3.2.4. Map of agreement of different assessment results.

Appendix 1. WFD assessments versus pressures

Letters after status class names indicate the results of pairwise post-hoc tests: levels are significantly different if they do not have any letters in common.




ee
WFD ecological status
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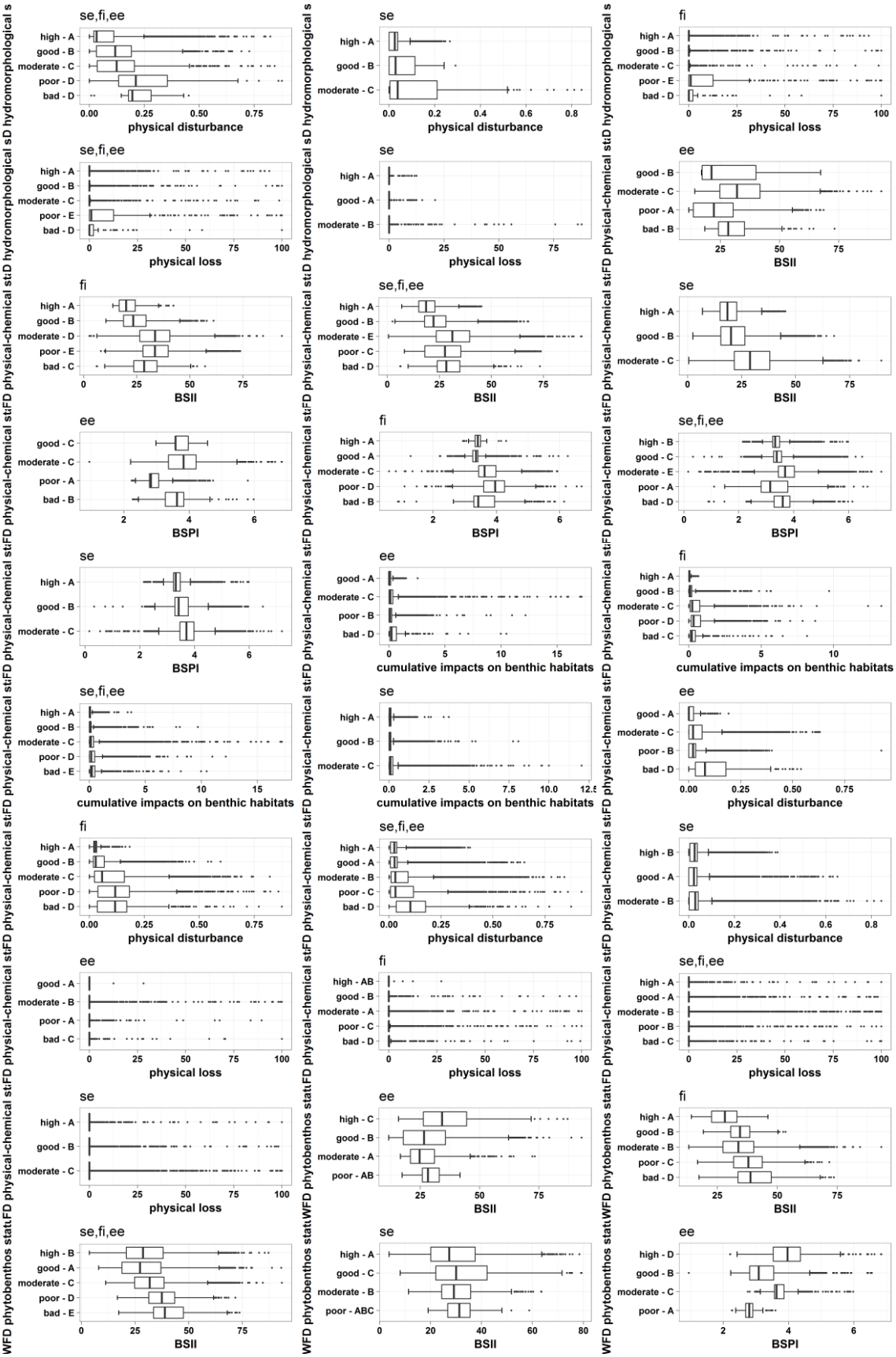
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moderate - C
BSII
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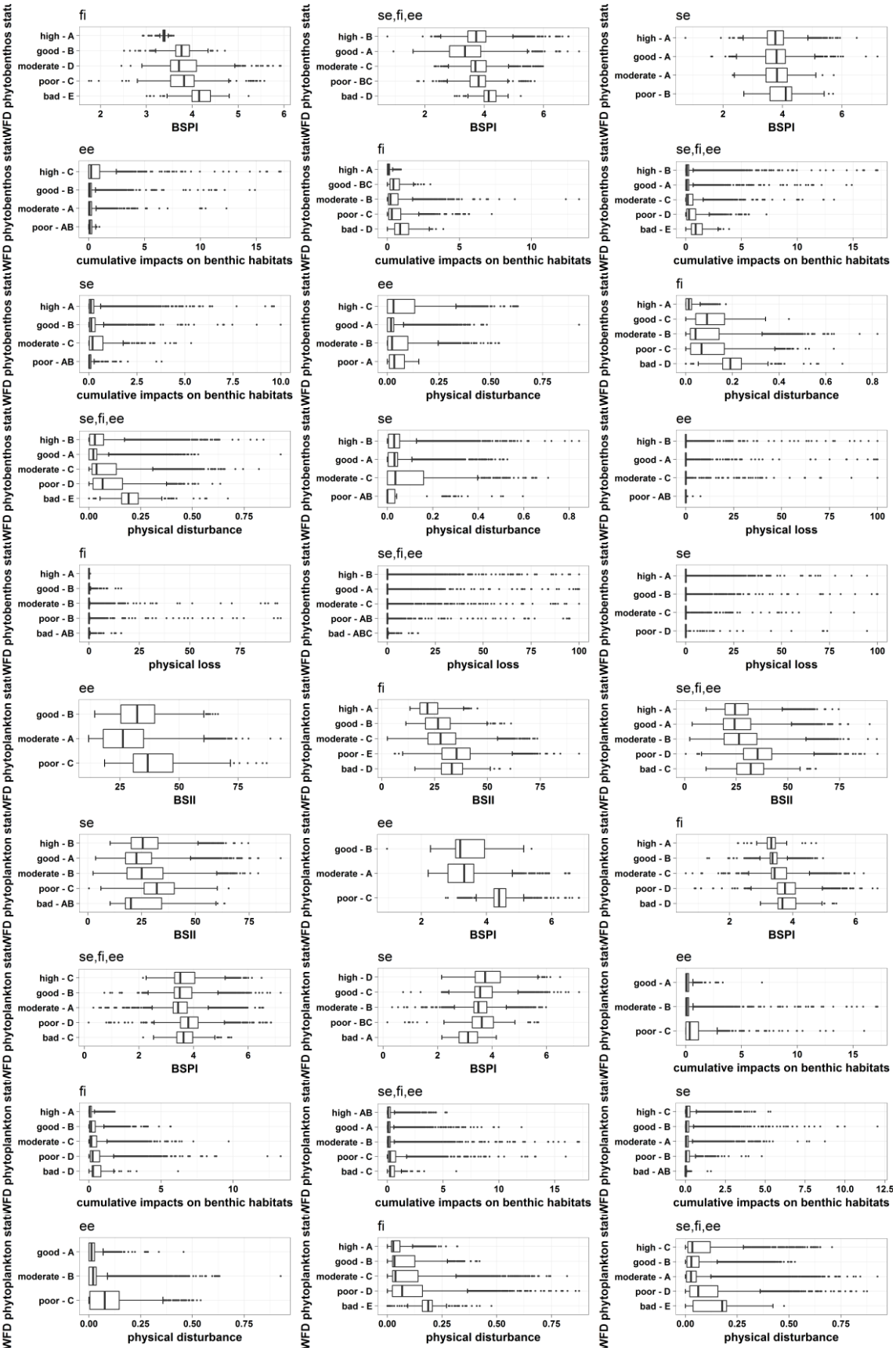
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cumulative impacts on benthic habitats
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poor - A
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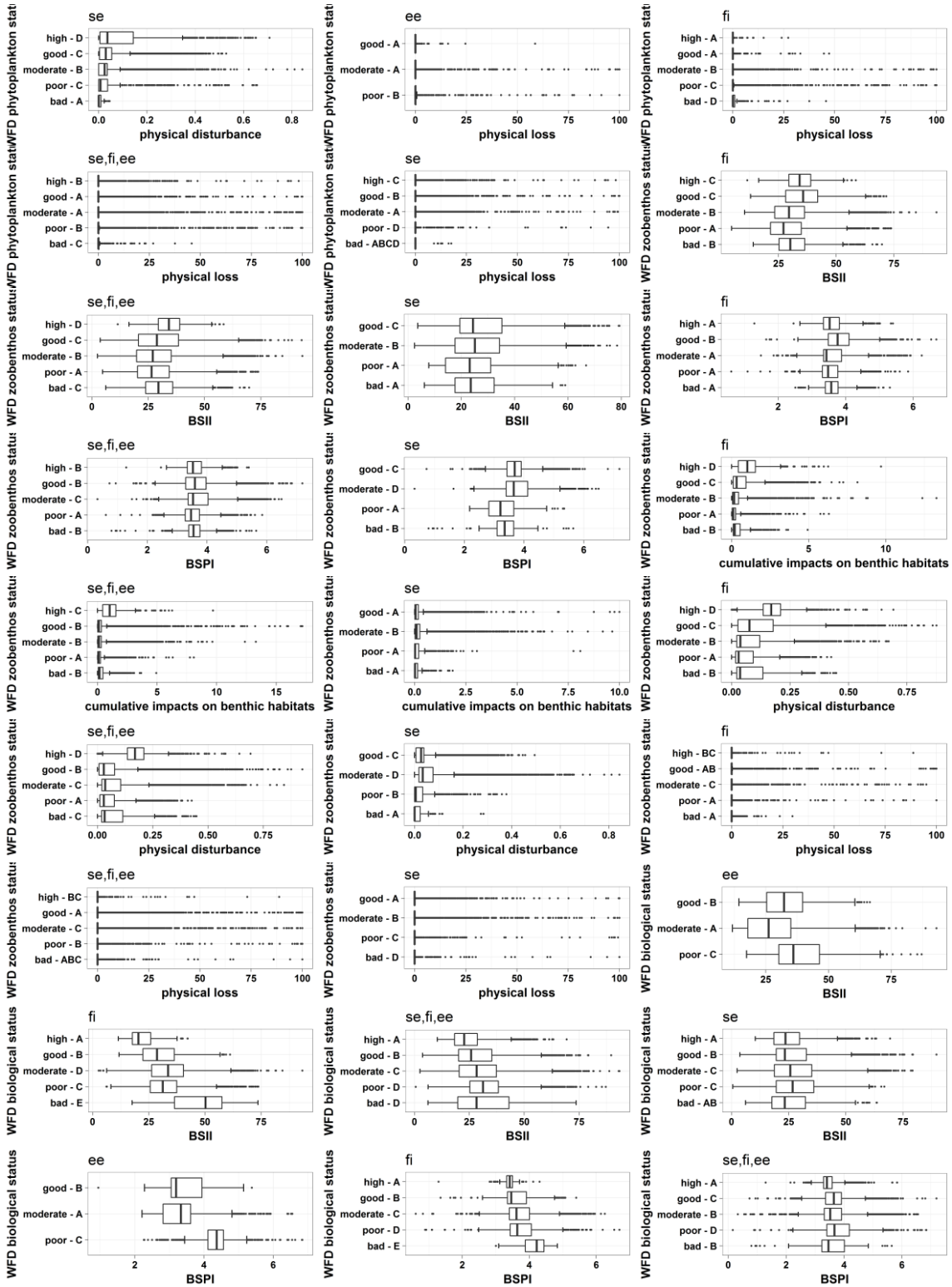
WFD phytoplankton status
WFD zoobenthos status
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cumulative impacts on benthic habitats
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physical disturbance
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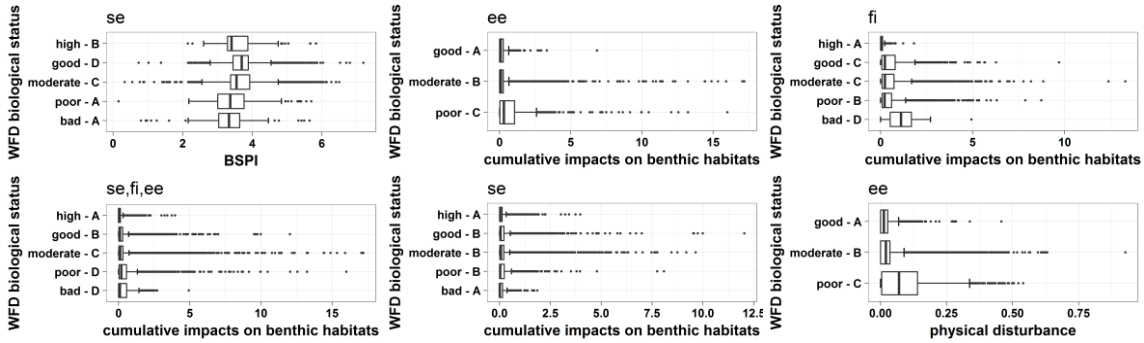
se
WFD biological status
high - B
good - D
moderate - C
poor - A
bad - A
0
2
4
6
BSPI
ee
WFD biological status
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cumulative impacts on benthic habitats
fi
WFD biological status
high - A
good - C
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bad - D
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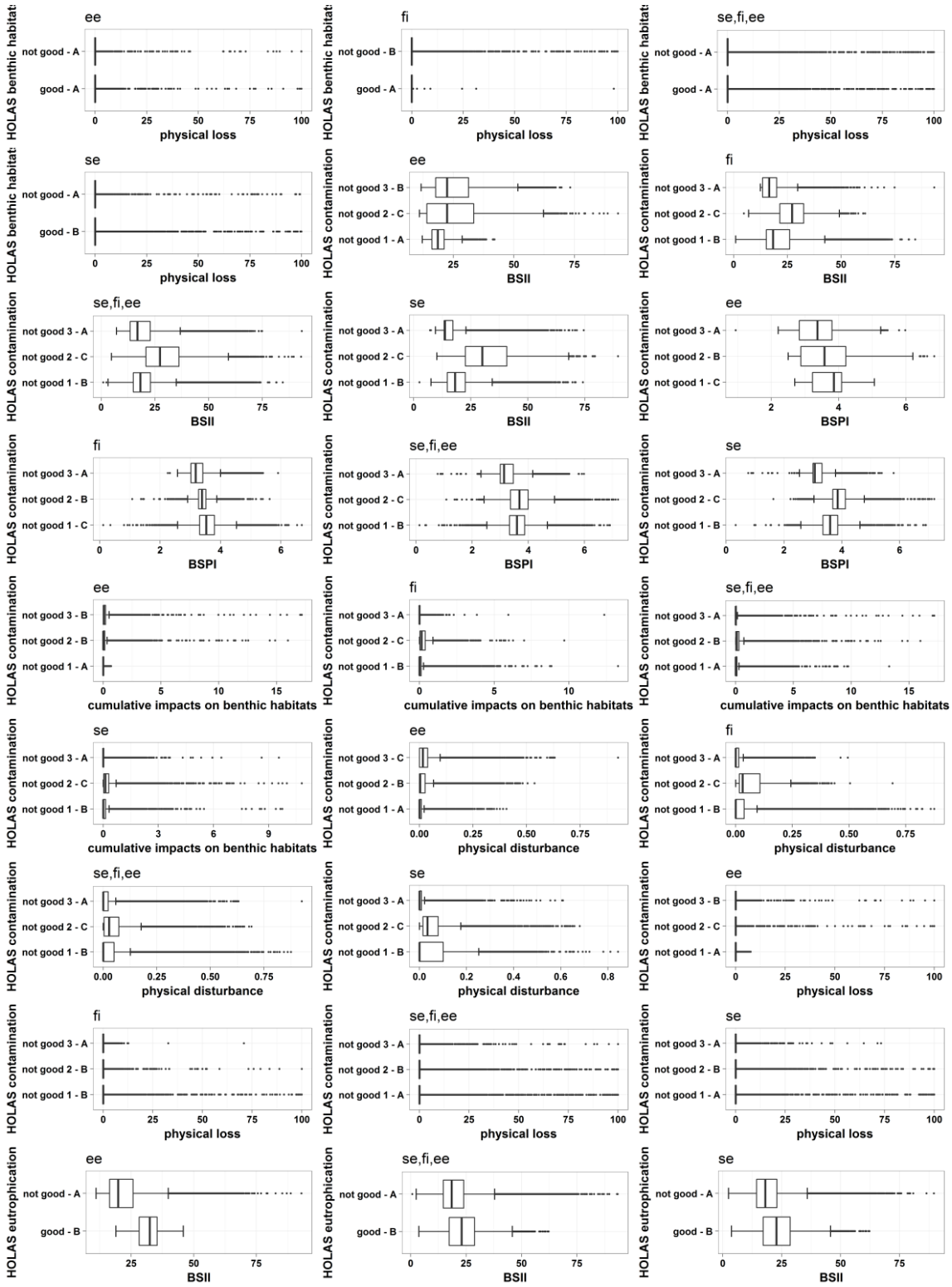
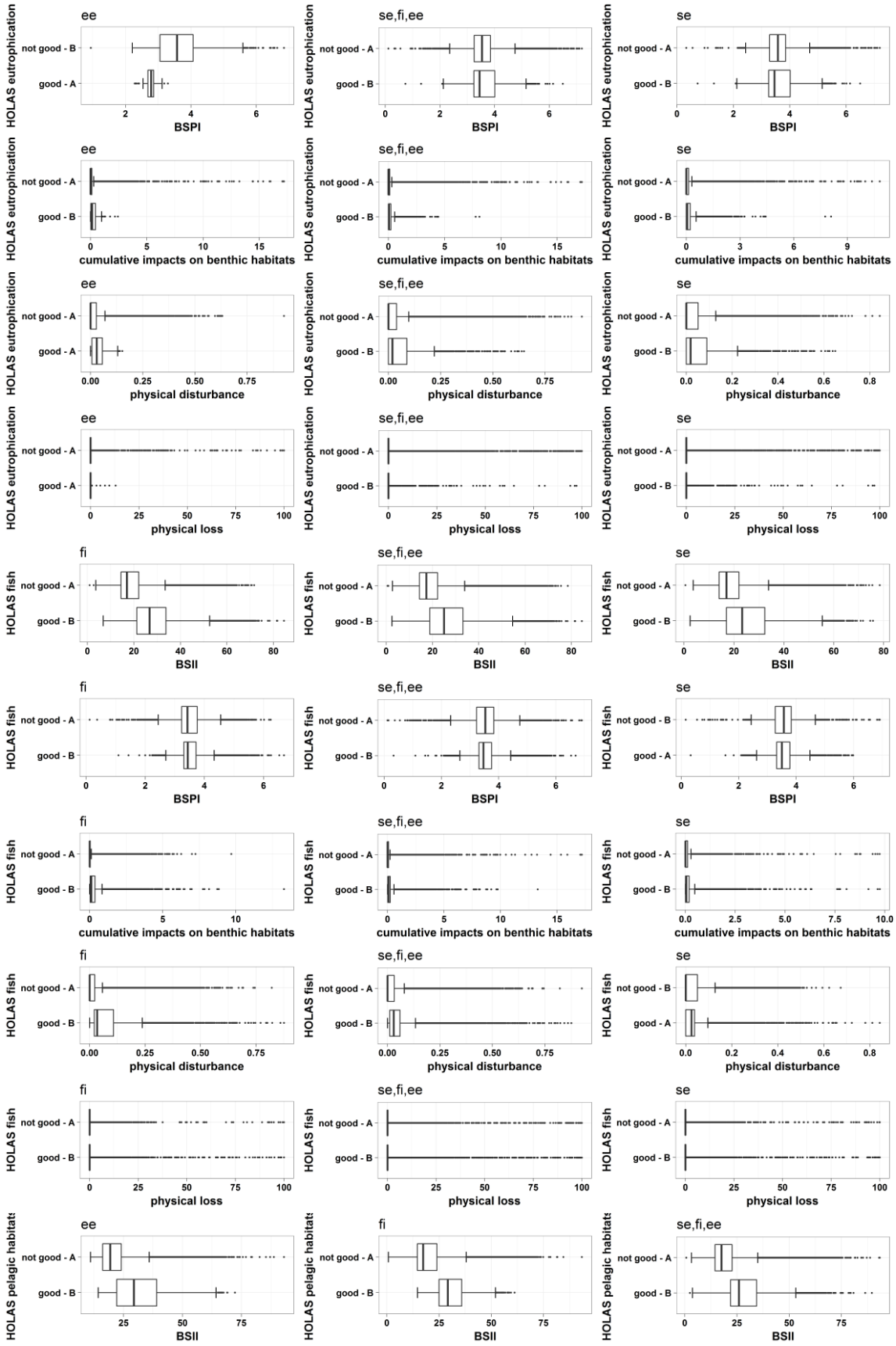
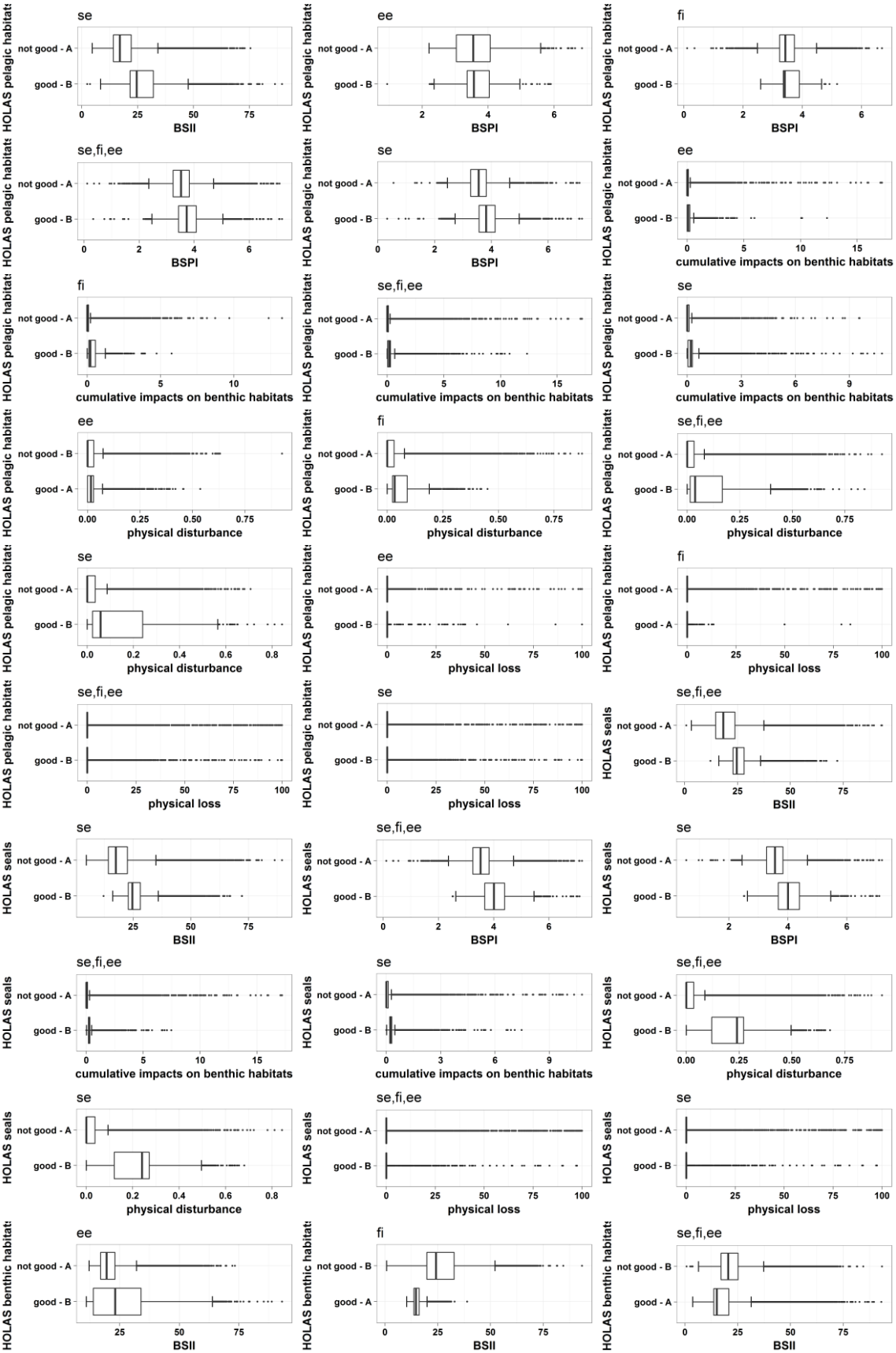
10
cumulative impacts on benthic habitats
se,fi,ee
WFD biological status
high - A
good - B
moderate - C
poor - D
bad - D
0
5
10
15
cumulative impacts on benthic habitats
se
WFD biological status
high - A
good - B
moderate - B
poor - B
bad - A
0.0
2.5
5.0
7.5
10.0
cumulative impacts on benthic habitats
ee
WFD biological status
good - A
moderate - B
poor - C
0.00
0.25
0.50
0.75
physical disturbance

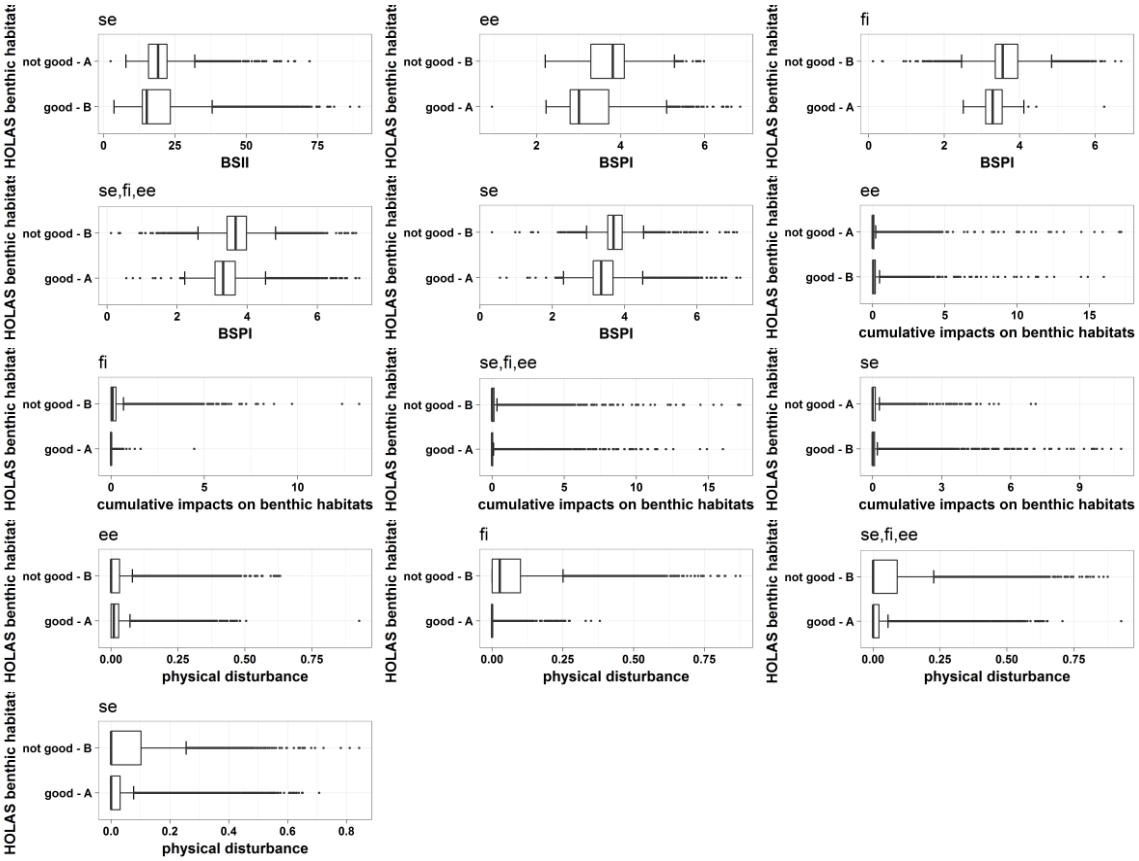
Appendix 2. HOLAS assessments versus pressures

Letters after status class names indicate the results of pairwise post-hoc tests: levels are significantly different if they do not have any letters in common.




ee
se,fi,ee
se
fi
HOLAS eutrophication
HOLAS fish
HOLAS pelagic habitats
not good - A
not good - B
good - A
good - B
BSPI
cumulative impacts on benthic habitats
physical disturbance
physical loss
BSII


HOLAS pelagic habitats
HOLAS benthic habitats
HOLAS seals
se
ee
fi
se,fi,ee
not good - A
not good - B
good - A
good - B
BSII
BSPI
cumulative impacts on benthic habitats
physical disturbance
physical loss


HOLAS benthic habitats
se
not good - A
good - B
BSII
se,fi,ee
BSPI
fi
cumulative impacts on benthic habitats
ee
physical disturbance
ee
se
se,fi,ee
fi
se
not good - B
good - A
BSPI
cumulative impacts on benthic habitats
physical disturbance
fi
ee
se
se,fi,ee
cumulative impacts on benthic habitats
physical disturbance