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Quality Assurance of the German Marine Monitoring Programme: The Quality Assurance Panel and Inter-laboratory Comparisons

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INTRODUCTION

Analytical data are collected on a large scale as part of the national German Marine Monitoring Programme of the North Sea and the Baltic Sea (GMMP) as well as within international monitoring programmes (Oslo-Paris-Convention, Helsinki-Convention, EU Water Framework Directive) for surveying the current status of the marine environment. In 1997 an agreement was concluded between the German Federal Government and the coastal Federal States Hamburg, Mecklenburg-Western Pomerania, Lower Saxony and Schleswig-Holstein to collaborate in the supervision of the marine environment. This commitment specifies a common marine monitoring strategy taking account competences shared between the Federal Government and the coastal Federal States.

In this context, a study group (ARGE BLMP) was established and several working groups (WG North Sea, WG Baltic Sea, WG Water Framework Directive and WG Quality Assurance) were established, which are responsible for specific monitoring programmes and the assessment of data. In 2007, the GMMP was restructured to improve the collaboration between the German Working Group on Water Issues of the Federal States and the Federal Government (LAWA), the German Working Group on Nature Conservation, Landscape Conservation and Rest (LANA) and the before mentioned Working Groups of the GMMP. A newly established Steering Group “Expert Group Sea” took over the central steering function within the GMMP. The former working groups WG North Sea, WG Baltic Sea and WG Water Framework Directive merged into a new working group WG Measurement and Assessment (WG ErBe), the WG Quality Assurance is continuing and a WG Data Management was founded (see Fig. 1).

The Quality Assurance Panel regularly organises inter-laboratory comparisons for biological parameters like phytoplankton, chlorophyll a, zooplankton and macrozoobenthos (see Table 2). Participation in these comparisons is mandatory for all laboratories involved in the GMMP. The aim of these activities is to check and improve the quality of the marine monitoring data as well as to optimise statistical methods for data assessment. Results from a phytoplankton inter-laboratory comparison are presented below as a case study.

The Quality Assurance Panel

Quality assurance is defined as part of a quality management focussing on providing confidence that quality requirements will be fulfilled and includes all attempts of a laboratory to ensure that data meet these requirements. Quality Assurance includes internal as well as external arrangements (see Fig. 2).

A high scientific quality and comparability of measuring results is assured by the Quality Assurance Panel at the Federal Environment Agency in co-ordination with the WG Quality Assurance.

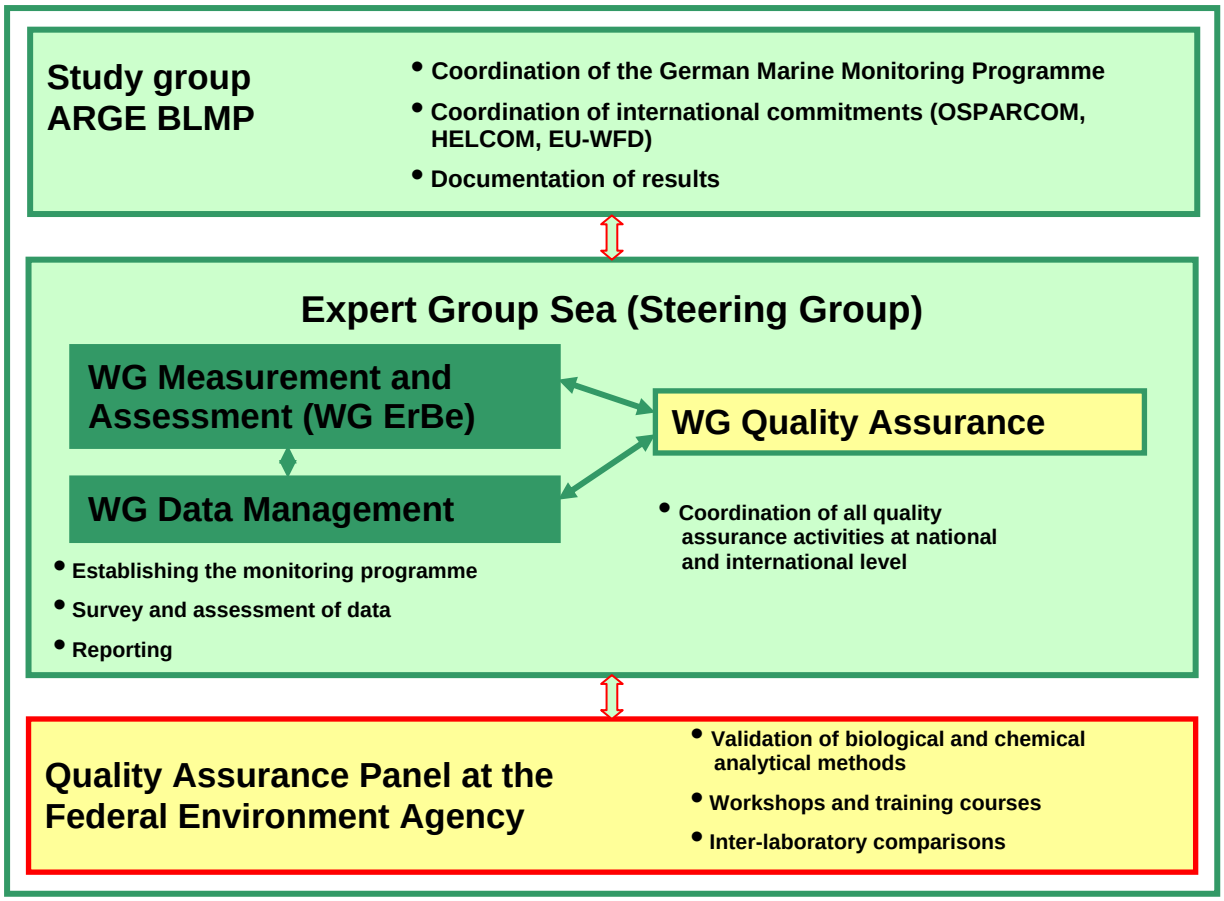

Fig. 1. Scheme of the organisation of the German Marine Monitoring Programme (GMMP).

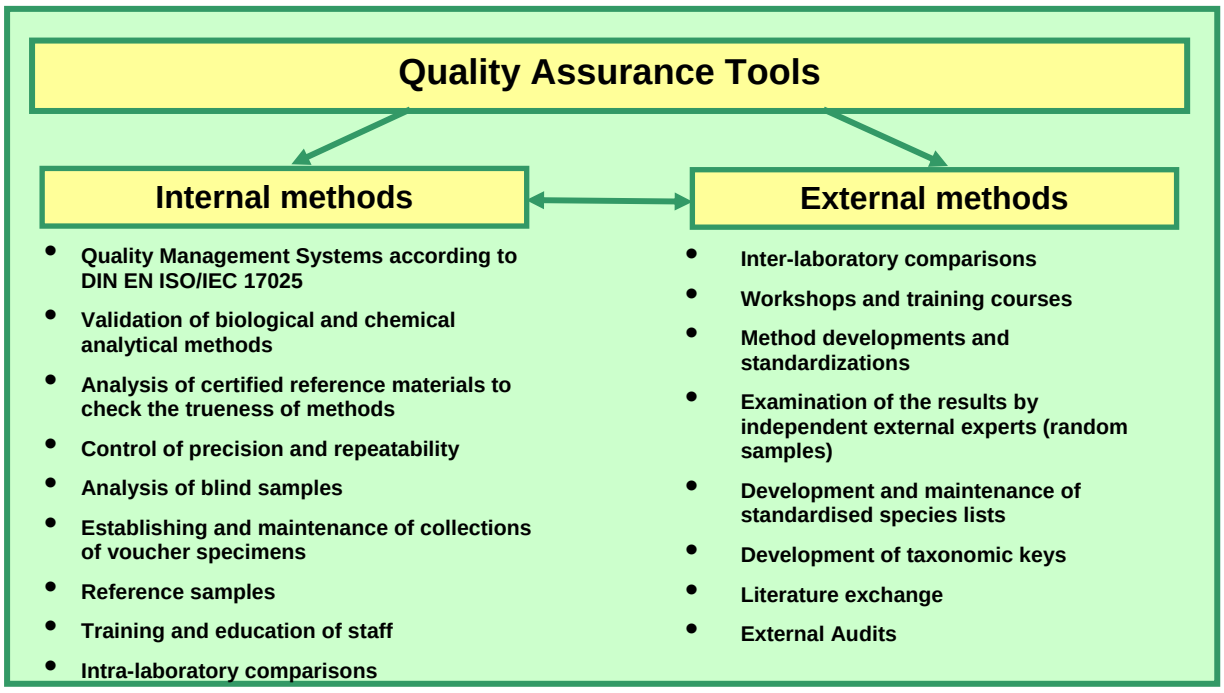

Fig. 2. Overview of internal and external quality assurance tools.

The tasks of the Quality Assurance Panel comprise in particular:

1. Development and updating of a quality assurance programme for biological and chemical measurements;

2. Coordination of the external quality assurance in close collaboration with the institutions involved in the marine monitoring programme;
3. Organisation and realisation of inter-laboratory comparisons, training courses and workshops;
4. Supporting the introduction of Quality Management Systems according to DIN EN ISO/IEC 17025;
5. Initiation of the development and standardisation of methods as well as assessment and validation of analytical methods;
6. Coordination of quality assurance activities at international and national levels.

Basis for all biological and chemical investigations is the implementation of the Quality Management Systems according to DIN EN ISO/IEC 17025 in each laboratory which performs measurements within the GMMP. Such a quality management system includes, for example, the qualifications of the staff, the equipment of the laboratory, correct validation and documentation of analytical procedures for own control and for data exchange. In addition, measures of external quality assurance have to be taken, e.g. participation in national and international inter-laboratory comparisons and workshops on the harmonisation of the applied procedures in order to contribute to the correctness and comparability of biological and chemical data. Table 1 and 2 give an overview of workshops and inter-laboratory comparisons within the GMMP since the founding of the Quality Assurance Panel in 1999.

Table 1. Workshops and training courses for biological parameters organised by the Quality Assurance Panel.

Parameter	Year	Topic
Macrozoobenthos	1998	Polychaeta
	1998	Amphipoda
	2004	Mollusca, Polychaeta, Oligochaeta
Macrophytobenthos	2001	Taxonomy of marine macrophytes and their importance for monitoring in the context of international marine conventions
	2005	Methods of the monitoring of marine macrophytes within the context of the BLMP and the Water Framework Directive including identification exercises part 1: Hard bottom monitoring part 2: Soft bottom monitoring
Phytoplankton	1998	Small naked flagellates
	1998	Species that are difficult to identify
	2000	Taxonomy of Cyanobacteria und coccal green algae and their distribution in the Baltic Sea
	2003	Identification and taxonomy of marine dinoflagellates
	2007	Identification and taxonomy of marine diatoms

Today, it is nationally and internationally accepted that assurance and documentation of data quality of biological investigations also can no longer be neglected. In future, data will be accepted only when they are accompanied by suitable quality assurance measures.

In addition, the Quality Assurance Panel at the Federal Environment Agency makes important contributions to the improvement of data quality within the GMMP by giving qualified advice to laboratories, by supporting the harmonisation of the methods used, by organising and evaluating inter-laboratory comparisons, by offering workshops and training courses as well as by acting as a national and international contact point for questions concerning quality assurance.

The Case Study: Phytoplankton Inter-laboratory Comparison

The presented results of a phytoplankton inter-laboratory comparison, completed in 2001, were intended to evaluate the process of analysing phytoplankton samples by Utermöhl technique excluding sampling and biomass determination. For this purpose, a set of phytoplankton samples was prepared from natural phytoplankton taken from the North Sea.

The aim of the study was to test whether the laboratories were able to correctly identify the phytoplankton taxa. At the same time the laboratories' counting accuracy was checked. Furthermore, the study aimed at detecting those species, which caused most problems in correct identification.

Table 2. Inter-laboratory comparisons for biological parameters organised by the Quality Assurance Panel.

Year	Topics of inter-laboratory comparisons	Number of participants
1999	Identification and counting of four selected phytoplankton species from cultured algae	10
1999	Identification of 20 selected phytoplankton species of the North Sea and the Baltic Sea via photographs	10
2000	Identification of 25 selected macrozoobenthos species	11
2001	Identification of 30 selected macrozoobenthos species	15
2001	Identification of species and their abundance in a natural phytoplankton sample from the North Sea	11
2002	Determination of chlorophyll a with different methods	11
2004	Identification of macrozoobenthos species in a artificial semi-natural sample	16
2007	Inter-laboratory comparison of zooplankton analysis (Baltic Sea)	26
2007	Inter-laboratory comparison of phytoplankton analysis (Baltic Sea)	28

MATERIAL & METHODS

A set of 30 natural phytoplankton samples were prepared by a reference laboratory (Research and Technology Centre, University of Kiel). The phytoplankton was collected in spring (03 June 1998) from the North Sea (Büsum Mole), fixed with Lugol's iodine solution (15 g KJ + 10 g J_2 in 500 ml distilled water) and divided into 30 sub-samples. Five randomly selected sub-samples were used to carry out a homogeneity check for selected species *(Guinardia delicatula* (Cleve) Hasle, *Lauderia annulata* Cleve, *Detonula pumila* (Castrac.) Gran, *Eucampia zodiacus* Ehrenb., and *Thalassiosira rotula* Meunier) by counting 7 x 1 ml sub-samples. The results of an ANOVA showed that the samples were homogeneous.

For data analysis the Q-method combined with an estimator according to Huber was used. The assessment of results was based on standardised deviations of laboratory values from the assigned value (target value), which are measured by so-called *Z*-scores [= (analysis result – target value)/standard deviation]. If the analysis results were normally distributed, the probability of the absolute value of the *Z*-score not exceeding a value of 2 would be approximately 95 %. Therefore, a *Z*-score of 2 is usually fixed as quality limit and thus, the tolerance limit in this inter-laboratory comparison was set to two. Due to substantial variability (over 25 %), the *Z*-scores in this study were replaced by Z_u-scores. Z_u-scores are corrected *Z*-scores based on an asymmetrical tolerance interval which guarantees that the lower tolerance limits will never be negative. The Z_u -scores were computed using the software ProLab 2000. Z_u-Score were calculated only if a species was found at least by 6 participants. 11 participants from Germany and Denmark took part in this inter-laboratory comparison.

RESULTS

In order to be able to perform a comparative evaluation, the different taxa lists of participants had to be combined into a uniform taxa list. Significant difficulties were experienced in setting up this list, particularly due to the fact that no uniform stipulations were made concerning the taxa list (usage of synonyms), the identification level and the indication of size classes and the designation of taxa which cannot be identified specifically. A list of at least 140 species and genera could be compiled. For the purpose of statistical assessment only results on species level were considered.

Based on data of all participating laboratories, the examined phytoplankton sample was dominated by individuals from the Prymnesiophyceae (15.8 %), Bacillariophyceae (7.3 %), Chrysophyceae (5.7 %) and Cryptophyceae (3.2 %) as shown in Fig. 3 (participating laboratories) and Fig. 4 (reference laboratory).

For about 67 % of the individuals present in the samples the participants were not able to determine the phytoplankton class. The highest average number of species per class was

found by the participating laboratories for Bacillariophyceae (about 43 %) and Dinophyceae (about 14 %). From the 140 taxa (genera and species) mentioned simply *Asterionellopsis glacialis* (Castrac.) Round, *Odontella sinensis* (Grev.) Grunow*, Eucampia zodiacus* Ehrenb. and *Guinardia delicatula* (Cleve) Hasle were detected by at least 10 participants. 11 further taxa were detected by at least 6 participants. Merely for these 15 taxa a Z_u-score could be determined, see Fig. 5. This corresponds to just 10 % of the data identified to the species level or at least the genus level. This means that most of the species listed were only cited by individual laboratories, and hence the results of different laboratories are difficult to compare. A final assessment of the qualification of participants in identification of phytoplankton species was not possible.

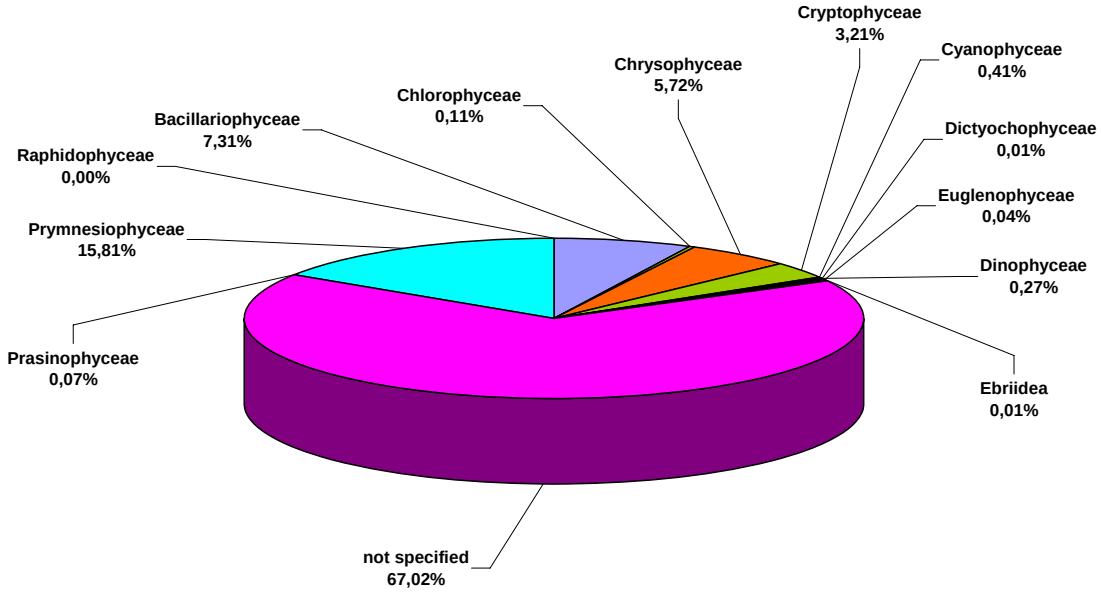

Fig. 3. Composition of the phytoplankton sample of the North Sea based on the number of individuals per class in percent, summarised results of all participants.

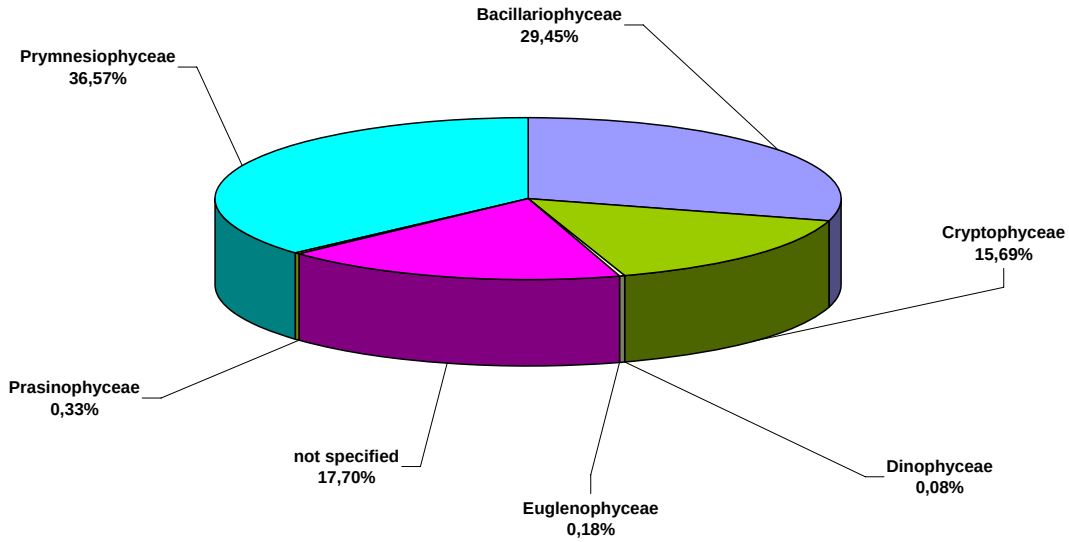

Fig. 4. Composition of the phytoplankton sample of the North Sea based on the number of individuals per class in percent, results of the reference laboratory.

DISCUSSION

The results of this inter-laboratory comparison illustrate the urgent need for quality assurance procedures for biological identifications. The lack of a consistent and comprehensive taxa list including all existing synonyms was one of the main problems in this inter-laboratory comparison. Furthermore, there is a need to agree on conventions for taxa, which cannot be

correctly identified by light microscopy. Size classes have to be defined in a standardised manner. Moreover, according to our experience careful sample preparation including homogeneity and stability testing are crucial points to be considered for future inter-laboratory comparison. Organisers of inter-laboratory comparisons should provide sufficient accompanying information concerning sample preparation and data analysis to participants. A standardised taxa list is indispensable and has to be updated regularly. For estimating counting errors repeated counts are recommended.

To improve the taxonomical skills, one key measure of external biological quality assurance is a mandatory regularly participation in training courses and taxonomical workshops of personnel involved in biological monitoring.

Despite all difficulties, the results show that inter-laboratory comparisons for phytoplankton analysis are meaningful because existing deficiencies can be detected. Their regular implementation is a precondition to improve the comparability and usability of biological data.

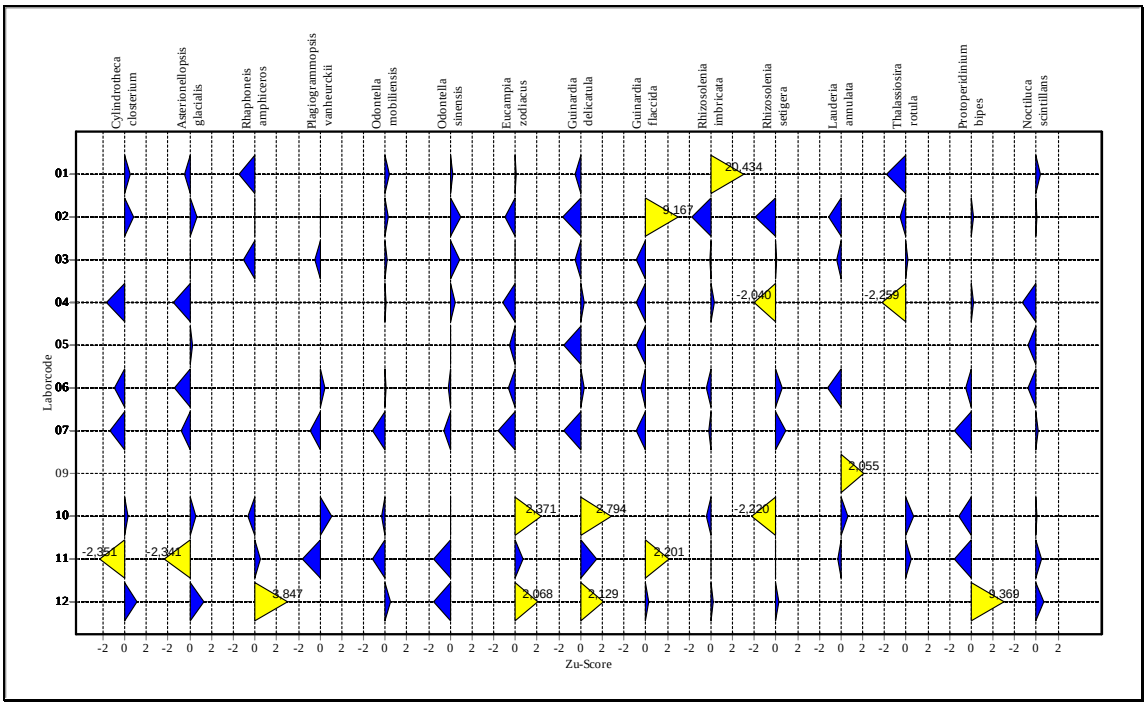

Fig. 5. Z_u-scores of taxa found by at least 6 participants (yellow: the quality limit of 2 was exceeded).

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More details available from <http://www.umweltbundesamt.de/wasser/themen/q-blmp.htm>

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