

from projects BONUS FUMARI and BONUS SEAM

## Strategic proposals for a revised Baltic Sea monitoring system

Environmental monitoring is required to implement effective actions to improve the environmental state of the Baltic. While monitoring is often viewed as a static task defined by legislation and based on tradition, changes in societal and policy demands, advances in science as well as methods necessitate its regular renewal. Revising monitoring efforts for a regional Sea like the Baltic Sea requires efficient cooperation among stakeholders and formalised processes. In earlier policy briefs and in numerous reports, BONUS SEAM and BONUS FUMARI have identified gaps in current Baltic Sea monitoring and presented specific recommendations appropriate for the future. In this joint policy brief, we present additional strategic recommendations which we believe would help to further develop the already well-renowned Baltic Sea monitoring system.

### Highlights

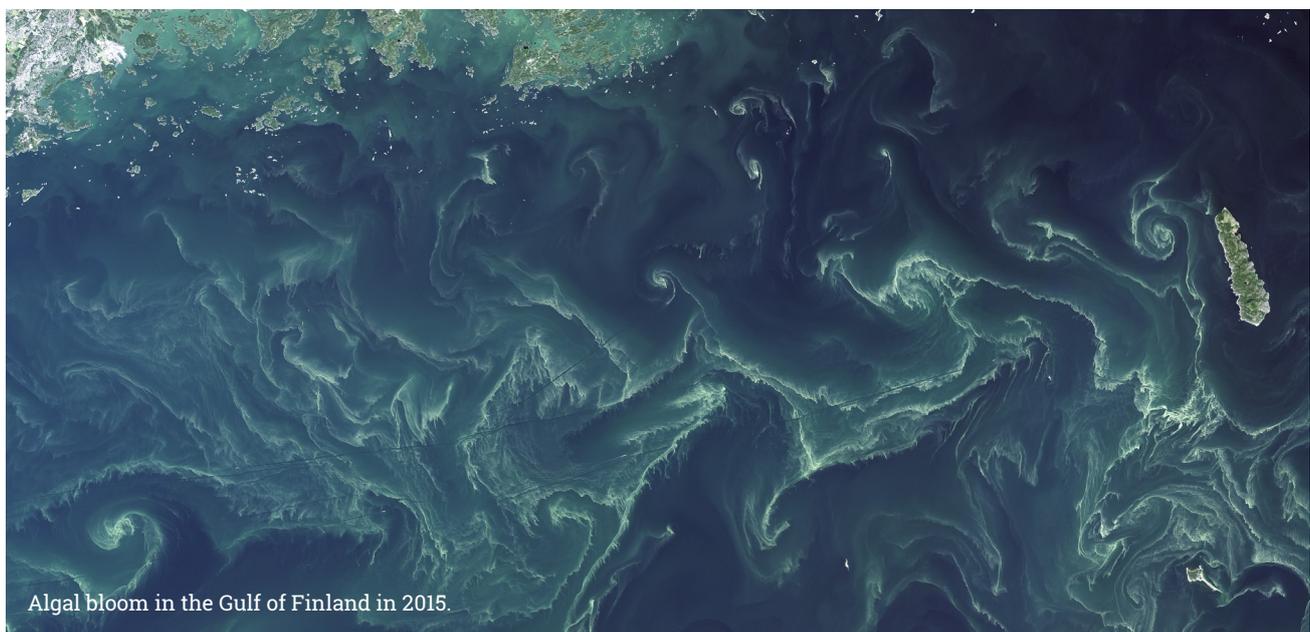
The purpose, precision and accuracy need to be explicitly stated to meet set requirements of monitoring programmes.

Monitoring of trends is essential to detect substantial changes in environmental conditions over time.

Increased international coordination, novel methods, and revised procedures can solve identified gaps and should be used to improve current monitoring.

Current and novel monitoring methods should undergo a recurring formalised review process to ensure transparency, speedy uptake and continuous viability.

The adoption of novel methods and revision of existing monitoring methods of the Baltic Sea should be evaluated and decided upon in a formalised process pipeline under HELCOM.



Algal bloom in the Gulf of Finland in 2015.

Photo: Landaat, image courtesy of the U.S. Geological Survey

BONUS SEAM and BONUS FUMARI have evaluated the adequacy of current Baltic Sea environmental monitoring in relation to the requirements of assessments under different environmental policies. The analyses include suggestions for revision of existing and, development of new programs, the use of novel methods<sup>1,2,3,4</sup> and opportunities for improved coordination<sup>5,6</sup> between countries in the Baltic Sea. A central aim was to increase the availability and quality of data for Baltic Sea management and to promote an efficient use of the resources allocated for environmental monitoring. Apart from a number of recommendations for monitoring of benthic<sup>7</sup> and pelagic<sup>8</sup> habitats and of hazardous substances<sup>9,10</sup>, we also identified overarching strategies that will promote the quality and usefulness of future monitoring<sup>11,12</sup>.

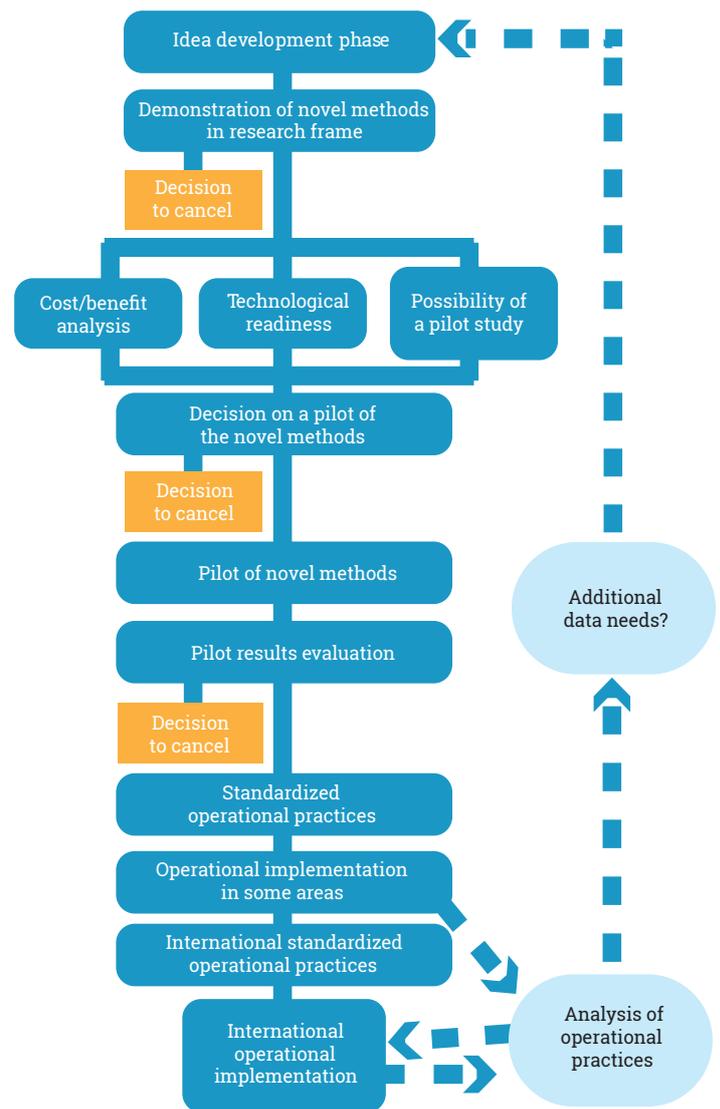
### Define purpose and context of monitoring

Gaps and developmental needs in current Baltic Sea monitoring were identified using different sources of information including peer-reviewed scientific literature<sup>13</sup>, project reports<sup>14,15</sup> and stakeholder surveys and expert opinion<sup>15,16,17</sup>. The main gaps can be roughly divided into three categories: gaps that can be filled with improved or novel monitoring, gaps that can be filled with science/policy action, and gaps that can be filled with better coordination. An important finding was that the source of information consulted to identify gaps influences the ranking of gap importance whereas the list of gaps remains mainly the same<sup>11</sup>. It is therefore vital for managers deciding on the prioritization of gaps to be aware of possible bias with respect to the source of information.

Generally, clearer definitions of the purpose of monitoring and recognition of differences in optimisation criteria depending on the defined purposes are needed. Current policies affecting the Baltic require that the state of the environment is assessed using e.g. specific indicators (Baltic Marine Environment Protection Commission, HELCOM), criteria (Marine Strategy Framework directive, MSFD), or Biological quality elements (Water framework directive, WFD) in relation to specific reference values or class-boundaries. Most of the existing Baltic Sea monitoring programmes were planned and implemented before these policies were formulated and their original purpose was to detect and describe trends at selected stations or water masses. The original trend-monitoring requirements are thus not necessarily those that will ensure a reliable and efficient monitoring programme for status assessment. To be reliable, the original efficient trend-monitoring requires high frequency sampling at a single station whereas efficient programmes for status assessment need to focus on cost-efficient solutions to maximize precision, accuracy and representativity in space and time to be relevant to the assessment and policy contexts.

### Define the required precision and accuracy of monitoring and status assessments

Another overarching conclusion is that it is imperative (1) to evaluate the confidence of the status classification and that

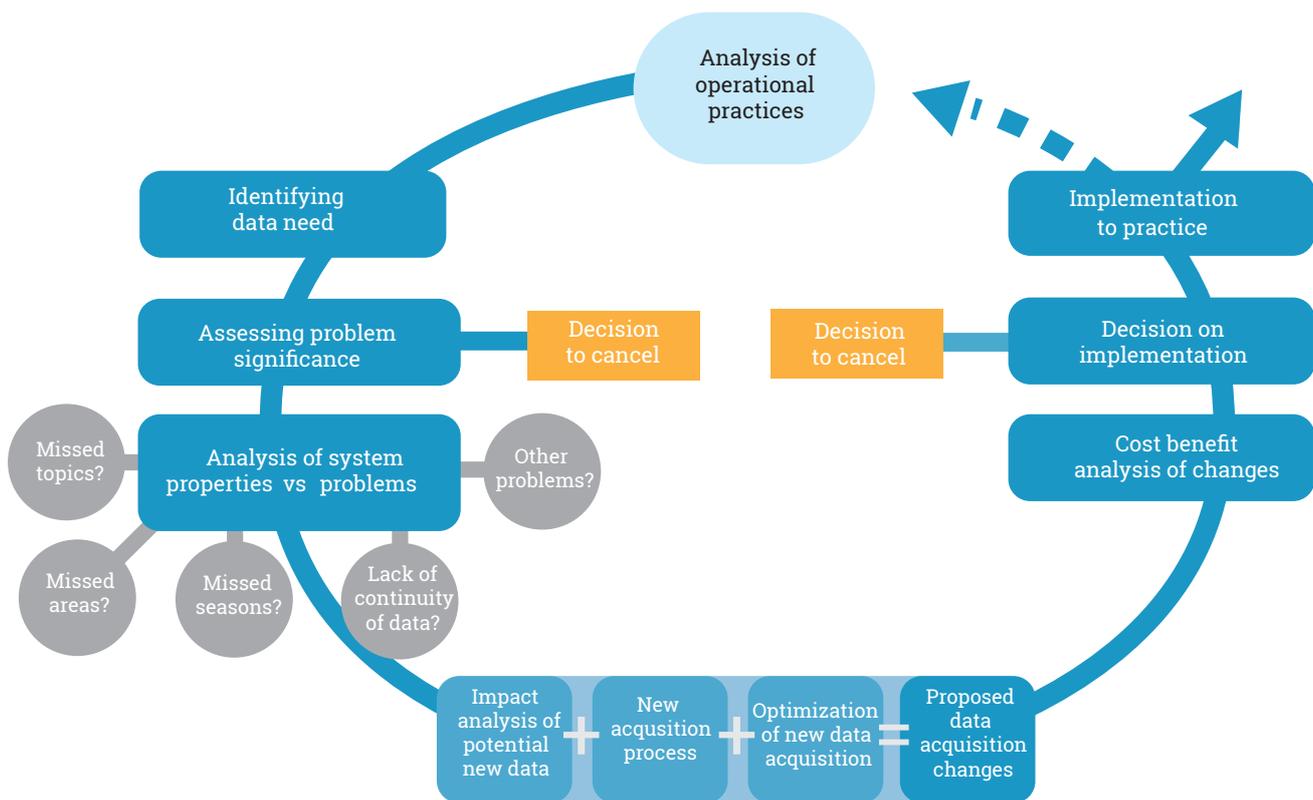


**Figure 1.** Suggested novel method uptake and method revision pipeline.

(2) inferences about the state of the environment are based on data with sufficient confidence to make correct and reliable decisions about environmental status. Confidence in classification depends on the observed average state in relation to class-boundaries which is not directly affected by the monitoring programme. However, precision and accuracy can be optimised by informed decisions in the planning phase to meet the set requirements of monitoring programmes. Further, it is important to have a good understanding of the natural variability and properties of the monitored parameters.

### Clarify aims and strategies for monitoring of trends

It is important to continue to assess trends in addition to status assessment as substantial changes in environmental conditions are visible only through the analyses of long-term data series e.g. analysing hydrological and hydrochemical parameters. A particularly important asset are the existing con-



**Figure 2.** Suggested pipeline for recurring evaluation of methods.

tinuous, long-term time series from coastal and offshore stations in different parts of the Baltic Sea. However, these are often located in strategic areas and cannot always be considered representative for the status assessment of sub-basins. Thus, there are a number of challenges related to trend-monitoring that need to be addressed, which cannot be solved only by safeguarding existing time-series.

### Improve coordination throughout the monitoring scheme

HELCOM monitoring fulfils coordination in terms of having agreed monitoring guidelines and coordinated data collection. While international monitoring programmes are based on agreed spatial and temporal sample collection, they sometimes represent the summation of national monitoring programmes. Also the use of shared platforms and vessel time is still rare. Enhanced cooperation and coordination could increase the adequacy of assessment results, optimize the use of expertise, and stimulate knowledge sharing. New monitoring programmes or the addition of parameters to existing programmes represent an opportunity to improve international cooperation and develop networks with joint monitoring stations. Considering these opportunities in advance can optimise data use and assessment results and result in more efficient use of monitoring resources for participating countries. Coordination should therefore be considered in the development of new programmes as well as in the review of existing programmes to enhance: (1) the purpose and design of a monitoring programme, (2) sampling collections and, (3) data processing.

### Modernizing and reviewing current monitoring methods

In addition to better coordination and definition of monitoring objectives, key stakeholder inputs identified novel monitoring methods that can address many of the identified gaps. Commonly agreed on measures of rating the suitability of novel methods need to be established and should include reliability, added value, indicative value, applicability and cost-efficiency in comparison to the currently applied methods<sup>2</sup>.

Implementing changes to Baltic Sea monitoring is a complex endeavour and filling the observed monitoring gaps with novel monitoring methods is a major undertaking. A factor slowing down the speedy adoption of novel, fit-for-purpose methods is the lack of a formalised structure and host organisation to oversee the implementation of methods. Currently novel method adoption proceeds in a non-structured form, but would benefit greatly from a formalised, multistep process with evaluation checkpoints (see a suggested draft in Fig 1). Such a formal process should not only include dedicated, recurring scanning for novel methods against clear evaluation criteria for adoption. In addition, the same set of criteria should also be applied to evaluate existing methods on a regular basis. This will ensure transparency in decisions on implementation of changes or continuation of current practices. Evaluations should coincide with reviews of the Baltic Sea Action Plan (BSAP) (Fig 2). A clear definition of process ownership for this monitoring method evaluation pipeline will be a necessary step in any modernization

effort of current Baltic Sea monitoring. We suggest that only HELCOM can implement and maintain such an evaluation pipeline and has the ability to look beyond current monitoring and anticipate future policy and thus monitoring method needs. Adopting a dedicated, transparent process for the inclusion of novel and review of current monitoring methods will solidify HELCOM's role as a forerunner in marine monitoring and management. The procedural process chains required in such an the evaluation pipeline are not unlike those used for European method standardization (i.e. CEN) and these CEN procedures could function as either a template or tool in the design of the process.



Taking water samples with the CTD probe close to the unattended MARNET station Darss Sill.

Photo: R. Prien, IOW

1. BONUS SEAM Deliverable 3.1. Review of novel and cost-effective monitoring technologies and their potential applicability in Baltic Sea monitoring and assessment (Kuss et al., 2020)
2. BONUS FUMARI Deliverable 3.3. Are we actually assessing the cost-efficiency of marine monitoring methods? – A systematic mapping of literature (Hyvärinen et al., 2020) Submitted manuscript
3. BONUS FUMARI Deliverable 2.4. A synthesis of novel marine monitoring methods with the potential to enhance the status assessment of the Baltic Sea (Mack et al., 2020) Submitted manuscript
4. POLICY BRIEF from projects BONUS FUMARI and BONUS SEAM Novel methods advancing Baltic Sea environmental monitoring
5. BONUS SEAM Deliverable 3.3. Technical report on potential for joint approaches in open-sea monitoring (Storr-Paulsen et al., 2019)
6. POLICY BRIEF from project BONUS SEAM Joint approaches in open-sea monitoring of the Baltic Sea
7. BONUS SEAM Deliverable 2.2. Analyses and recommendations for a revised benthic monitoring in the Baltic Sea (Nygård et al., 2019)
8. BONUS SEAM Deliverable 2.3. Improvement of pelagic monitoring (Lips et al., 2019)
9. BONUS SEAM Deliverable 2.4. Technical report on improvement of hazardous substances monitoring (Kanwischer et al., 2019)
10. POLICY BRIEF from project BONUS SEAM Strategies for revising monitoring in support of Baltic Sea management
11. BONUS SEAM Deliverable 4.3. Proposals for a revised Baltic Sea monitoring system (Lindgarth et al., 2020)
12. BONUS FUMARI Deliverable 3.1. Proposal for the renewed monitoring system for the Baltic Sea, including analysis of cost efficiency and a road map for implementing the proposed system (Uusitalo et al., 2020)
13. BONUS FUMARI Deliverable 1.1. Gaps in the current monitoring and data management of the Baltic Sea (Kahlert et al., 2019)
14. BONUS SEAM Deliverable 2.1. Holistic synthesis of reviews and analysis of current Baltic Sea monitoring and assessment (Emmerson et al., 2019)
15. BONUS FUMARI Deliverable 1.2. Report on stakeholder survey (Kahlert et al., 2019)
16. BONUS SEAM Deliverable 4.1. Summary of questionnaire-based survey on priorities for improvement of Baltic Sea monitoring programme (Lindgarth et al., 2020)
17. POLICY BRIEF from projects BONUS FUMARI and BONUS SEAM Identifying gaps and opportunities for future monitoring of the Baltic Sea

**THIS POLICY BRIEF** summarises suggestions for a revision of the current Baltic Sea monitoring system, conducted in the projects BONUS FUMARI and BONUS SEAM. The general aim of these projects is to develop recommendations to improve the monitoring of the Baltic Sea. Our series of five policy briefs provide comprehensive evidence based perspectives on current and improved future monitoring and aim to support monitoring of the Baltic Sea ecosystem and its ecosystem services.

**BONUS FUMARI** – Future Marine Assessment and Monitoring of the Baltic

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