A multibiomarker approach to the assessment of pollution impacts in two Baltic Sea coastal areas in Sweden using caged mussels (Mytilus trossulus)


HIGHLIGHTS
• A variety of biomarker responses were measured in caged mussels (Mytilus trossulus).
• Biomarkers clearly discriminated between polluted and reference sites.
• At polluted sites different stressors induced separate biomarker patterns.
• Mytilus trossulus is a suitable indicator of pollution impacts in the Baltic Sea.

ABSTRACT
Blue mussels (Mytilus trossulus) were transplanted in cages for three months in two Swedish coastal areas in the Bothnian Sea (northern Baltic Sea) to investigate the interactions between analysed environmental chemicals and biological responses. A wide array of biological parameters (biomarkers) including antioxidant and biotransformation activity, geno-, cyto- and neurotoxic effects, phagocytosis, bioenergetic status and heart rate were measured to detect the possible effects of contaminants. Integrated Biomarker Response index and Principal Component Analysis performed on the individual biological response data were able to discriminate between the two study areas as well as the contaminated sites from their respective local reference sites. The two contaminated sites outside the cities of Sundsvall (station S1) and Gävle (station G1) were characterised by different biomarker response patterns. Mussels at station S1 showed a low condition index, increased heart rate recovery time and phagocytosis activity coinciding with the highest tissue concentrations of some trace metals, polycyclic aromatic hydrocarbons and organotins. At station G1 the highest organochlorine pesticide concentration was recorded as well as elevations in glutathione S-transferase activity, thiamine content and low lysosomal membrane stability. Significant variability in the geno- and cytotoxic responses and bioenergetic status was also observed at the different caging stations. The results obtained suggest that different chemical mixtures present in the study areas cause variable biological response patterns in organisms.

1. Introduction
Serious concern about the release of hazardous substances and their adverse effects on marine organisms has been voiced globally for a long time. Contamination of the marine environment is also explicitly recognised in the current European legislation; e.g., the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) currently under implementation in all EU countries calls for biological tools for monitoring of chemical contamination. In the Oslo–Paris convention area (OSPAR) new recommendations and guidelines have been prepared for the Joint Assessment and Monitoring Programme (JAMP), greatly with the help of expert groups of the International Council for the Exploration of the Sea (ICES) (Davies and Vethaak, 2012). In the Baltic Sea...