9. Conclusions

The results presented in the report lead to the following conclusions for nitrogen, heavy metals and lindane.

Nitrogen

Annual emissions of nitrogen oxides and ammonia from the HELCOM Parties have not changed much from 2002 to 2003, but for HELCOM sources theyare 2% lower in 2003, both for nitrogen oxides and ammonia. The updated nitrogen oxides emissions from the international ship traffic on the Baltic Sea are 7% higher in 2003 than in 2002.

For all HELCOM Parties, transport and combustion are the main sources of nitrogen oxides emissions into the Atmosphere both, in 2003 and 2002. The transport sectors prevail in all HELCOM Parties except Poland and the Russian Federation, where the road transport (sector 7) is the major source of nitrogen oxides pollution. In Poland and the Russian Federation, combustion in energy and transformation industry is the major contributor to the emission, however, road transport is the next on the list also in these countries in 2003.

In case of ammonia emissions, emissions from the agriculture (sector 10) are much higher than emission from any other sector in all HELCOM countries. Contribution of agricultural emissions to annual total ammonia emissions in 2003 varies between 81% and 96% in different HELCOM Parties. Contribution from other sectors to ammonia emission is much lower.

Despite lower emissions, computed 2003 annual depositions of total (oxidized and reduced) nitrogen are slightly higher than corresponding 2002 depositions, in five out of six sub-basins and in four out of six catchments of the Baltic Sea and in.

Like in the previous years, there is no clear seasonal pattern of computed deposition in 2002, but in general maxima of the deposition can be observed in May and November, and minima in February and March. Except for March, April and May, monthly deposition of oxidized nitrogen is higher than monthly deposition of reduced nitrogen to both, the Baltic Sea basin and the catchment.

Like in 2000, the main emission sources of oxidized nitrogen deposition to the Baltic Sea sub-basins and catchments in 2003 are located in Germany, Poland and belong to the ship traffic on the Baltic Sea. It should be noted, however, that the distant emission sources, such as the United Kingdom, France and ship traffic on the North Sea have also

significant contributions to the deposition in 2003. In case on reduced nitrogen, local sources are more important. The main contributors to reduced nitrogen deposition are: Germany, Poland and Denmark.

In general, the comparison between modelled and measured concentrations of nitrogen compounds at HELCOM stations is good and comparable to the model performance for the EMEP sites. The model provides a reliable tool in order to assess the nitrogen supply to the Baltic Sea.

Heavy metals

Atmospheric transport and depositions of lead, cadmium, and mercury to the Baltic Sea and its catchment area were evaluated using MSCE-HM model on the basis of latest available official information on emission from HELCOM countries and other European countries. Levels of annual and monthly lead depositions have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea and its catchment area have been estimated.

Annual emissions of heavy metals from anthropogenic sources of HELCOM countries in 2003 amounted to 116 tonnes of cadmium, 61 tonnes of mercury, and 3271 tonnes of lead. Major contribution to the total emission of heavy metals from anthropogenic sources within the Baltic Sea region belonged to Poland, Germany, and Russia. Comparing to the level of emissions in 2002 lead, cadmium, and mercury emissions of HELCOM countries in 2003 have decreased by 1%, 4%, and 6%, respectively.

Annual depositions of lead to the Baltic Sea and its catchment area in 2003 accounted for 134 and 934 tonnes, of cadmium to 7 and 55 tonnes, and of mercury to 4.2 and 23 tonnes, respectively. Elevated levels of heavy metals depositions were obtained for the Gulf of Riga, the Kattegat sub-basins, and southern part of the Baltic Proper sub-basin. In comparison to computations for 2002 cadmium depositions to the Baltic Sea have decreased by 5%, lead depositions have decreased by 10%, while mercury depositions have increased by 11%. Changes in lead and cadmium depositions over the catchment area between these two years were less significant. Mercury depositions over the Baltic Sea catchment area have decreased by 5%.

Contributions of HELCOM countries to depositions of heavy metals over the Baltic Sea in 2003 accounted for 46% for lead, 49% for cadmium, and 30% for mercury. Among the HELCOM countries major contributions to lead depositions belonged to Poland (17%) and Germany (14%), in case of cadmium depositions to Poland (30%), in case of mercury depositions to Germany (12%) and Poland (7%). Contribution of European countries outside the Baltic Sea region amounted to 10-20%. Significant contribution belonged also

to the input of re-emission and natural sources.

Modelling results for lead, cadmium, and mercury were compared with available measurements carried out within the Baltic Sea region in 2003. Results of the comparison of computed lead and cadmium concentrations in air with measurements showed some underestimation of observed levels by a factor of 2. The underestimation of concentrations in precipitation is more significant accounting for a factor of 3-4 for lead and cadmium. The most likely reason of the underestimation of observed level of concentrations can be connected with the uncertainties in spatial distribution and seasonal variations of lead emissions, the influence of local sources, and differences between precipitation amount observed at the sites and used in modelling. Additional reason of underestimation of lead and cadmium concentrations can be connected with the contribution originated from the ship traffic in the Baltic Sea.Thus evaluated atmospheric load of lead and cadmium to the Baltic Sea for 2002 can be lower than actual depositions by a factor of 2-3.

Reasonable agreement with measurements was obtained for computed mercury concentrations. Annual and monthly computed air concentrations of mercury are in a good agreement with measured ones. Model results for mercury in precipitation are 40% higher than measured values on average.

Lindane

Atmospheric input of lindane to the Baltic Sea and its catchment area was evaluated for 2003 using MSCE-POP model. Modelling was performed using available emission data officially reported by EMEP countries to the UN ECE Secretariat and expert estimates of lindane emissions. Following officially reported information on emissions lindane is no longer applied in the following HELCOM countries: Denmark, Estonia, Finland, Germany, Russian Federation and Sweden. No information is available for Latvia, Litghuania, and Poland. Major lindane emission sources are located outside the Baltic Sea region in the United Kingdom, Spain, Portugal, Greece, and Croatia.

Evaluation of lindane long-range transport and depositions over the Baltic Sea area was carried out for a period 1990-2003. Following the model results total annual deposition of lindane to the Baltic Sea for 2003 accounted for 0.5 tonnes and to its catchment area about 3.3 tonnes. Most significant total deposition fluxes are obtained in the Belt Sea sub-basin and for the Baltic Sea catchment area in catchment of the Baltic Proper sub-basin.

Reasonable agreement is found between computed and measured annual mean air concentrations of lindane for SE14 (Råö) and NO99 (Lista). At FI96 (Pallas) the model underestimates measured concentrations in air about a factor of 2. Computed concentrations of lindane in precipitation reasonably agree with measured ones at DE01 (Westerland) and DE09 (Zingst). At the same time the model underestimates concentrations of lindane in precipitation measured at BE04 (Knokke) and NL91 (De

Zilk) about a factor of 3-4. The reason for the underestimation can be connected with the influence of local sources not taken into account in the emission data.