# 3. Atmospheric Supply of Nitrogen to the Baltic Sea in 2007

Nitrogen emission data, as well as the model results presented here have been approved by the 33rd Session of the Steering Body of EMEP in Geneva in September 2009. The EMEP Unified Eulerian model system has been used for all nitrogen computations presented in this Chapter.

It should be mentioned here that the model domain used for 2007 computations was different from this used for 2006. The 2007 domain covers the extended territory of the Russian Federation and therefore the Russian 2007 nitrogen emissions are higher than 2006 emissions. In addition, meteorological data used for deposition calculations for 2007 came from (HIRLAM) a slightly different numerical weather prediction model than the one used for 2006 (PARLAM).

Annual deposition of total nitrogen to the Baltic Sea basin in 2007 was 202 kt, approximately on the same level (1% higher) as in 2006. Deposition of oxidized nitrogen was 1% lower and deposition of reduced nitrogen was 5% higher in 2007 compared to 2006. Deposition of oxidized nitrogen accounted for 52% of total nitrogen deposition in 2007.

## 3.1 Nitrogen emissions

**Table 3.1**. Annual total 2007 emissions of nitrogen oxides and ammonia from the HELCOM Contracting Parties and Baltic See ship traffic. Sum of HELCOM emissions is also included. Units: kt N per year.

| Emission source | Pollutant | |
|---|---|---|
| | $NO_x$ | $NH_3$ |
| Denmark | 51 | 62 |
| Estonia | 11 | 8 |
| Finland | 56 | 29 |
| Germany | 391 | 514 |
| Latvia | 13 | 13 |
| Lithuania | 21 | 30 |
| Poland | 269 | 240 |
| Russian Federation | 1 327 | 750 |
| Sweden | 50 | 41 |
| **HELCOM** | **2 188** | **1 687** |
| Baltic Sea | 107 | 0 |

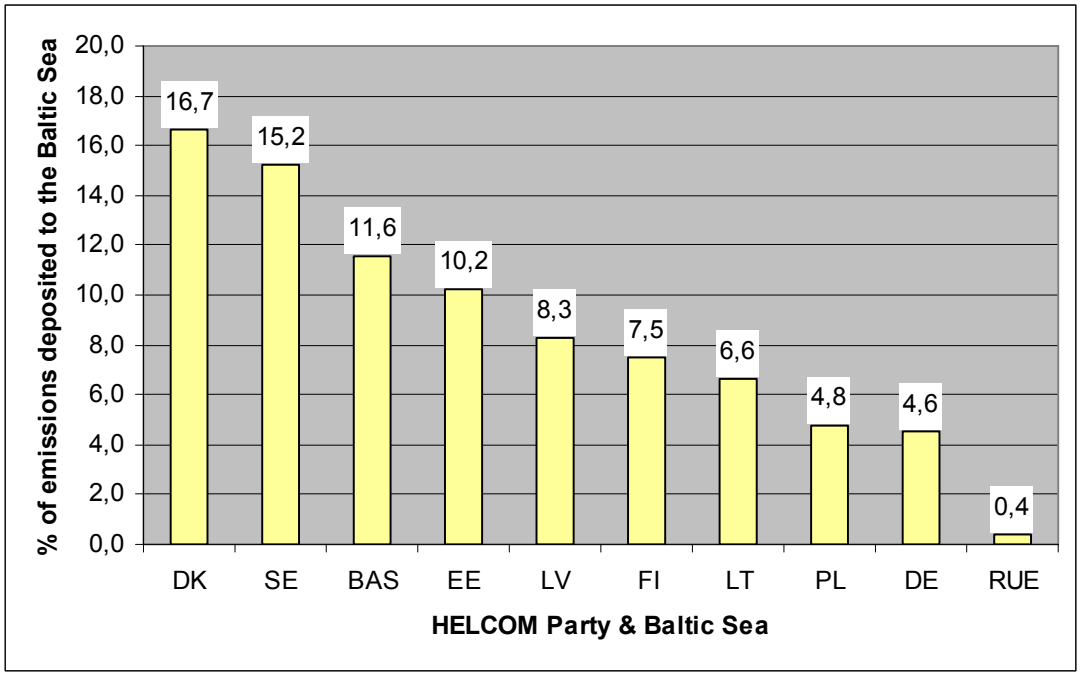


**Figure 3.2.** Percent of annual emissions of total (oxidized + reduced) nitrogen from the HELCOM Parties and international ship traffic emissions on the Baltic Sea (Baltic Ship) deposited to the Baltic Sea basin in 2007.

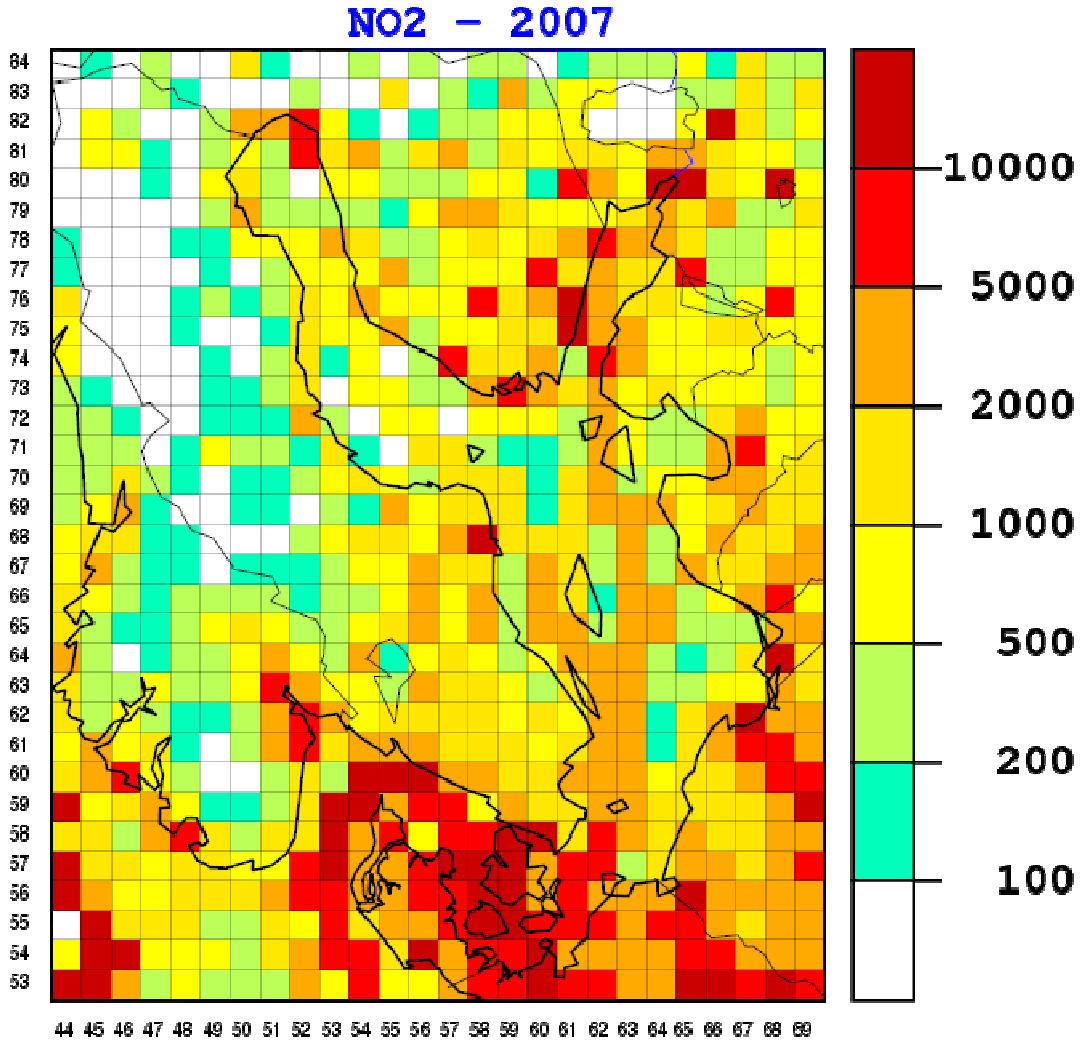


**Figure 3.3**. Map of annual emission of oxidized nitrogen (including emissions from the ship traffic) in the Baltic Sea region in 2007. Units: Mg (tones) of $NO_2$ per year and per 50×50 km grid cell.

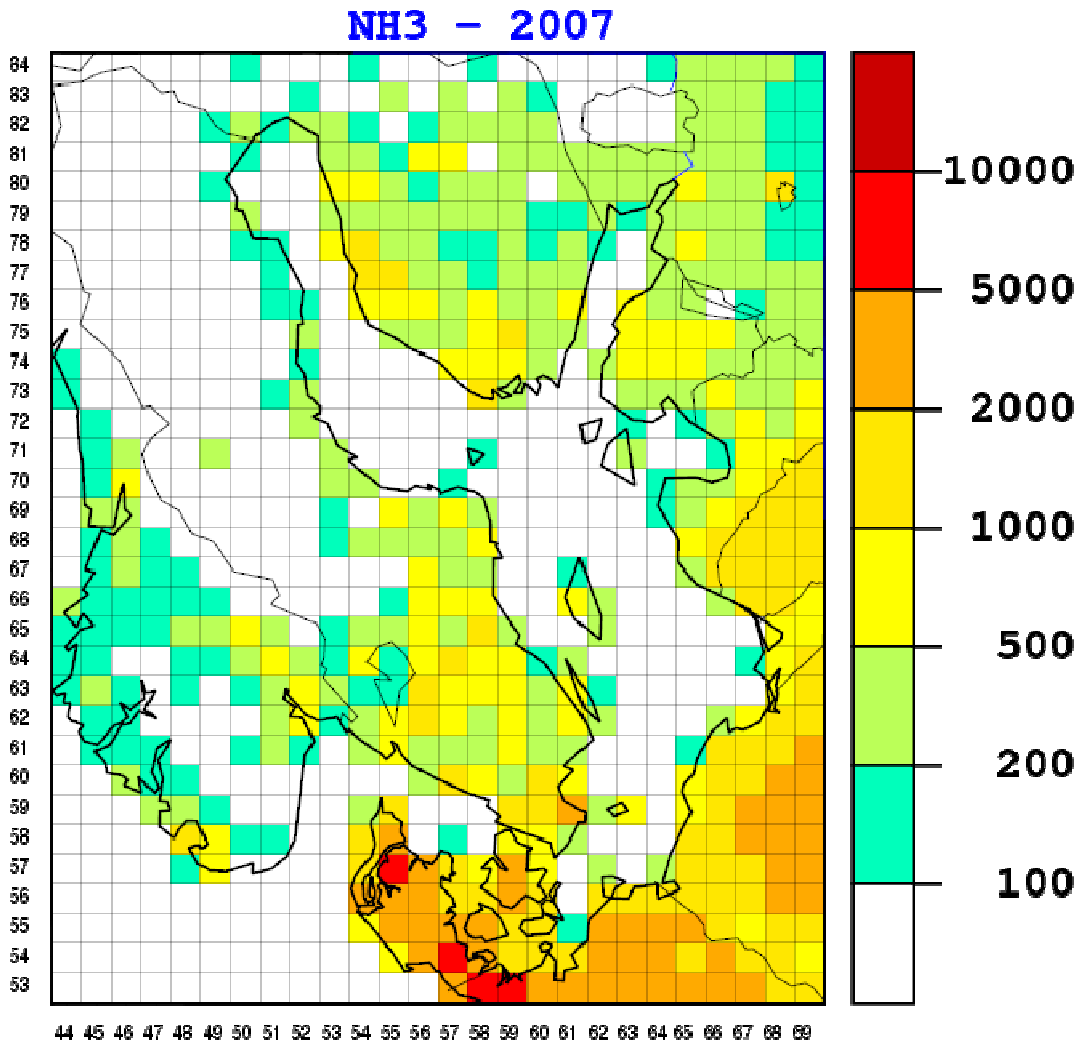


**Figure 3.4.** Map of annual emission of ammonia in the Baltic Sea region in 2007. Units: Mg of $NH_3$ per year and per 50×50 km grid cell.

**Table 3.2**. The list of 11 SNAP emissions sectors as specified in the EMEP-CORINAIR Emission Inventory Guidebook.

| | |
|---|---|
| Sector 1 | Combustion in energy and transformation industry |
| Sector 2 | Non-industrial combustion plants |
| Sector 3 | Combustion in manufacturing industry |
| Sector 4 | Production processes |
| Sector 5 | Extraction and distribution of fossil fuels and geothermal energy |
| Sector 6 | Solvent and other product use |
| Sector 7 | Road transport |
| Sector 8 | Other mobile sources and machinery (including ship traffic) |
| Sector 9 | Waste treatment and disposal |
| Sector 10 | Agriculture |
| Sector 11 | Other sources and sinks |

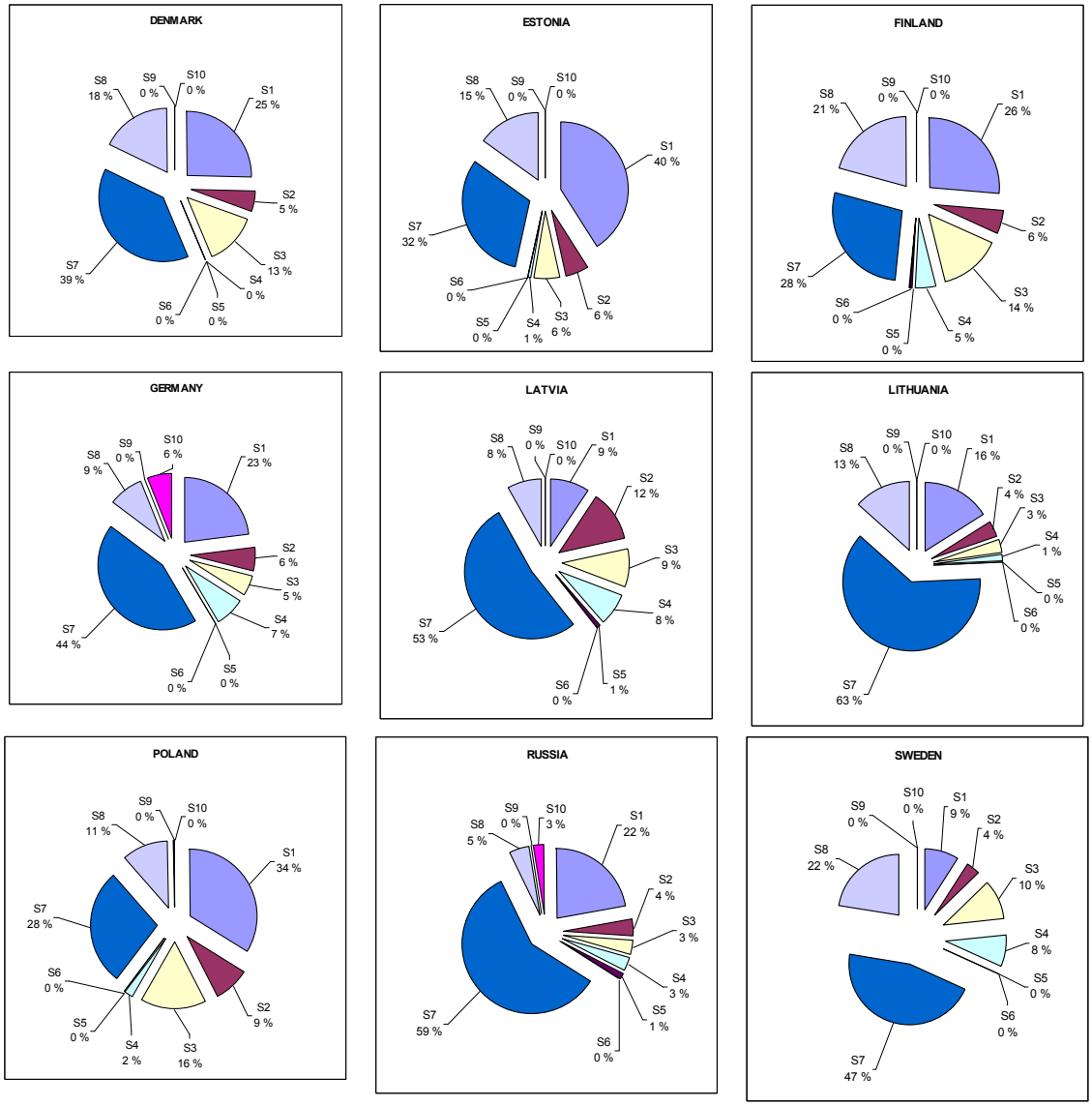


**Figure 3.5.** Annual 2007 nitrogen oxides emissions from the HELCOM Parties split into the SNAP sectors. sectors. Compared to 2006, the nitrogen oxides emissions from much larger part of the Russian Federation are taken into account for 2007.

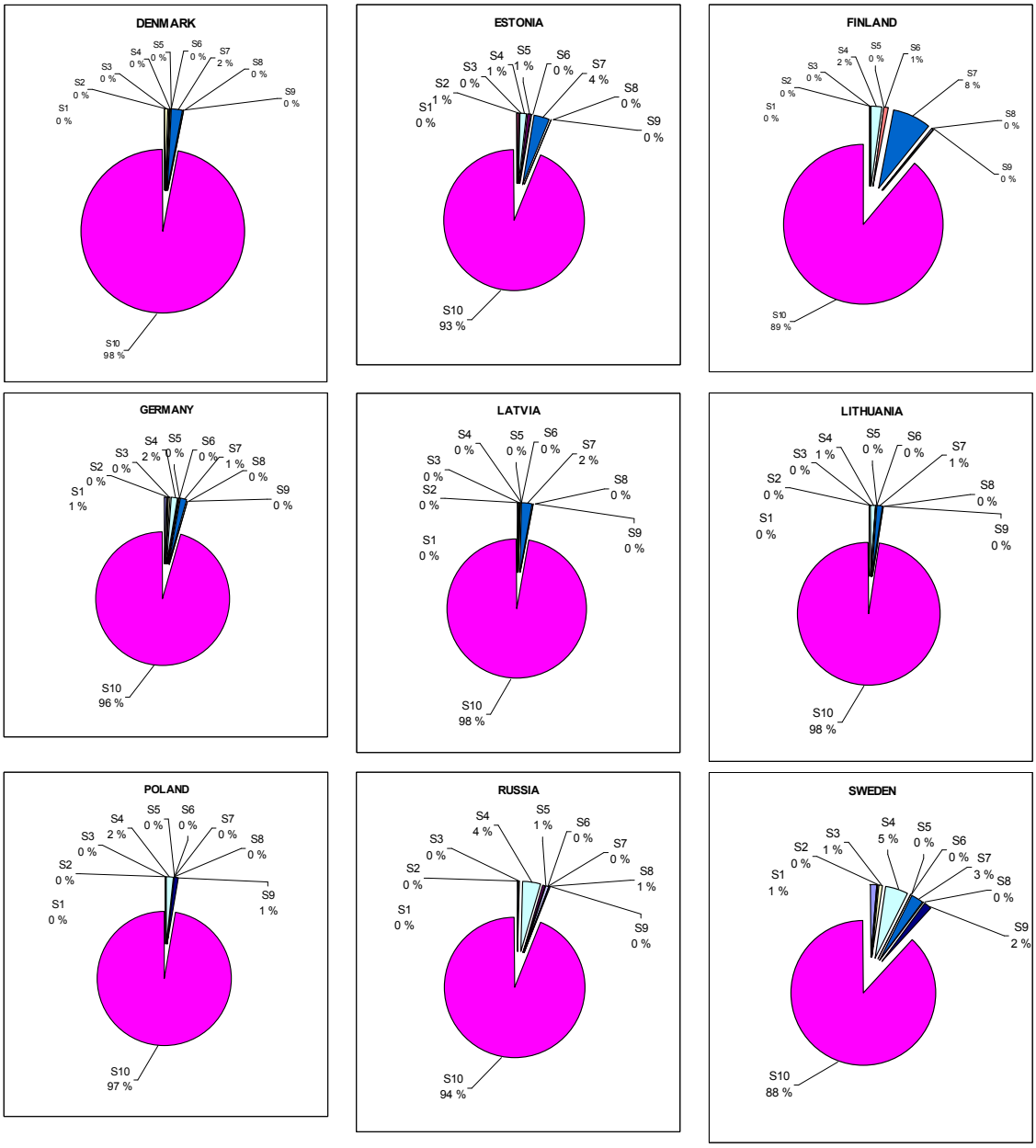


**Figure 3.6.** Annual 2007 ammonia emissions from the HELCOM Parties split into the SNAP sectors. Compared to 2006, the ammonia emissions from much larger part of the Russian Federation are taken into account for 2007.

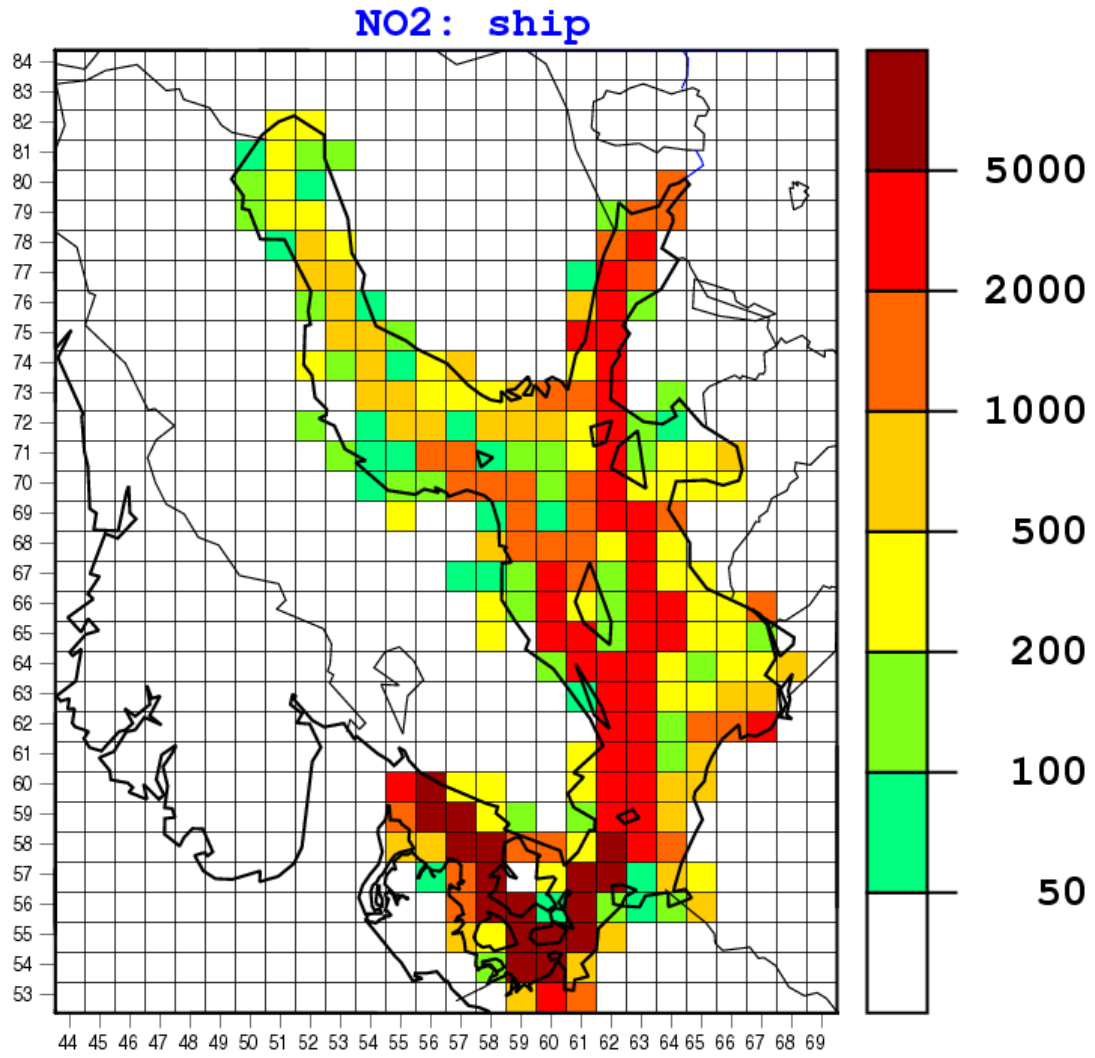


**Figure 3.7** Map of annual emissions of nitrogen oxides from the international ship traffic on the Baltic Sea in 2007 used in the EMEP model calculations. Units: Mg of $NO_2$ per year and per 50×50 km grid cell. There are large uncertainties in the estimate for ship traffic emissions. The international ship emissions and their spatial distribution have been updated based on new emission estimates derived by ENTEC for the year 2000. Ship emissions for 2007, were deduced by applying an increase factor of 2.5 % per year on cargo vessel traffic and 3.9 % per year on passenger vessel traffic. The factors are the same as used by ENTEC for predicting emissions of nitrogen in 2010 based on the emission estimates for 2000.

## 3.2 Annual deposition of nitrogen

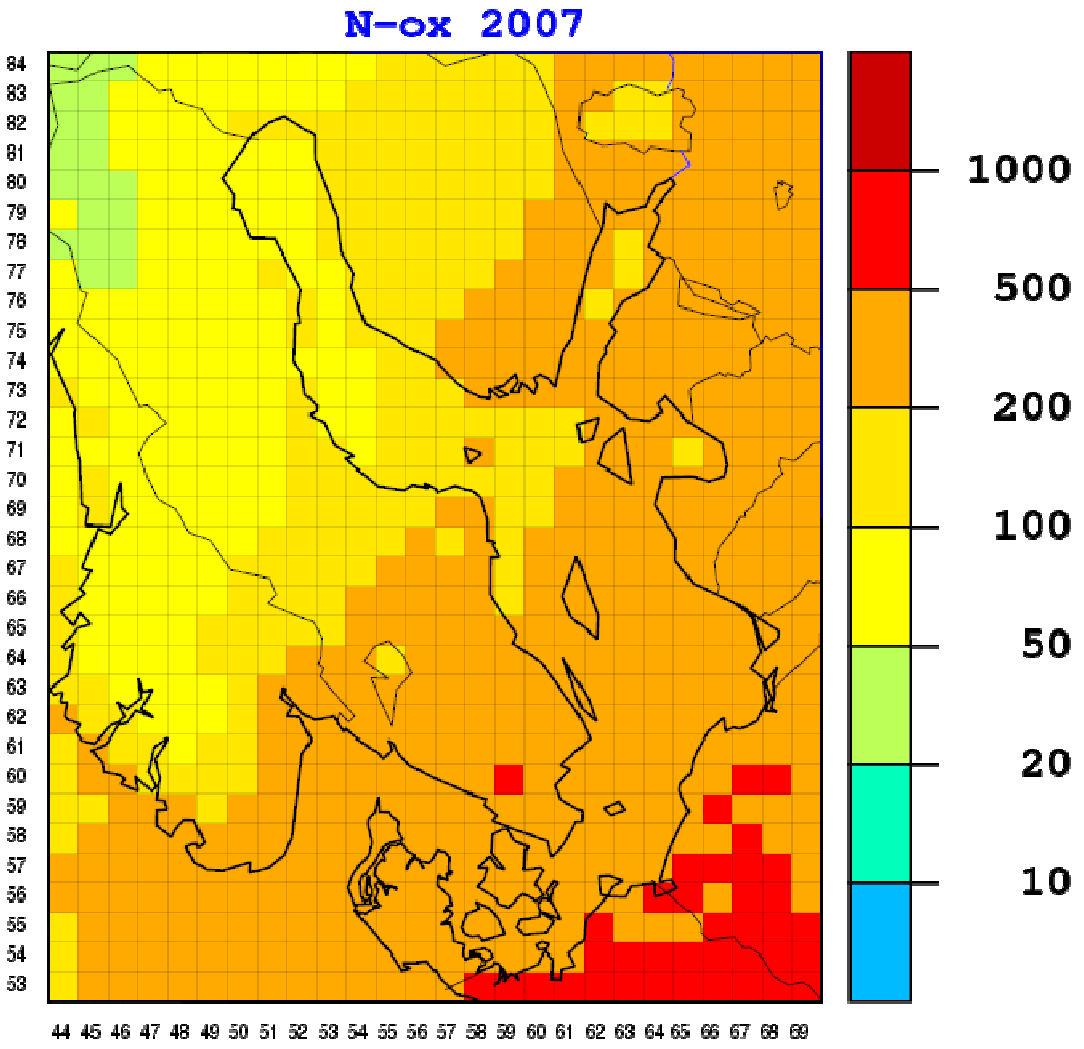


**Figure 3.8.** Map of annual deposition flux of oxidized nitrogen (dry + wet) in 2007. Units: mg N $m^{-2}$ $yr^{-1}$.

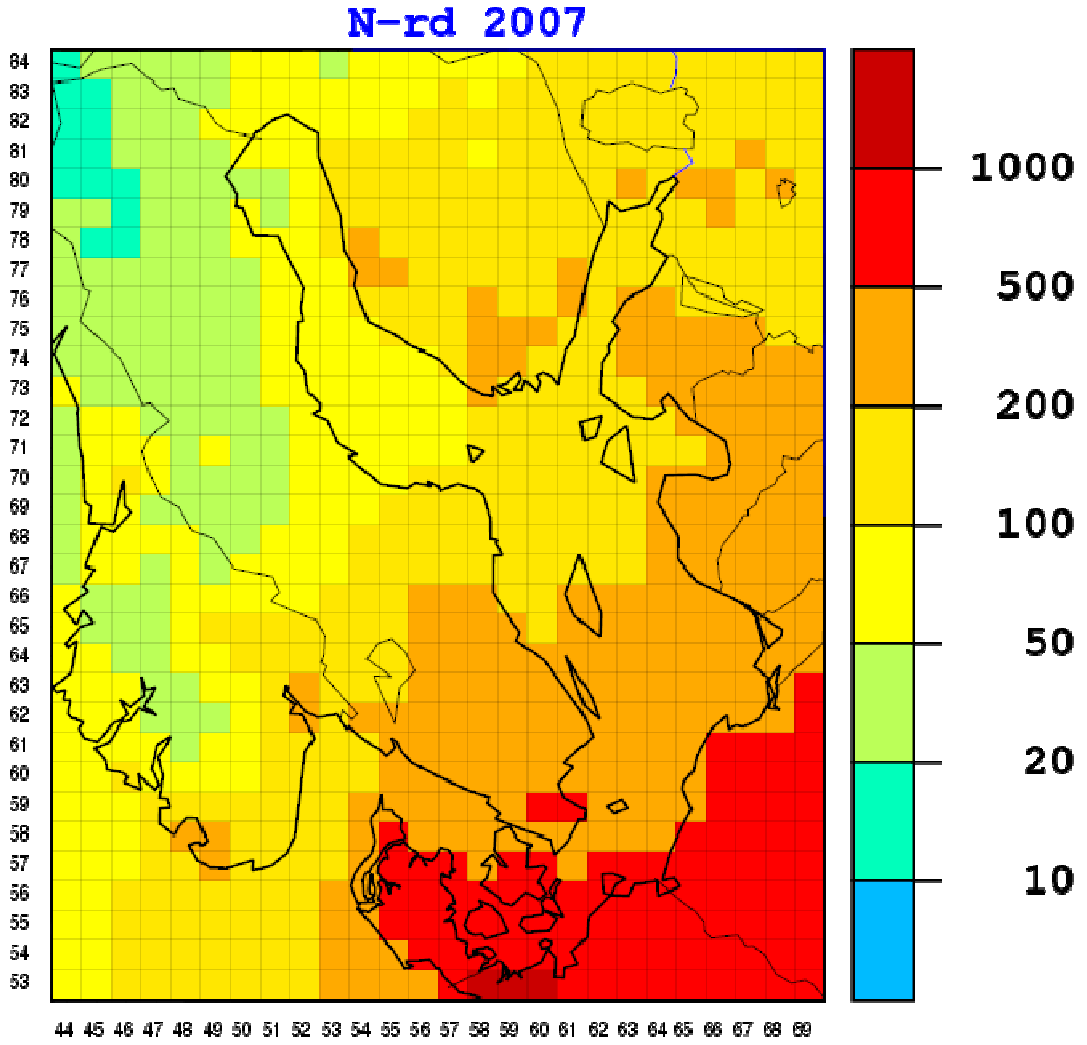


**Figure 3.9**. Map of annual deposition flux of reduced nitrogen (dry + wet) in 2007. Units: mg N $m^{-2}$ $yr^{-1}$.

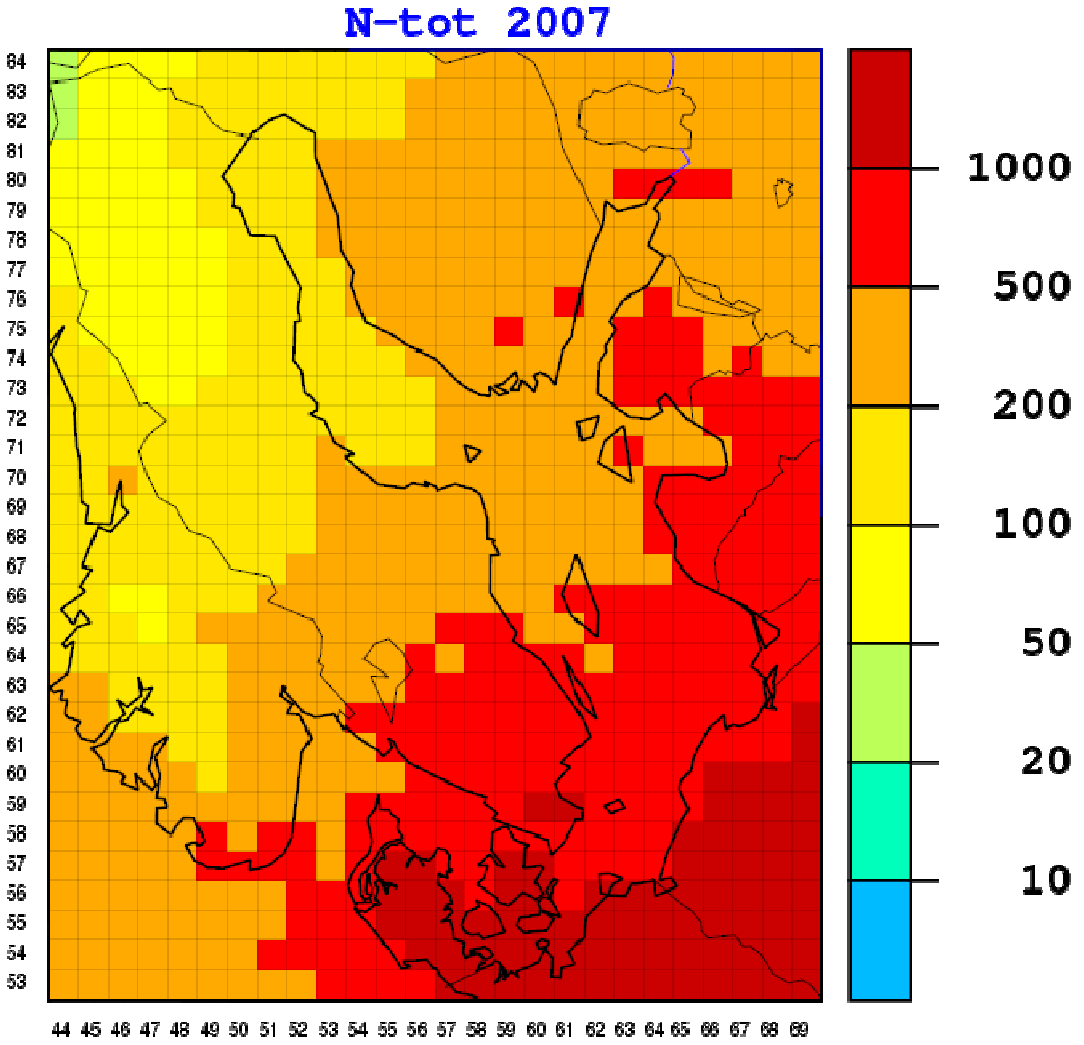


**Figure 3.10.** Map of annual deposition flux of total (oxidized + reduced) nitrogen in 2007. Units: mg N $m^{-2}$ $yr^{-1}$.

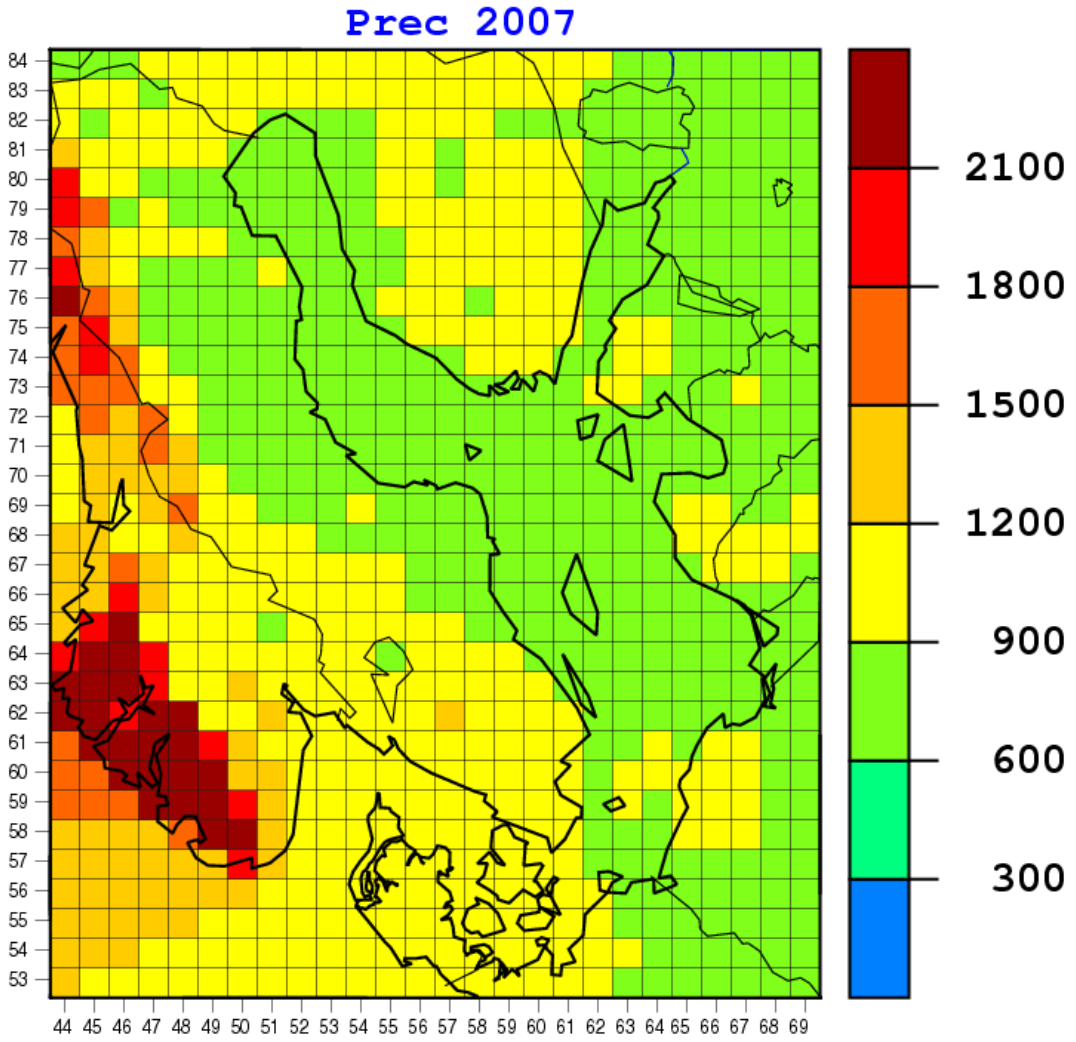


**Figure 3.11.** Map of annual precipitation in 2007. Units: mm $yr^{-1}$.

## 3.3 Monthly depositions of nitrogen

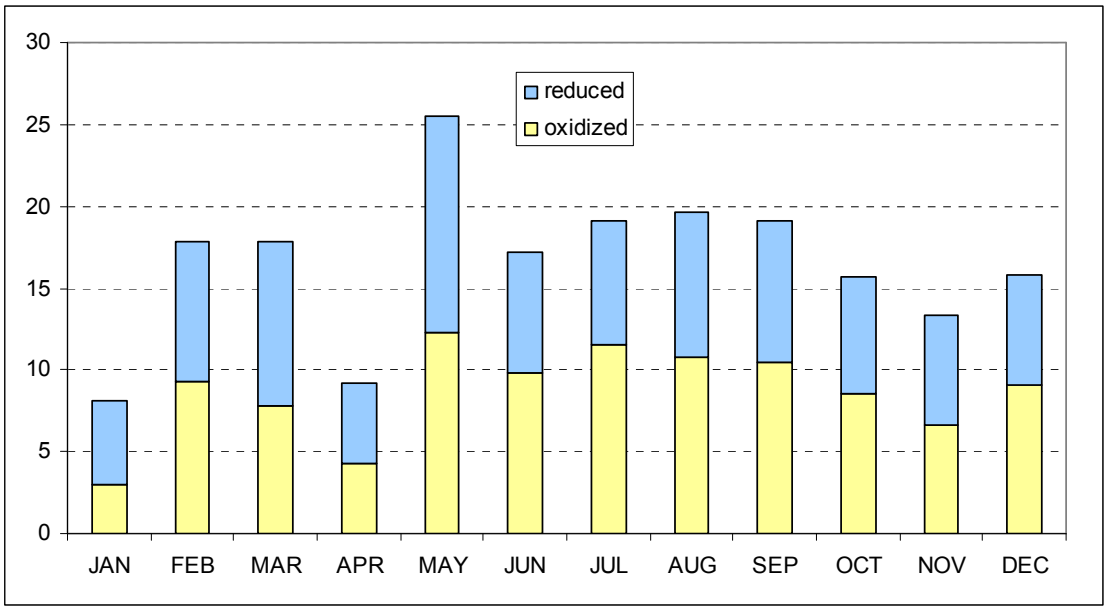


**Figure 3.12.** Monthly depositions of oxidized, reduced and total (oxidized +reduced) nitrogen to the entire Baltic Sea basin in 2007. Units: ktonnes N month$^{-1}$.

**Table 3.3.** Values of monthly depositions of oxidized, reduced and total (oxidized +reduced) nitrogen to the entire Baltic Sea basin in 2007. Units: ktonnes N month$^{-1}$.

| Month | Oxidized | Reduced | Total |
|---|---|---|---|
| January | 3.0 | 5.1 | 8.1 |
| February | 9.3 | 8.5 | 17.8 |
| March | 7.8 | 9.9 | 17.8 |
| April | 4.3 | 4.9 | 9.2 |
| May | 12.2 | 13.3 | 25.5 |
| June | 9.9 | 7.3 | 17.2 |
| July | 11.6 | 7.6 | 19.2 |
| August | 10.8 | 8.9 | 19.7 |
| September | 10.5 | 8.6 | 19.1 |
| October | 8.5 | 7.2 | 15.7 |
| November | 6.6 | 6.8 | 13.4 |
| December | 9.0 | 6.8 | 15.8 |

## 3.4 Source allocation of nitrogen deposition

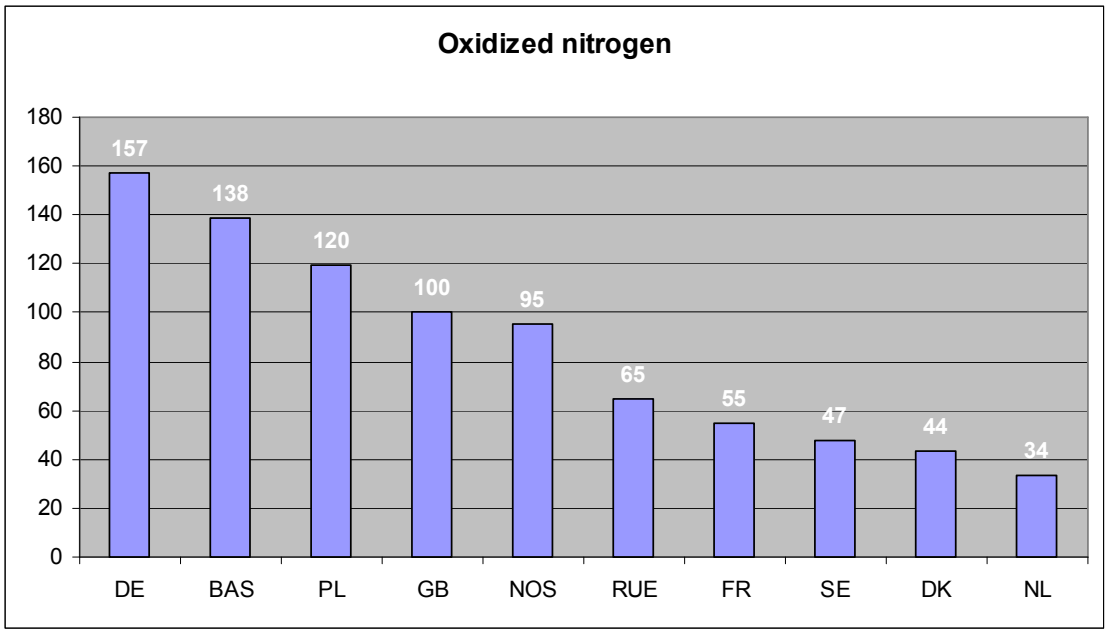


**Figure 3.13**. Top ten countries with highest contributions of nitrogen emissions to annual deposition of oxidized nitrogen into the Baltic Sea basin in the year 2007. Units: 100 tonnes N year$^{-1}$. BAS and NOS denote ship emissions form the Baltic Sea and from the North Sea, respectively. RUE denotes the contributions from emissions in extended Russian territory.

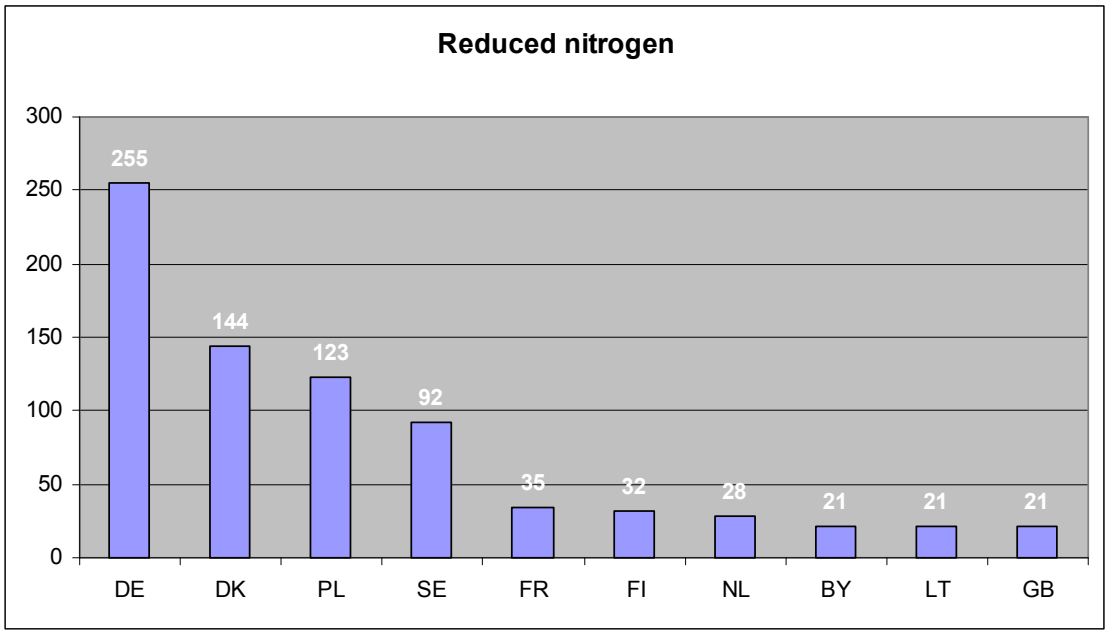


**Figure 3.14**. Top ten countries with highest contributions of nitrogen emissions to annual deposition of reduced nitrogen into the Baltic Sea basin in the year 2007. Units: 100 tonnes N year$^{-1}$.

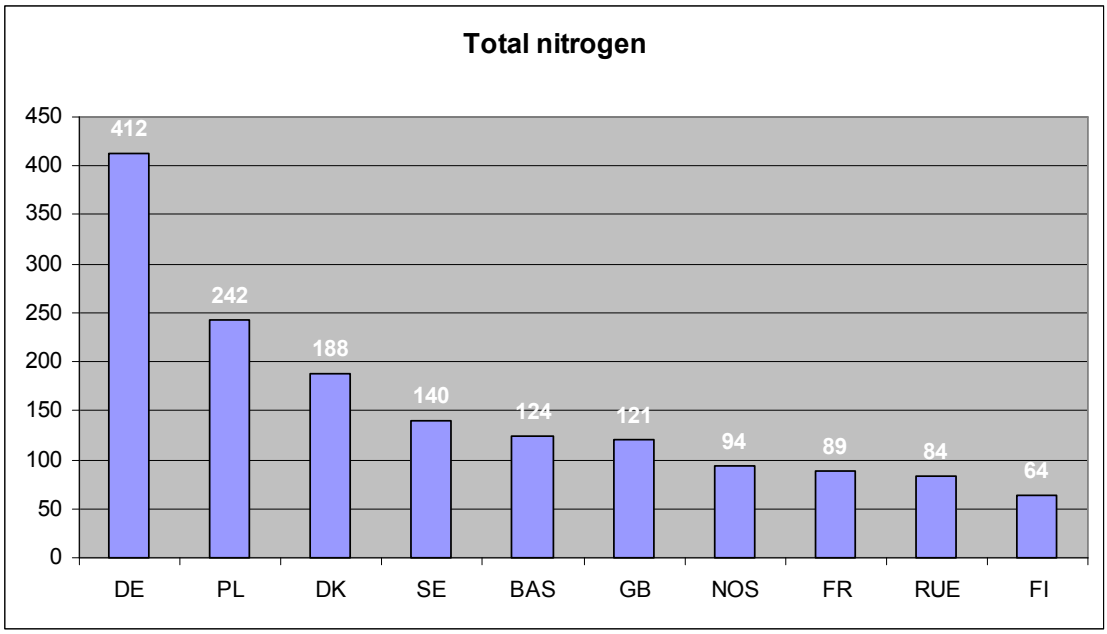


**Figure 3.15**. Top ten countries with highest contributions of nitrogen emissions to annual deposition of total (oxidized + reduced) nitrogen into the Baltic Sea basin in the year 2007. Units: 100 tonnes N year$^{-1}$. BAS and NOS denote ship emissions form the Baltic Sea and from the North Sea, respectively. RUE denotes the contributions from emissions in extended Russian territory.

## 3.5 Conclusions for Chapter 3

- The extension of the EMEP model domain with inclusion of larger part of the Russian territory resulted in larger 2007 emissions of nitrogen oxides and ammonia.
- In six out of nine HELCOM countries 2007 emissions of nitrogen oxides were lower compared to 2006 emissions and in three countries (Russia, Lithuania, Estonia) higher. Ship emissions from the Baltic Sea were also higher in 2007.
- Annual 2007 ammonia emissions were higher than annual 2006 ammonia emissions in six out of nine HELCOM countries. They were lower in Denmark, Finland and Sweden.
- Among the HELCOM Contracting Parties, the largest percent of 2007 nitrogen emissions deposited to the Baltic Sea basin can be noticed for Denmark (16.7) and the lowest for Russia (0.4%).
- Calculated annual deposition of total nitrogen to the Baltic Sea basin in 2007 was 202 kt N, 1% higher than in 2006.
- Compared to 2006, annual 2007 deposition of oxidized nitrogen to the Baltic Sea was 1% lower and deposition of reduced nitrogen 5% higher.
- No clear seasonal pattern can be found in monthly nitrogen depositions in 2007.
- Germany, ship traffic on the Baltic Sea and Poland are the main emissions sources contributing to oxidized nitrogen deposition into the Baltic Sea basin in 2007.
- Germany, Denmark and Poland are top three sources contributing to reduced nitrogen deposition into the Baltic Sea basin in 2007.
- Some distant sources, like United Kingdom, France and ship traffic on the North Sea contribute significantly to nitrogen deposition into the Baltic Sea basin in 2007.