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The nutrient load from food waste generated onboard ships in the Baltic Sea

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ABSTRACT

The combination of the sensitive characteristics of the Baltic Sea and the intense maritime traffic makes the marine environment vulnerable to anthropogenic influences. The theoretical scenario calculated in this study shows that the annually generated food waste onboard ships in traffic in the Baltic Sea contains about 182 tonnes of nitrogen and 34 tonnes of phosphorus. Today, all food waste generated onboard can be legally discharged into the marine environment at a distance of 12 NM from the nearest land. The annual load of nitrogen contained in the food waste corresponds to 52% of load of nitrogen from the ship-generated sewage. Future regulations for sewage discharge in the Baltic Sea will require significant reduction of total nitrogen and phosphorus released. The contribution of nutrients from food waste compared to sewage will therefore be relatively larger in the future, if food waste still can be legally discharged.

1. Introduction

The continuing increase in cruise tourism in the Baltic Sea with an increasing size and number of passengers onboard combined with the European policy to move more cargo from road to sea is resulting in an increasing number of people onboard ships. Thus, there is a rise in the number of people who generate waste that potentially can be released to the sensitive sea. This study aims to evaluate nutrient load from waste generated onboard.

Many ships transport cargo and people across the Baltic sea round the clock. The types and sizes of the ships and also the number of people onboard vary; however, proper management of the waste generated is a prerequisite. Food waste can either be stored for disposal at the next port of call or treated at sea. Food waste with its specific characteristics can be a major concern particularly for the people onboard. It is a wet waste and is subjected to microbial activity. Further, rapid autooxidation leads to the generation of foul-smelling fatty acids. In addition, enzymes contained in plant-based fraction of the food waste remain in their active state and accelerate the spoilage process (Oreopoulou and Russ, 2007).

The Baltic Sea is classified as Particularly Sensitive Sea Area (PSSA) under the International Maritime Organization (IMO). The definition of a PSSA is "an area that needs special protection through action by the IMO because of its significance for recognized ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities" (IMO, 2005). The area hosts a dense maritime traffic (Fig. 1) consisting of a wide range of ship segments, and an increasing trend has been observed in the last 15 years, for example, for cruise ships. The increase of waterborne transport of cargo and passengers is also supported and can be sustained by a roadmap adopted by the European Commission. One of the key goals in this road map include a 50% shift of medium-distance intercity passenger and freight journeys from road to rail and water-borne transport (European Commission, 2011).

1.1. The Baltic Sea

The Baltic Sea is the largest brackish sea in the world, connected with the North Sea only by the Danish Straits (Fig. 1). Inflows of salty water do not appear frequently because shallow and narrow thresholds keep the Baltic Sea isolated from the Atlantic Ocean. The water mean residence time in the Baltic Sea is about 30 years, implying that any possible pollutant released into the water may remain there for years. Moreover, the water is stratified in two layers of different salinities with small exchange of water creating low levels of oxygen content in the bottom layer. Human activities on the sea and in its catchment area, inhabited by about 85 million people, place an increasing pressure on the marine ecosystem.

Eutrophication in seawaters results mostly from inflow of nutrients such as phosphorus and nitrogen, water stratification, and a low water-exchange frequency. Under eutrophication conditions, the marine ecosystem is characterized by intense algal growth (especially blue–green algae), increased oxygen consumption, oxygen depletion

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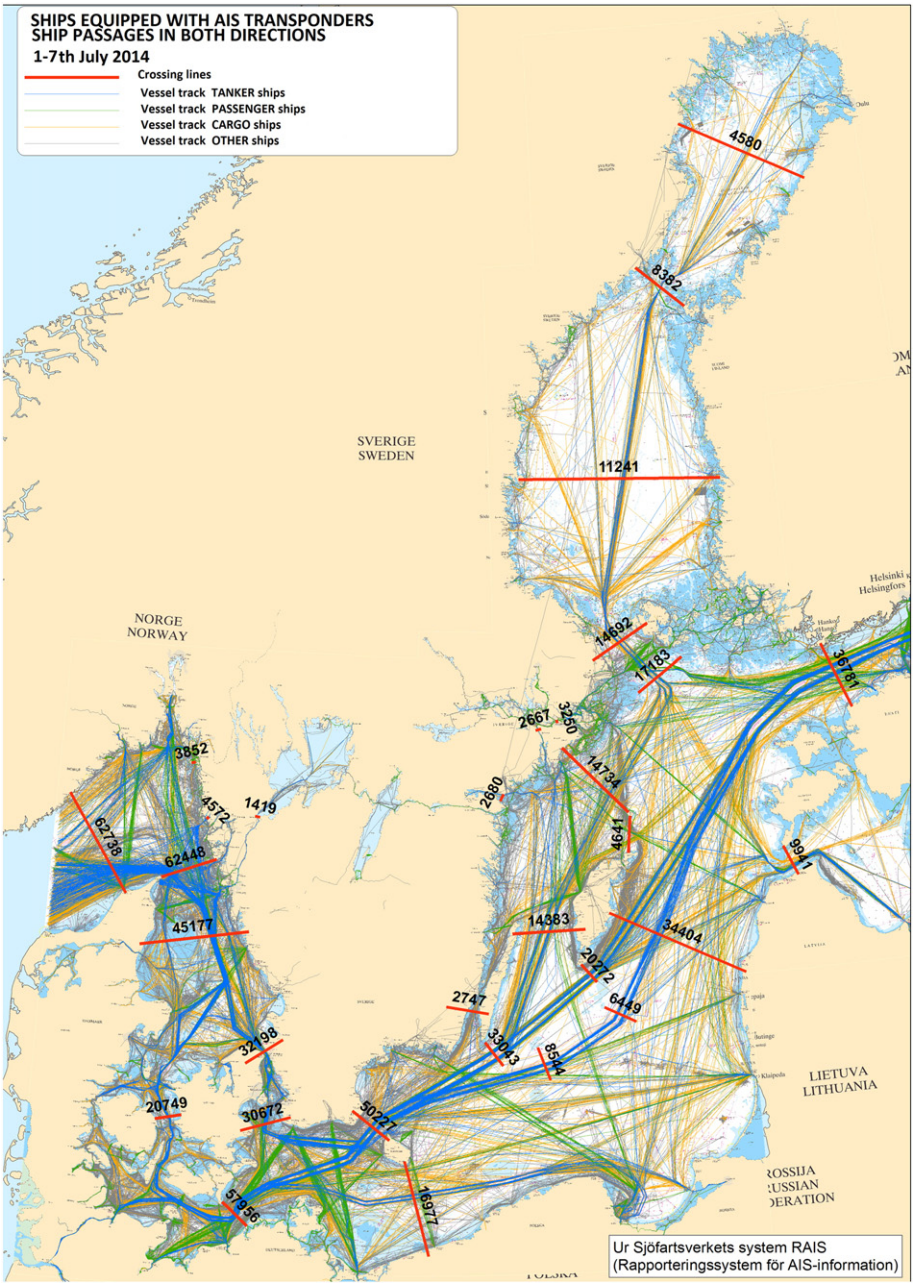

Fig. 1. Number of ships, equipped with AIS transponders, crossing over passage lines in the Baltic Sea during the first week of July 2014. The numbers refer to ship passages in both directions (SMA, 2015). Courtesy of Swedish Maritime Administration. Used with permission.

with a recurrent internal loading of nutrients, and death of benthic organisms (HELCOM, 2007). In general, phosphorus is considered a limiting factor for primary production in freshwater, whereas nitrogen is a limiting factor in seawater. In brackish water, the limiting factor can vary depending on the supply and state of the ecosystem (Ackefors and Enell, 1994). Nitrogen enters the Baltic Sea from both air and waterborne sources, while phosphorus only from waterborne sources. Nutrient pollution is currently recognized as one of the major environmental issues of the Baltic Sea (HELCOM, 2013). Eutrophication contributes to deterioration of oxygen conditions in the Baltic Sea deepwater. It has been reported that a 10-fold increase of low-oxygen areas in the Baltic Sea is mainly related to increased inputs of nutrients from land, although climate warming also contributes to the worsening oxygen conditions (Carstensen et al., 2014).

It is estimated that about 2000 ships transit the Baltic Sea waters at any given time (HELCOM, 2010). Approximately 15% of the world's cargo transportation occurs in this area (HELCOM, 2009).

1.2. Regulations and recommendations

Necessary steps must be taken to improve the environmental status of the Baltic Sea. Countries in the Baltic Sea region have agreed on the Baltic Sea Action Plan to manage human activities for restoring the good ecological status of the Baltic marine environment by 2021 (HELCOM, 2007). One of the goals of the plan is “Baltic Sea unaffected by eutrophication”. HELCOM recommendations, European Union (EU), and national legislation aim to reduce nutrient pollution from point sources on land. Besides, the International Maritime Organization