# Testing ballast water exchange efficiency

On its 65th voyage (leg 130) from Rotterdam, The Netherlands to Sept Iles, Canada, four biologists joined Berge Nord to study organisms in the ship's ballast water, and ways to reduce the delivery of exotic marine organisms to the Great Lakes of North America.

**This is the last of two articles about ballast water research on Berge Nord, contributed by captain A.K. Pandey (Berge Nord), Kate Murphy and Melinda Bednarski (Smithsonian Environmental Research Center in Maryland, USA), Stefan Heinemann and Dr. Martina Doblin (Old Dominion University in Virginia, USA).**

The experiment was hosted on Berge Nord by captain Ashok K. Pandey, his officers and crew – all of whom helped make the experiment a great success.

The goal of the experiment on Berge Nord was to test the ability of mid-ocean ballast water exchange to expel or kill organisms in the ballast tanks. To achieve this goal, we also measured the physical dilution efficiency of the exchange process – that is, the extent to which the original (coastal) water was replaced by new (open-ocean) water.

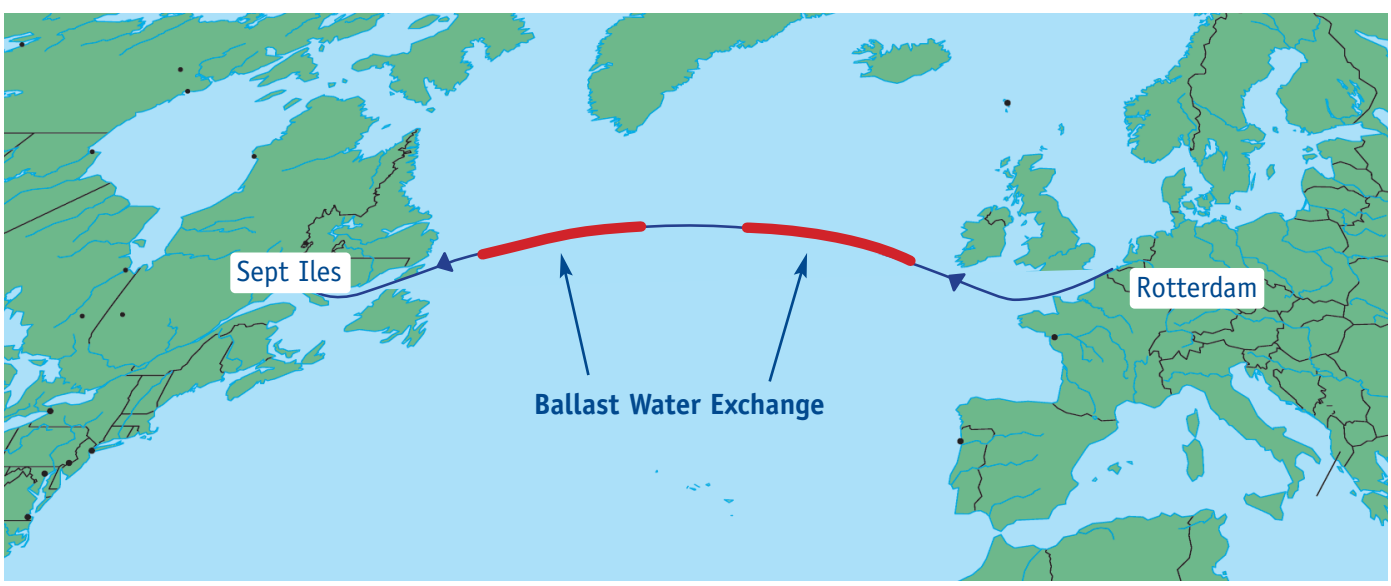
## Measuring exchange

Ballast water exchange was conducted on Berge Nord once the vessel was 200 nautical miles southwest of the British Isles. First, the coastal water in the tanks was dropped to 20 per cent under gravity. Oceanic water was then simultaneously pumped into the bottom of the tanks while the excess overflowed from the deck hatches. With two pumps operating, it took Berge Nord almost 24 hours to flush four dedicated ballast tanks each with three tank volumes of ocean water, in accordance to the IMO guidelines for the "flow-through" method.

Exchange efficiency was measured using two types of water tracers. While the ship was berthed in Rotterdam, non-toxic fluorescent dye and tiny fluorescent beads were added to the empty ballast tanks. During the first days of the voyage, these tracers mixed with the coastal ballast water and thereafter served as markers of its displacement from the ballast tanks. The dye showed that 95 per cent of the coastal water in tank 3 (port) and 86 per cent of the coastal water in tank 5 (starboard) was replaced during ballast water exchange.

## Two groups of ballast tanks

We decided to concentrate our sampling efforts on six of the eight large wing ballast tanks on Berge Nord. The six experimental tanks were first divided into two groups. The first group was designated "treatment tanks" – these tanks would undergo ballast water exchange as soon as the vessel entered water at least 200 nautical miles or more offshore




*Cruise track of Berge Nord during ballast water experiments.*

*Samples from the ballast tanks were processed in a temporary laboratory on ship*

and not less than 2,000 metres deep. The second group was designated "control tanks" – these would not be exchanged until the last possible moment before arrival in Sept Iles.

By staggering exchanges of the two groups of ballast tanks, two crucial goals were achieved: First, the un-exchanged "control tank" would serve as a reference against which the exchanged "treatment tanks" could be assessed. Second, this schedule gave the team enough time to collect water from each of the tanks before and after they underwent exchange, as well as time to implement other short-term experiments.

## Analyses

A range of equipment was deployed in the ballast tanks of Berge Nord. While a few analyses could be completed onboard, most of the time was spent collecting samples to be analysed using specialised instruments in the laboratory.

Melinda and Kate gathered zooplankton (microscopic animals), since they were interested to learn whether coastal species would be flushed out of the tanks at the same rate as the dye and bead tracers. Despite their small size, most zooplankton have some ability to swim, sink, or stick to surfaces –

*Cages containing tiny crabs were deployed in ballast tanks*

behavior which can affect their retention in tanks during ballast water exchange.

Stefan's and Martina's research concentrated on bacteria, viruses and phytoplankton (microscopic algae). These micro-organisms are natural components of marine food webs, and while most species are benign, some can be harmful to humans. Viruses and bacteria have relatively short generation times, which could allow them to rapidly recover from potential losses imposed by ballast water exchange. On Berge Nord, bacteria abundance increased after ballast water exchange, but virus abundance decreased. This result suggests that there was a die-off of bacteria in ballast tanks before exchange. Exchange then replenished the bacteria population with healthy cells and caused a decrease in virus abundance.

## A part of the solution

Bergesen has co-operated with scientists studying ballast water exchange since 1998, when Berge Nord first hosted scientists from the Maurice Lamontagne Institute of Quebec. The experiment on Berge Nord would not have been possible without the cooperation of Bergesen and financial support from the Great Lakes Protection Fund.

Cooperation among shipping industry leaders, environmental agencies, and scientists is fundamental to the development of sound policies concerning ballast water issues. Since it is hoped that ballast water exchange will be superseded by more effective treatments, studies like this one provide a baseline against which competing technologies can be evaluated.